

**MASTER**

**The Effect of Personality on the Effectiveness of a Robotic Mindfulness Coach**

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# **The Effect of Personality on the Effectiveness of a Robotic Mindfulness Coach**

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Identity number: 0957864

In partial fulfilment of the requirements for the degree of  
**Master of Science in Human-Technology Interaction**

Supervisors:  
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## Abstract

Mental health disorders have always been a topic of interest for both researchers and psychologists, as they make a large contribution to the total of diseases worldwide. Since the COVID-19 pandemic, the mental health and well-being of people all around the world have been affected. The demand for mental health care support has reached a new peak level and the need for new innovative interventions to give this support is increasing. Mindfulness could be such an intervention. Mindfulness is a relatively new psychological intervention, and its goal is to create and maintain self-awareness by disengaging oneself from beliefs, thoughts or emotions. Ultimately, this should lead to a stronger emotional balance and well-being. Even though mindfulness has several benefits, the practice of it can be challenging and inaccessible due to the lack of trained teachers and training programs (Bodala, Churamani & Gunes, 2020). Social robots in the form of a mental health coach could be a solution to this problem. However, when practicing mindfulness, one of the main components that make it effective is the attitude of the individual practicing (Shapiro et al., 2006). Therefore, the personality of a robot might be of importance as it can significantly influence the attitude that the user has towards the robot, both positively and negatively. The topic of robot personality and a robotic mindfulness coach have never been studied before. This study aims to close this research gap by investigating the effect of different personalities (dominance-submissive, introvert-extravert) on the effectiveness of a robotic mindfulness coach.

A laboratory experiment with a 2x2 between-subjects design was conducted ( $N = 46$ ). The independent variable was the personality of the robot. The dependent variable was the mindfulness state of the participant, measured through a self-report. In total there were four conditions. In each of the conditions the personality of the robot was manipulated in such a way that it either had a dominant-extravert, dominant-introvert, submissive-extravert, or a submissive-introvert personality. Participants practiced mindfulness exercises together with the robot for approximately 10 minutes. The results of this study showed that the mindfulness state of all participants significantly increased after participating with the robotic mindfulness coach. However, the personality of the robot did not have a significant effect on participants' mindfulness state. Additionally, no evidence was found for the similarity-attraction-hypothesis, which states that a robotic mindfulness coach is more effective when its personality matches the personality of the user.

**Keywords:** Social Robots, Personality, Mindfulness, Human-Robot-Interaction

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# 1. Introduction

## 1.1 Mental Health and Mindfulness

Mental health has always been a topic of interest for both psychologists and scientists. The World Health Organization (WHO, 2004, p. 10) defines mental health as “a state of well-being where the individual realises their own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and can make a contribution to their community”. People that experience mental health issues often have difficulties with their capacity to be productive and make a positive contribution to society. The recent COVID-19 pandemic has presented a severe challenge to mental health globally and a growing body of evidence has suggested that there has been a significant rise in mental health concerns among both the general population and vulnerable groups (Vadivel et al., 2021). In a recent study conducted by Ravens-Sieberer, Kaman, Erhart, Devine, Schlack and Otto (2022), an assessment of the effect of the COVID-19 pandemic on the quality of life and mental health of children and adolescents in Germany has been conducted. They found that children and adolescents experienced more mental health issues (17.8% vs. 9.9%) and greater anxiety levels (24.1% vs. 14.9%) than before the pandemic. Notably, children from low socioeconomic backgrounds, migration backgrounds, and limited living space were affected to a greater extent. In another study by Liu et al. (2021), a meta-analysis on seventy-one published papers focusing on mental health was performed. These papers reported results for populations all over the world. It was found that mental health problems including anxiety, depression, post-traumatic stress disorder, and insomnia suddenly increased after the COVID-19 outbreak.

As a consequence of the increasing numbers in mental health issues world-wide, it is very important that we implement new health promotion and prevention strategies to maintain or improve individual's mental health. One promising psychological state that has received a great deal of attention, and can be used as a method to deal with mental health issues is mindfulness. The goal of mindfulness interventions is to foster greater awareness of the present moment in order to help us better manage our daily life experience and to better deal with unexpected life events. However, there is still an ongoing dialog about how to properly define mindfulness as a state. One way to define mindfulness would be “an inherently state of consciousness which involves consciously attending to one's moment-to-moment experience” (Shapiro, Carlson, Astin & Freedman, 2006, p. 374). The majority of individuals has lost this process of awareness of the present moment experience in their daily life, as we often find our minds wandering unintentionally. Besides, we often strive for suppressing unwanted experiences and run our daily life on automatic pilot. This, what we call ‘mindless state’, can have undesirable outcomes on our daily life experience. Killingsworth and Gilbert (2010) showed that our minds are being lost in thought approximately 47% of the time, which predicts for subsequent unhappiness. On the other hand, the ability to be present and fully engaged in the moment is linked to greater overall well-being and satisfaction in one's daily life (Brown & Ryan, 2003).

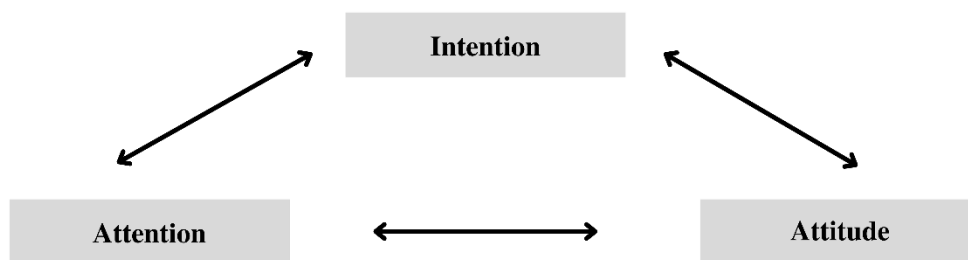
Mindfulness itself is a very complex construct. There have been several efforts to establish a good definition and to determine the components of which mindfulness is made. Multiple models that explain the effects of mindfulness on overall mental health have been proposed, including potential mechanisms of mindfulness that could possibly explain its clinical efficacy. According to Farb, Anderson and Segal (2021), emotion regulation is one of the main mechanisms that make mindfulness effective. At the same time, an increase in metacognitive awareness (Grabovac, Lau & Willett, 2011), affective adaption - the process of weakening emotional responses over time (Uusberg, Uusberg, Talpsep & Paaver, 2016), and

reducing negative reactivity (Huston, Garland & Norman, 2011) are all mechanisms found to explain the effects of mindfulness practice. However, most of this research focused on clinical studies. There are only a few studies that have tried to establish an empirically tested model to explain the complexity of mindfulness as a construct.

The first and most referenced model to explain the effects of mindfulness was reported by Shapiro, Carlson, Astin and Freedman (2006). They looked for possible mechanisms that explain how mindfulness produces positive change in an individual’s well-being. They propose three components of which mindfulness consist; (1) intention, (2) attention, and (3) attitude. The first component intention is crucial for understanding the process of mindfulness as a whole. At the same time, it is the central component of mindfulness. According to the authors, mindfulness practice is only effective if it includes some kind of personal intention. This means that the individual practicing should know or have a vision of why they are doing the practice. The second component attention is all about observing one’s internal and external experiences, moment-to-moment. This form of attention to self is critical to restore one’s mindfulness state. The final component of the mindfulness model is attitude, and has to do with how we attend the mindfulness practice. When practicing mindfulness, it is important to be aware of your own attitude towards the practice. One should try to be patient, compassionate, and non-striving to the mindfulness practice. By doing so, one can develop the capacity to deal with negative experiences and not try to continually strive for enjoyable experiences. The mindfulness model suggests that (1) intentionally (2) attending with (3) adopting an open and non-judgemental attitude can lead to a major change in one’s perspective, often referred to as ‘reperceiving’. This shift in perspective may lead to four different mechanisms that explain the effectiveness of mindfulness: self-regulation: maintaining one’s stability of functioning, values clarification: recognizing what is meaningful to oneself, flexibility: more flexible and adaptive responding to one’s environment, and exposure: experiencing strong emotions with greater objectivity.

**Figure 1**

*The three components of mindfulness (Shapiro, Carlson, Astin & Freedman, 2006).*



## 1.2 Mindfulness-Based Interventions

As mentioned before, a large portion of studies on mindfulness have concentrated on examining the effectiveness of mindfulness-based techniques in clinical settings. This line of research has suggested that mindfulness-based interventions are effective for treating psychological symptoms. Demarzo et al. (2015) showed that mindfulness can be a promising method for improving mental health and increasing overall quality of life, whereas Eisendrath et al. (2016) showed that mindfulness practice can significantly decrease depression symptoms. Similarly, Garland and Howard (2013) found that mindfulness-based-

interventions can significantly decrease perceived stress and posttraumatic avoidance symptoms, and increase one's positive state of mind.

Since the early 2000's there has been dramatic increase in published studies that compare different mindfulness-based interventions. One of the most prominent mindfulness interventions in the scientific literature is the mindfulness-based stress reduction program (MBSR) (Creswell, 2017). This is an 8-week intervention that consists of weekly group-based classes and daily audio-guided home practice among other things. The program makes use of mindfulness exercises such as body scans, body stretching, and breathing exercises, and centres on utilizing a state of mindfulness in everyday experiences and managing stress. The last thirty years, MBSR has stimulated the development of other mindfulness-based interventions that have a similar program to MBSR, but are modified to treat specific mental health symptoms. For example, Mindfulness-Based Cognitive Therapy (MBCT) focusses on treating depression symptoms (Kuyken et al., 2010). There are also shorter mindfulness-based interventions ranging from days to weeks. Research has even suggested that a brief 10-minute meditation session can already have positive effects on a person's mental health. Norris, Creem, Hendler and Kober (2018) investigated the effects of a 10-minute meditation session on attention. Participants that listened to a 10-minute meditation tape performed better at some tasks compared to the control participants. The results supported the hypothesis that even a short meditation session improves allocation of attentional resources. In another study performed by Burnett, Philips and Tashani (2017) it was hypothesized that a 10-minute mindfulness intervention performed by a professional would have a positive effect on pain responses in participants. The control group had to sit in between two cold pressors for 10 minutes. The mindfulness intervention group also sat between the two cold-pressors, but practiced 10 minutes of mindfulness in-between the tasks. They used breathing meditation techniques that were instructed by the professional. The results suggest that even a single 10-minute mindfulness meditation intervention guided by a professional can decrease anxiety towards pain, but also improve pain tolerance and pain threshold.

### **1.2.1 Mindfulness Home Practice**

All mindfulness-based interventions are build on therapists or professionals that provide the mindfulness sessions to patients. However, these MBI's also encourage the home practise of mindfulness, as this supports the development of the learned skills. They even consider home-practise to be an essential component of the intervention because it should increase the therapeutic effects of the intervention (Quach, Gibler & Jastrowski Mano, 2017). The problem however, is that these home-practises are a neglected research area, and have rarely been investigated. In response to this, Lloyd, White, Eames and Crane (2018) conducted a systematic review in which they evaluated controlled studies on mindfulness-based interventions which specifically measured home-practice, published until June 2016. In the end there were only seven studies that examined the relationship between the practice of mindfulness at home, and its clinical outcomes. Out of seven, only four studies found that mindfulness home practice actually improved the clinical outcomes. This emphasizes the importance of a therapist of professional for mindfulness-based interventions.

## **1.3 Mindfulness in Human-Robot-Interaction**

### **1.3.1 Robots in Society**

Research has shown that mindfulness practice can be a promising intervention to deal with mental health issues. However, it is important that this mindfulness practice can be delivered by therapists or professionals. Currently, there is a substantial gap between the need for mental health treatment and the availability of these treatments. This is mainly due to growing amount of individuals dealing with mental health issues, and the lack of trained professionals (Lee & Lee, 2021). The recent COVID-19 pandemic made the access to healthcare workers even harder, as direct person-to-person contact was being avoided (Vadivel et al., 2021). As a result, the pandemic has helped accelerate the development of technology in many industries, including health care. Even though the digital age already pushed the healthcare sector into innovations for contactless services and applications, the pandemic has accelerated this process by about 10 years (Kilic & Marin, 2020).

Raje et al. (2021) highlighted the importance of the emerging role of robotic application in the health care sector. Not only does the introduction of robots in the healthcare sector protect the healthcare workers from getting exposed, this also decreases the need for trained professionals as robots can partially take over some medical roles. Over the last ten years, advancements in robotics technology have led to the creation of robots that are increasingly able to coexist and interact with humans in our society (Niculescu et al., 2013). One of the most common examples of these robots are social robots that are designed to provide care for elderly. Examples of such care robots are PHAROS, a robot that helps people with physical exercises (Martinez-Martin, Costa & Cazorla, 2019); Care-O-bot II, a robot that helps elderly with everyday tasks such as making the bed (Graf, Hans & Schraft, 2004); and GUARDIAN, a project in which a robot acts as both a companion and caregiver for elderly so that they can live independently for a longer time (Margaritini et al., 2022). Research has also shown that robot therapy can be an effective method to improve overall well-being. The seal robot PARO is a companion robot for non-pharmacological therapy. The robot is used in non-pharmacological therapy for patients with specific goals. The robot has proved to be a meaningful support tool in non-pharmacological activities for individuals of all ages, and serves the role of a therapist. In one study, patients diagnosed with dementia received therapy from PARO (Shibata & Coughlin, 2014). The results showed that the therapy had positive effects on both cognitive and physical rehabilitation. In a more recent study conducted by Støre et al. (2021), the Somnox sleep robot is used to give physical and auditive guidance to calm down the users' breathing. The results suggested that the sleep robot is a method and potential treatment option for people with insomnia. Therapeutic robots have also been used as a treatment for children that are diagnosed with cancer. In a study conducted by Alemi, Meghdari, Ghanbarzadeh, Moghadam and Ghanbarzadeh (2021), ten children aged 6-10 were randomly assigned into two groups. A NAO robot was employed as a robotic therapist to assist a psychologist in one of the groups. The results showed that the robot was a promising factor in decreasing the level of anger, depression, and anxiety in children diagnosed with cancer.

### **1.3.2 Mindful Robots**

Social robots could also be used as a promising method to deliver mindfulness practice to individuals. Currently, virtual conversational agents already exist in the form of mobile applications and chat-bots. One of the most well-known mindfulness apps is called



HeadSpace<sup>1</sup>. On this app, people can receive guided meditation practices. No research has been conducted on the effectiveness of such apps as a method to deal with mental health issues. A limited amount of studies have been conducted on the effectiveness of delivering mindfulness through a social interactive robot with the capabilities of speech and gestures. In one study, the use of robots to deliver mindfulness sessions is investigated (Bodala, Churamani and Gunes 2006). They carried out a 5-week study on mindfulness, in which two separate groups participated in mindfulness sessions once a week, led by both an experienced human coach and the Pepper robot. The mindfulness sessions delivered by both the human coach and Pepper led to positive feedback from the participants for all the sessions. However, it was observed that the participants consistently rated the interactions with the human coach as highly favourable across all aspects, whereas the interaction with Pepper was not rated as high on all aspects such as communication. It was also found that the personality traits of the participant influenced the perceptions of the robot coach. Robot-assisted mindfulness practice has also been studied by means of a Brain-Computer-Interface system (Alimardani, Kemmeren, Okumura and Hiraki, 2020). Two group of users engaged in a meditative vs. non-meditative human-robot interaction. EEG signals from both groups were collected. The results showed that there was an increased sensory awareness and open monitoring in the meditative condition. Additionally, both groups indicated an improved mood after the robot interaction. Axelsson, Bodala and Gunes (2021) used a qualitative approach to study the effectiveness of a robotic well-being coach. In their study they invited both prospective users and experienced health coaches to discuss the design of such a robotic well-being coach in individual interviews and focus group discussions. Among other things, the advantages and disadvantages of a robotic well-being coach were discussed. A robot was seen to have the potential advantage of being more accessible than a human coach. Additionally, a robot's physical presence was seen as an advantage over mobile apps. Even though robotic mindfulness coaches are very promising, more research is necessary to establish the benefits of such robots. This study aims to further investigate the effectiveness of a robotic mindfulness coach.

#### **1.4 Robots and Personality**

One aspect that might be of high importance for a robotic mindfulness coach is the personality of the robot. The last twenty years, robot personality has started concerning scientists. Nass et al. (1995) were pioneers in studying the effects of aligning an artificial agent's personality to that of a human. More specifically, they examined if the similarity attraction hypothesis, which posits that people with similar personality traits are drawn to each other, also applies to artificial agents such as computers. In their study, they created computers with two different personalities, one dominant one and one submissive one. The results showed that participants preferred the computer with a personality that resembled their own. The dominant behavior was defined by attributes such as self-confidence, leadership, assertiveness, strength, and taking charge. On the contrary, submissive behavior was associated with self-doubt, weakness, passiveness, and obedience.

The link between robots and personality has been studied by many others afterwards. Hiah et al. (2013) explored the interaction between humans and an intelligent walk-in closet by simulating dominant and submissive behaviours and analysing the corresponding human reactions. The personality of participants was also measured. A surprising effect was found, where participants with a dominant personality reported feelings of submissiveness towards the dominant walk-in closet, and participants with a submissive personality felt more

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<sup>1</sup> <https://www.headspace.com/>

dominant towards the submissive walk-in closet. Furthermore, it was found that a submissive system was generally more preferred by users. This is in line with the results found in the study performed by Fong et al. (2003), who hypothesized that a compelling personality will increase a robot's likeability. The reasoning behind this lies in the fact that agreeability is a personality trait of submissiveness rather than dominance. Hence, a submissive robot shows more compelling behavior compared to a dominant robot. In another study, the relation between preferred level of user control and robot personality has been studied (Meerbeek, Hoonhout, Bingley & Terken, 2006). In this study, an application named 'iCat' was developed that helped users find an interesting TV-show. The application showed either introverted or extraverted personality traits. Overall, the most preferred combination was an extraverted and friendly personality with low user control.

There is a rich amount of studies available that discuss the topic of robot personality. However, Mileounis, Cuijpers & Barakova (2015) were the first ones to investigate the topic of personality with an actual humanoid robot. They studied the effect of two personality traits, dominance and extroversion, on a humanoid NAO robot. In their study, participants were asked to cooperate with the robot to play the game "Who wants to be a millionaire". After each condition, participants completed a modified version of the Godspeed questionnaire (Bartneck, Croft & Kulic, 2008) concerning several personality traits of the robot. The results suggest that there is a significant effect of dominance and extroversion on the perceived social intelligence of the robot. The dominant robot was characterized as less socially intelligent, emotionally expressive, and likeable compared to the submissive robot. It was assumed that the cooperative nature of the submissive behavior was primarily responsible for this outcome. Similarly, the introvert robot was characterized as less socially intelligent, emotionally expressive, and likeable compared to the extravert robot. A potential explanation for this outcome might be attributed to the verbal feedback and gestures that were present in the extravert condition. These were limited or absent in the introvert condition. This study also tested the similarity-attraction hypothesis by letting participants fill in a personality questionnaire before the experiment. There was no significant effect found that could indicate that the similarity attraction hypothesis holds.

The use of humanoid robots to investigate the role of robot personality has been studied by many after. In a more recent study conducted by Paetzel-Prüsmann, Perugia and Castellano (2021), participants played a game together with a Furhat robot to investigate the effect of robot personality on uncanny feelings. The robot displayed two personalities; optimistic and encouraging or impatient and provocative. The results of the study suggest that a robot that is more agreeable, emotional stable, and conscientious can weaken uncanny feelings in its user. So far, research on robot personality has shown that the personality of a robot can significantly influence the perception of the robot, both positively and negatively. Similarly, the personality of the user can significantly influence the perception of the robot. When practicing mindfulness, one of the main components that make it effective is the attitude of the individual practicing (Shapiro et al., 2006). When the individual's attitude is negatively affected by the robot's personality, it could be possible that the practice becomes less effective. Therefore, it would be very interesting to combine robot personality and mindfulness practice into one study, to test the influence of robot personality on mindfulness.

## **1.5 Research Gap**

The research on mindfulness revealed a selection of studies showing that mindfulness practice can be an effective intervention for improving overall mental health. Research has also shown that robots are a promising method of delivering mindfulness to individuals. However, the research on mindfulness in HRI remains limited. In fact, there is only one study

that investigated mindfulness delivered by a humanoid robot, with the capabilities of speech and gestures (Bodala et al., 2006). In this study, the mindfulness sessions with a human guide were rated overall higher compared to the mindfulness sessions with a robotic guide. However, more research would be necessary to study the effectiveness of a robotic mindfulness coach. Furthermore, research has shown why personality might be an important aspect in mindfulness and human-robot-interaction. This study will be the first HRI study to combine the topic of robot personality and mindfulness.

## 1.6 Current Study

This study aims to investigate whether and to what extent brief mindfulness practice can be delivered by a robot. This study will also investigate whether the personality of a robot influences the effectiveness of the mindfulness practice. The personality traits that will be studied are dominance and extraversion, as these have shown to be successfully applied to robots before (Mileounis et al., 2015). Hence, the main research question of the study is as follows:

*“How does the personality of a robot influence the effectiveness of a robotic mindfulness coach based on the dominance-submissive and extroversion-introversion personality traits?”*

In order to establish a hypothesis for this research question, it is important to break it down into two components; the effectiveness of the mindfulness practice and the personality of the robot. The first component, the mindfulness state of an individual, will be measured by means of a self-assessment. Research on the second component, the personality of the robot, has suggested that users prefer a submissive robot over a dominant robot (Hiah et al., 2013; Fong et al., 2003; Mileounis et al., 2015). Similarly, research suggests that users prefer an extraverted robot over an introverted robot (Meerbeek et al., 2006; Mileounis et al., 2015). Hence, the following two hypotheses have been formulated:

*H1.* The interaction with a robotic mindfulness coach will be more effective for the robot with a submissive personality compared to the robot with a dominant personality. Thus, submissive behavior will result in a higher increased mindfulness state compared to dominant behavior.

*H2.* The interaction with a robotic mindfulness coach will be more effective for the robot with a extravert personality compared to the robot with an introvert personality. Thus, extravert behavior will result in a higher increased mindfulness state compared to introvert behavior.

This study will also test the similarity-attraction hypothesis. Therefore, the following sub-question has been formulated:

*“Is a robotic mindfulness coach more effective when its personality matches the personality of the user?”*

Previous research has suggested that the similarity-attraction hypothesis holds for HRI, in such way that users prefer to interact with a robot that has a similar personality to theirs (Nass et al., 1995). Hence, the hypothesis corresponding to the sub-question is as follows:

*H3.* The robotic mindfulness coach will be more effective when the personality of the robot matches the personality of the user.

*Note:* This study will focus on a brief 10-minute mindfulness practice. Hence, there is a possibility that this time will be too short to show an effect for the self-assessment of users' mindfulness state before and after the practice. With an eye on future research, this study will also measure the users' psychophysiological measures, which has become an increasingly used biomarker in mindfulness-based intervention research (Christodoulou, Salami & Black, 2020). Research has shown that an increased heart rate variability (HRV) is associated with self-regulation and skills necessary to manage thoughts, emotions, and goals (Christodoulou et al., 2020). Similarly, a decrease in skin conductance (SC) has shown to be related to lower levels of stress (Storm et al., 2002). The psychophysiological data that will be collected falls outside the scope of the analyses of this study and will only be collected to support future research in this field.

## 2. Method

### 2.1 Design

The experimental design of this study was a 2x2 between-subjects design. The independent variable was the personality of the robot. The mindfulness state of the participants, as measured through self-reports, was the dependent variable. In total there were four conditions, where each participant was assigned to one of the conditions. In each of the conditions, the personality of the robot was manipulated in such a way that it either had a dominant-extravert, dominant-introvert, submissive-extravert, or a submissive-introvert personality. The dominant-submissive spectrum of the personality concerned the assertiveness of the robot, and the extravert-introvert spectrum concerned the expressiveness of the robot in the following way. The dominant robot used strong and confident language while the submissive robot expressed uncertainty (see Table 1). In addition, the pitch of the voice of the robot was manipulated in such way that the dominant robot sounded more serious (low-pitch voice) and the submissive robot sounded more insecure (high-pitch voice). The extroversion-introversion spectrum of the personality was designed through changing the intensity of the expressiveness of the robot by using either gestures or no gestures, emotions or no emotions and changing the speech rate. Figure 2 shows which cues were manipulated per personality condition. Table 1 shows examples of expressions that were used by the robot in either the dominant or submissive condition. In Appendix B, the full dialog including all the manipulations are shown.

**Figure 2**

*An overview of the personality traits that were manipulated in each of the four personality conditions.*

1. Dominant-Extrovert	2. Dominant-Introvert	3. Submissive-Extrovert	4. Submissive-Introvert
Low-pitch speech Assertive	Low-pitch speech Assertive	High-pitch speech Insecure	High-pitch speech Insecure
Gestures Emotions High-speed speech Talkative	No gestures No emotions Low-speed speech Less talkative	Gestures Emotions High-speed speech Talkative	No gestures No emotions Low-speed speech Less talkative

**Table 1**

*An overview of expression examples used in the dominant-submissive personality spectrum.*

	Dominant (assertive)	Submissive (insecure)
Example expressions used by robot	"I am sure you will enjoy this session."  "I want you to perform them with me today."	"I am a little bit nervous, but I think we will be fine."  "I am a bit worried that you did not like the session."

## 2.2 Participants

For this study, the required sample size was determined by means of R Superpower, aiming for an alpha level of  $\alpha = .05$  and power of  $1 - \beta = .90$ . In order to justify the effect size, reported effects on similar self-report measures were analysed. Two effects were taken into account: the effect of a robotic mindfulness coach, and the effect of robot personality. Since the latter is the more critical assumption, the effect size of the study of Mileounis et al. (2015) was taken as a reference. In their study, an effect size of  $f=0.57$  gave an a priori estimated sample size of  $n=48$  for fixed effects of ANOVA (12 participants in each condition). The effect size used is considered big by Cohen, so it was decided to increase the sample size to  $n = 60$ . A sensitivity analysis for  $n=60$  gives an effect size  $f=0.5$ , which translates to an observable difference of 0.8 on a 7-point Likert scale.

This study aimed for a sample size of 60 participants, but eventually the experiment was completed by 46 participants (28 females; 16 males; 2 prefer not to say). Their ages ranged from 18 to 35 ( $M = 22.8$ ,  $SD = 3.3$ ). Most participants completed high school as their highest degree of education (18 out of 46) and were either still studying or working. Most of the participants were recruited using the JSF participant database. Some of the participants were recruited via convenience sampling using the researcher's own network. Participants were required to be sufficiently skilled in English language (both understanding and speaking), and they could not be severely visually nor auditorily impaired. No other exclusion criteria was applied. Participants were paid €10 for their participation with an additional €2 bonus for participants outside of the TU/e. Alternatively, participants were paid in course credits.

## 2.3 Materials & Setting

### 2.3.1 Robot

For this study, participants would practise mindfulness exercises that were delivered by a robot. The robot that was used in this study is the Misty II robot. Figure 3 shows an image of the robot. The Misty II robot is able to play audio files, make head- and arm movements, and is capable of displaying various facial expressions, specifically through the use of different eye expressions on its screen. These applications were all necessary in order to make a distinction between the four different personalities of the robot. Hence, Misty II was a suitable robot for this study. It also has many more applications but they were not needed for this particular experiment.

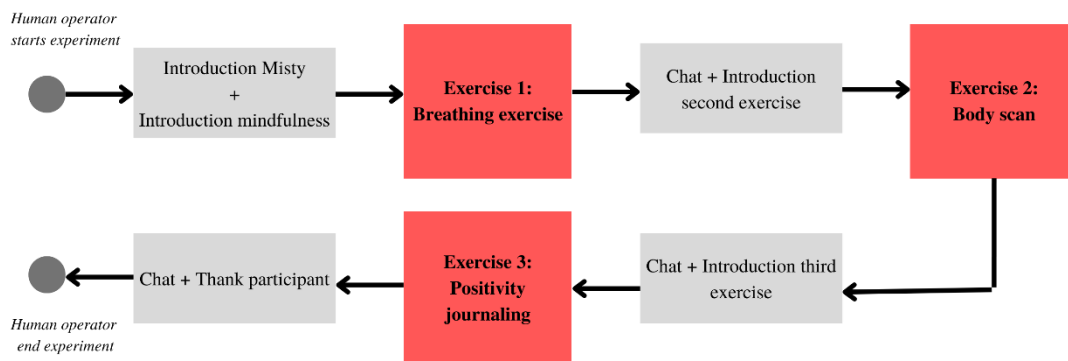
### Figure 3

*Image of the Misty II robot.*



Misty was programmed using Python, following the guidelines provided in Misty Robotics' documentation<sup>2</sup>. The robot was connected through the local network at the TU/e and its actions were controlled through Python code. For each personality of the robot a new script was created. Hence, four different scripts were created. Visual Studio Code<sup>3</sup> was used to run the Python scripts, that can be found in the Supplementary Materials or online at the Open Science Framework. Misty did not operate autonomously, but was controlled using the Wizard of Oz method. This method is used to let participants believe that Misty operates autonomously, but in reality it is controlled by a human operator. The human operator would start the mindfulness session by clicking on a button. It would then listen to the interaction between the participant and Misty, and click on the right button that would give the next corresponding response. Figure 4 shows the overall flow of the experiment.

**Figure 4**  
*The flow of the experiment.*



### **Speech**

The content of Misty's speech was almost the same in all the conditions. However, it slightly varied based on personality traits. In the dominant condition Misty used more assertive phrases, whereas Misty used more insecure phrases in the submissive conditions. The content of Misty's dialog can be found in Appendix B. All of Misty's speech was generated from audio files that were pre-recorded and uploaded to Misty's local database. The audio files were generated by the paid version of an online Text-To-Speech engine<sup>4</sup>. The online engine allows to change voices, but also parameters such as speaking pitch and speaking rate. For this study a robot-like voice named 'Ivy' was chosen. To generate a difference in voice-pitch, the pitch was set to -20% in the two dominant conditions whereas the pitch in the two submissive conditions was set to 0%. Similarly, the speech rate was set to 'slow' in the two dominant conditions, whereas the speech rate was set to 'normal' in the two submissive conditions. These values were chosen because increasing the pitch and rate in the submissive conditions would lead to a somewhat unnatural voice.

<sup>2</sup> <https://docs.mistyrobotics.com/>

<sup>3</sup> <https://code.visualstudio.com/>

<sup>4</sup> <https://ttsmp3.com/>

### ***Facial Expressions***

Misty has a collection of pre-configured facial expressions that were labelled by the robot designers. Facial expressions were used in order to emphasize Misty's emotion in the two extravert conditions. The facial expressions could only be displayed in between the mindfulness exercises, as the participants closed their eyes during the exercises. Since the possibility to use facial expressions was limited in terms of timing, only a happy facial expression was chosen from Misty's database. The used facial expression is shown in Figure 5. In the two introvert conditions, in which the robot did not have to be expressive in terms of emotions, it would not show any facial expressions.

**Figure 5**

*Facial expression used to emphasize Misty's happy emotion.*



### ***Movement***

The final personality trait that was manipulated was the use of gestures made by the robot in the two extravert conditions. This was done by manipulating the movements of the robot. Misty is capable of moving its arms up and down, and it can also move its head in terms of yaw, pitch, and roll. In the two introvert conditions, in which the robot did not have to be expressive in terms of gestures, it would not move while guiding the session. Its arms were in a neutral position, and its head yaw, pitch and roll were set in such way to make it look like the robot was making eye contact with the participant. In the two extravert conditions, movements were used to emphasize the expressiveness of the robot. Misty would raise its arms when saying something exciting and it would raise one arm when greeting the participant. Additionally, Misty would tilt its head left and right when asking the participant a question. Again, these gestures were only used in between the mindfulness exercises, where participants had their eyes open.

### **2.3.2 Mindfulness Exercises**

During the interaction with Misty, participants would perform a set of three mindfulness exercises that were guided by the robot. The mindfulness exercises were the same across all conditions, and based on similar exercises that are part of MBSR training. The first exercise that participants would perform was a three-minute breathing exercise. During this exercise, participants would try to shift their attention on their breathing rhythm. The second exercise that participants would perform was a body-scan exercise. During this exercise, participants would try to shift their attention towards different parts of the body while deeply breathing in and out. The final exercise that participants would perform was a positivity-journaling exercise. During this exercise, participants were asked to reflect back on a positive event that happened during that week, and focus their attention on the feeling that specific event was giving. The exact content of the exercises can be found in the dialogs in Appendix B.

### **2.3.3 Mobi3 Device**

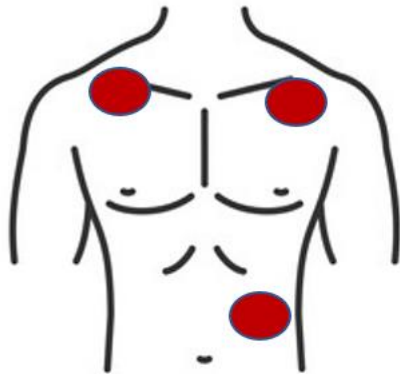
During the entire session with Misty, the heart rate variability (HRV) and skin conductance



(SC) of the participants were monitored using the Mobi3 device. The device was located in the room with participants and operated by the experimenter via Bluetooth. The Mobi3 device uses three ECG sensors to measure the HRV and two GSR sensors to measure skin conductance. The GSR sensors were positioned on the ring- and middle finger of the right hand. Figure 6 shows the position of the three ECG sensors. Note that the psychophysiological data is outside the scope of the analyses in this study, but is collected for possible future research.

**Figure 6**

*Visual representation of the position of the three ECG sensors.*

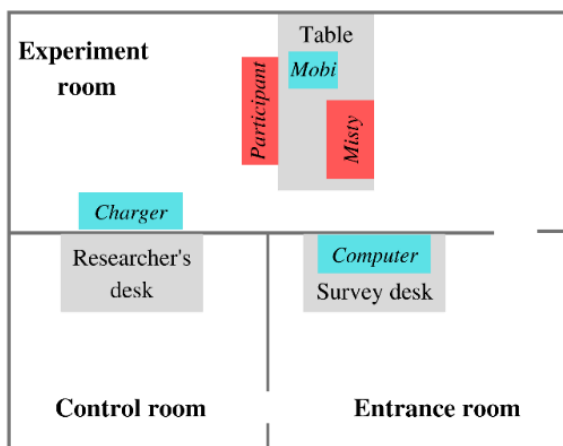


### 2.3.4 Experimental Set-Up

The experiment was conducted in the social robotics lab in the Atlas building on TU/e grounds. Figure 7 shows an overview of the experimental setup in the lab. Participants were seated at a table in front of Misty. Misty had a fixed position throughout the experiment in which it would look slightly right so it would make eye contact with the participant as soon as the experiment started. The Mobi3 device would be ready on the table, and the wires would be attached to the participant once they were seated. Misty's charger was also located in the room, but only used in-between participants as it produces a loud noise while charging.

**Figure 7**

*A visual representation of the social robotics lab in the Atlas building of the TU/e.*



## 2.4 Measurements

To find out whether the personality of the robot would influence the effectiveness of the mindfulness exercises, participants were instructed to fill out a number of questionnaires via Limesurvey<sup>5</sup>. Participants would fill in a questionnaire before and after the interaction with Misty. The questionnaires started by asking the participant for a participant number. This was done to connect the questionnaires to the same participant in the end. The first questionnaire, that was filled in before the interaction with Misty, started with a short demographic questionnaire that covered information about the participant’s gender, age, and highest level of education. The demographic questionnaire was followed by a personality questionnaire, which was used to assess the personality of the participant, and a mindfulness questionnaire to measure participants’ mindfulness state. After the experiment participants repeated the mindfulness questionnaire, and filled in a robot personality questionnaire. All questionnaires can be found in Appendix A.

### *Personality questionnaire*

The first questionnaire that was used is the participant personality questionnaire. It consists of 48 items and uses a 5-point Likert scale, with 1 being the lowest and 5 the highest. This questionnaire has been used before in the study performed by Mileounis et al. (2015), and measures both a persons’ dominance and extraversion. Table 2 shows which personality traits are addressed by the questionnaire. The questionnaire was needed in order to answer the third hypothesis by testing the effect of the robot personality on the effectiveness of the mindfulness session when controlling for the participant’s personality respectively. Participants filled in this questionnaire before interacting with the robot.

**Table 2**

*Personality traits and corresponding items addressed by the questionnaire.*

<b>Introvert-Extravert (18 items)</b>	<b>Dominant-Submissive (30 items)</b>
Silent-Talkative (4 items) (q 1-4)	Dominance (8 items) (q 19-26)
Shy – Not shy (4 items) (q 5-8)	Assertive (7 items) (q 27-33)
Introverted-Extraverted (6 items) (q 9-14)	Forceful (3 items) (q 34-36)
Inward – Outgoing (4 items) (q 15-18)	Domineering (6 items) (q 37-42)
	Submissive (6 items) (q 43-48)

### *Mindfulness state questionnaire*

The second questionnaire that was used is the Cognitive and Affective Mindfulness Scale-Revised (CAMS-R) (Feldman, Hayes, Kumar, Greeson & Laurenceau, 2007). This questionnaire measures participant’s mindfulness state by asking them to reflect back on their thoughts, and is used to answer the first hypothesis. The CAMS-R is written in everyday language, so it is understandable for everyone, including people that are not familiar with the concept mindfulness. The original questionnaire consists of 10 items with a 4-point Likert scale, ranging from ‘Not at all’ to ‘Almost always’. For this experiment two of the original items were removed. These are the items ‘*I can tolerate emotional pain*’ and ‘*I am able to pay close attention to one thing for a long period of time*’. The experiment only lasted for fifteen minutes, and the mindfulness questionnaire was used both before and after the

<sup>5</sup> <https://www.limesurvey.org/>

experiment. In this short amount of time it is difficult to detect a difference for the items that were removed. Accordingly, the item ‘*I can usually describe how I feel at the moment in considerable detail*’ was re-written to ‘*I can describe how I feel at the moment in considerable detail*’. Additionally, a 7-point Likert scale was used in order to be able to measure a smaller difference in mindfulness state before and after the experiment. The scale ranges from ‘Almost never true’ to ‘Almost always true’.

***Robot personality questionnaire***

The final questionnaire that was used in this study is a modified version of the Godspeed questionnaire by Bartneck et al. (2009), and is used to assess participant’s general impression of Misty. The questionnaire consists of 33 items that describe seven different dimensions and uses a 5-point Likert scale ranging from ‘Strongly disagree’ to ‘Strongly agree’. In this modified version of the Godspeed questionnaire the anthropomorphism and safety dimensions are replaced by extraversion, dominance, and emotion. This way, the questionnaire can be used to validate the personalities of the robot. Additionally, the questionnaire measures the animacy, perceived intelligence, likeability and social intelligence dimensions, and will be used for exploratory research. Table 3 shows the robot personality traits and items that are addressed by the questionnaire.

**Table 3**

*Robot personality traits and corresponding items addressed by the questionnaire.*

<b>Animacy (q 1-6)</b>	<b>Perceived- Intelligence (q 7-11)</b>	<b>Emotion (q 12-15)</b>	<b>Likeability (q 16-20)</b>	<b>Social- Intelligence (q 21-23)</b>
Lively	Skills	Understanding	Friendliness	Cooperation
Stagnant	Knowledge	Compassion	Kindness	Persuasion
Mechanical	Responsibility	Stability	Pleasantness	Awareness
Artificial	Intelligence	Energy	Niceness	
Interaction	Rationality		Likeability	
Responsiveness				

<b>Extraversion (q 24-28)</b>	<b>Dominance (q 29-33)</b>
Talkative	Final word
Shyness	Seriousness
Expressive	Confidence
Outgoing	Forceful
Attention	Domineering

## 2.5 Procedure

The participant had to go through several stages during the experiment. First, the participant was welcomed in the social robotics lab, where the researcher would explain the procedure of the experiment. Then, they were requested to take a seat and read and sign the informed consent form for the study (Appendix C). After that, the participant was asked to fill out the questionnaire that was already available on the computer screen in front of them. When the participant was finished with the first questionnaire, they were asked to follow the researcher into the experiment room (Figure 4). There they were seated at a table in front of Misty. The researcher would explain to the participant that they were going to have an interaction with the robot for approximately 10 minutes. The researcher would then attach the sensors of the Mobi3 device to the participant’s body and leave the room. During the experiment, the researcher was located in the control room, where it would operate Misty using the Wizard of Oz method. After the interaction with Misty ended, the researcher would enter the experiment room to detach the sensors from the participant’s body. Participants were instructed to return to the entrance room, where they would fill in the final questionnaire.

Once all steps were successfully completed by the participant, the researcher went back to the entrance room to have a short conversation about their experiences with the Misty robot. During this conversation, the researcher would always ask the participant how they evaluated their interaction with Misty. Finally, participants were debriefed and thanked for their participation. They would receive their compensation before taking off.

## 3. Results

### 3.1 Descriptive Statistics

Table 4 shows the descriptive statistics of the demographic variables used in this study. The first three variables were directly taken from the survey. The last variable named ‘experience’ was retrieved during the interaction that the participants had with the robot. The robot would ask all participants “*Are you familiar with the concept mindfulness?*”. The answers of the participants were collected by the researcher and added to the dataset manually.

**Table 4**

<b>Variable</b>	<b>Obs</b>	<b>M</b>	<b>SD</b>	<b>Min</b>	<b>Max</b>	<b>Total</b>
Age	46	22.85	3.27	18	35	-
<u>Gender</u>	46	.43	.58	-	-	
Female						28
Male						16
Prefer not to say						2
<u>Education</u>	46	1.35	1.20	-	-	
High school						18
Bachelor (HBO)						3
Bachelor (University)						3
Master Degree						9
<u>Experience</u>	46	.83	.71	-	-	
No						16
Little bit						22
Yes						8

### 3.2 Reliability Analysis

For the first part of the analysis, the questionnaires were analysed to measure the internal consistency between the items. A Cronbach's alpha reliability test was conducted on all questionnaires. The results are shown in Table 5. For all questionnaires, all the items were eventually used in the analysis, since the removal of certain items did not improve the alpha of the factor significantly. The final factor scores for the participant- and robot personality questionnaire were computed by averaging the values of the items that describe each factor in the questionnaire. The final score for the mindfulness questionnaire was computed by summing the values of each item.

**Table 5**

*Reliability analysis on mindfulness, participant-, and robot personality questionnaires.*

Factors	Cronbach's Alpha
<b>Mindfulness questionnaire</b>	
Mindfulness state (8 items)	.75
<b>Participant personality questionnaire</b>	
Introvert-Extravert (18 items)	.87
Dominant-Submissive (30 items)	.83
<b>Robot personality questionnaire</b>	
Animacy (6 items)	.73
Perceived Intelligence (5 items)	.67
Perceived Emotion (4 items)	.47
Likeability (5 items)	.85
Social Intelligence (3 items)	.73
Extraversion (5 items)	.41
Dominance (5 items)	.56

#### 3.2.1 Manipulation Check

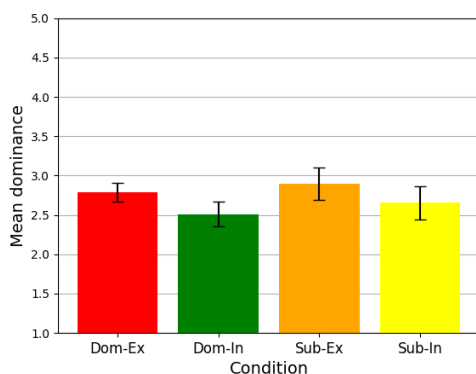
Before continuing with the analysis, it was important to check whether the robot personality was achieved in each condition. In other words, it needed to be verified whether the dominance and extraversion traits were perceived by the participants as such. Therefore, the participants filled in the robot personality questionnaire. Among other things, the questionnaire measures the dominance and extraversion of the robot. As shown in Table 4, the Cronbach's alpha reliability test resulted in an alpha value of  $\alpha = .41$  for extraversion and  $\alpha = .56$  for dominance. Both values represent a low internal consistency of the items, meaning that the items do not measure dominance and extraversion well. It is still interesting to check how the participants scored the robot personality on these items. First, a one-way ANOVA was performed to compare the effect of the four different conditions on dominance. The one-way ANOVA revealed that there was no statistically significant difference in mean

dominance scores between any group ( $F(3,42) = [.910]$ ,  $p = .445$ ). This is further illustrated in Figure 8, and suggests that the dominance traits of the robot were not perceived as such by the participants. Next, a one-way ANOVA was performed to compare the effect of the four different conditions on extraversion. The one-way ANOVA revealed that there was a statistically significant difference in mean extraversion scores between at least two groups ( $F(3,42) = [11.56]$ ,  $p < .001$ ). A Tukey's test with follow-up post hoc estimated margins around the means found that the mean value of extraversion was significantly different between the "Dominant-Introvert" and "Dominant-Extravert" condition ( $p < .001$ , 95% C.I. =  $[-1.50, -.515]$ ), the "Submissive-Extravert" and "Dominant-Introvert" condition ( $p = .000$ , 95% C.I. =  $[.346, 1.33]$ ), and the "Submissive-Introvert" and "Dominant-Introvert" conditions ( $p < .001$ , 95% C.I. =  $[.260, 1.27]$ ). This suggests that the extraversion traits of the robot were perceived as such, especially in the dominant condition. This is further illustrated in Figure 9, which shows the average perceived robot extraversion per condition.

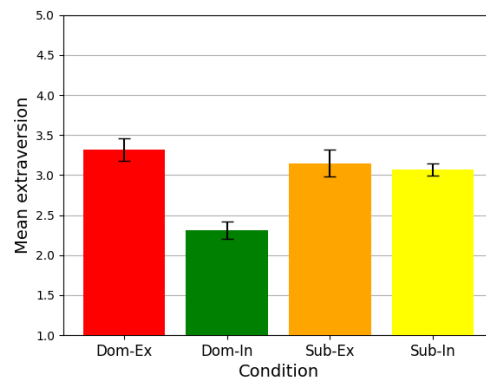
To further investigate this, it is interesting to take a look at the perceived animacy (liveliness of the robot) and perceived emotion of the robot in each condition, as both traits were used to emphasize the extraversion of the robot. A one-way ANOVA was performed to compare the effect of the four different conditions on animacy and perceived emotion. The one-way ANOVA revealed that there was no statistically significant difference in mean perceived emotion scores between the conditions ( $F(3,42) = [0.31]$ ,  $p = .819$ ). A Shapiro-Wilk test for normality revealed that normality was rejected for the animacy variable ( $p = .005$ ). Therefore, a Kruskal-Wallis test was conducted and revealed that there was also no statistically significant difference in mean animacy scores between conditions ( $\chi^2 = 5.22$ ,  $p = .156$ ). Even though there was no significant effect found, Figure 10 and 11 show that both animacy and emotion score highest in the two extravert conditions. This supports the idea that extraversion traits were indeed perceived as such by the participants.

Despite the fact that the manipulation check did not yield the desired results, it was decided to continue with the analysis because the manipulation check was not the only indicator of the validity of the study. The manipulation check only assesses one aspect of the study and there were other factors, such as the experimental design, that were well controlled. Furthermore, the manipulation check revealed that the manipulation was not completely ineffective, and there were still some significant effects found in the dependent variables. Therefore, the analysis will still provide valuable insights and contribute to the existing literature on this topic.

**Figure 8**  
*Average perceived robot dominance per condition using standard errors.*

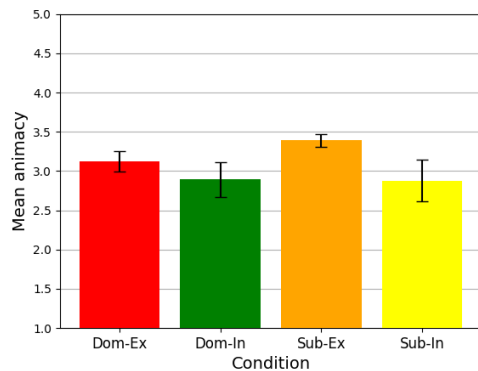


**Figure 9**  
*Average perceived robot extraversion per condition using standard errors.*



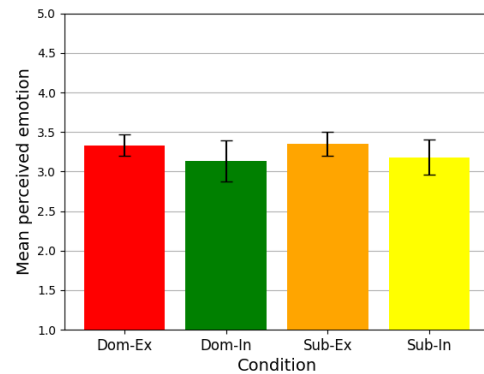
**Figure 10**

*Average robot animacy per condition using standard errors.*



**Figure 11**

*Average perceived robot emotion per condition using standard errors.*



### 3.3 Hypotheses Analysis

#### 3.3.1 Mindfulness

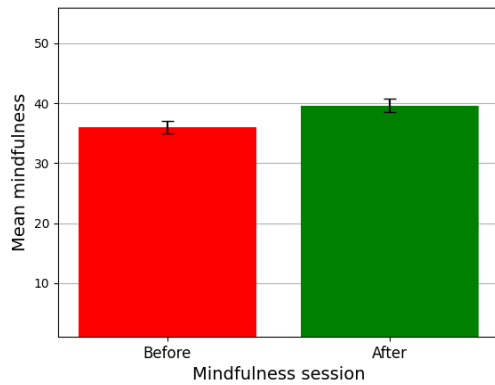
The first research question of this study was formulated as follows: *“How does the personality of a robot influence the effectiveness of a robotic mindfulness coach based on the dominance-submissive and extroversion-introversion personality traits?”*

The first thing that is worth investigating, is whether or not the overall mindfulness of all participants has been improved after the interaction with the robot. The average mindfulness scores before and after the experiment for all participants are depicted in Figure 12. The figure shows that the mindfulness state of participants increased after the experiment. A simple t-test on the difference between the means of the mindfulness scores before and after the experiment was performed. First, the normality assumption was checked for the difference in mindfulness score by means of a skewness and kurtosis test. The results showed that the normality assumption was met ( $p > 0.05$ ). The variable was also checked for outliers, based on the z-scores  $> 3.00$  threshold. There was one participant with a z-score higher than  $-3.00$ . This person had a score of  $-13$  for the difference in mindfulness score, which seems odd compared to the rest of the data. Therefore, the rest of the analyses was run without this datapoint. The results of the t-test showed that there was a statistical significant difference in mindfulness score before and after the experiment ( $t(44) = -5.01, p < .001$ ). This implies that the mindfulness exercises that were delivered by the robot did have an effect on the participants’ mindfulness state. However, this analysis did not take the robot personalities into account and thus does not answer the initial research question.

Figure 13 shows the distribution of mindfulness scores before and after the experiment for each condition. The figure shows that the mindfulness scores increased in all conditions. To get a better overview of the intensity of the increase, the difference in mindfulness score before and after the experiment for each condition is depicted in Figure 14. Here it is easy to see that the increase in mindfulness score is not really high, given that they could have increased their scores with a maximum average of 19 points.

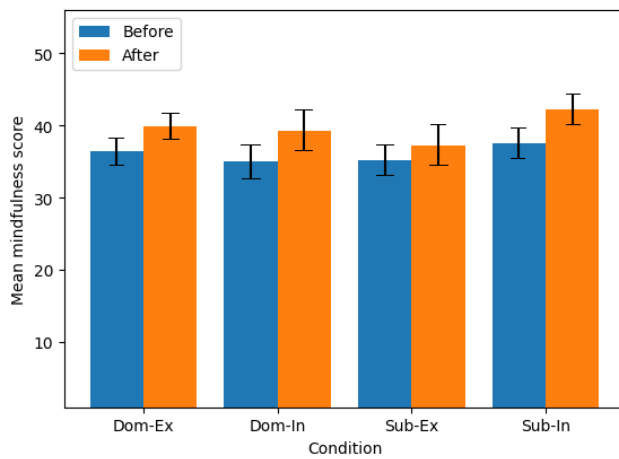
**Figure 12**

*Average mindfulness scores of all participants before and after interaction with the robot using standard errors, \*\*  $p < .01$ .*



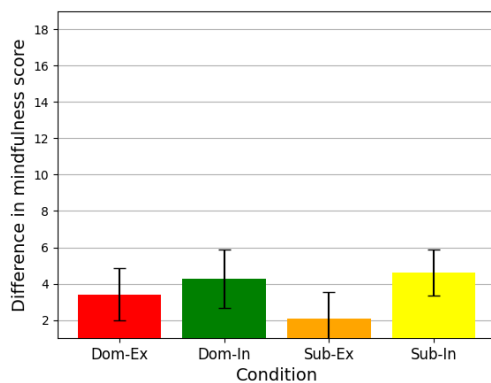
**Figure 13**

*Average mindfulness scores before and after interaction with the robot for each condition using standard errors.*



**Figure 14**

*Difference in mindfulness scores before and after the interaction with the robot for each condition using standard errors.*





To answer the initial research question, an ANOVA was conducted to test the effect of the robot personalities on the difference in mindfulness scores. First, a possible interaction effect between the dominance and extraversion of the robot was closely inspected. An interaction effect would imply that the main effect of dominance depends on the extraversion of the robot and vice versa. Two new variables were created, with ‘robot dominance’ representing a 1 if the condition was either “Dominant-Introvert” or “Dominant-Extravert”, and ‘robot extraversion’ representing a 1 if the condition was either “Dominant-Extravert” or “Submissive-Extravert”. An ANOVA was run with difference in mindfulness score as the dependent variable and robot dominance, robot extraversion, and the interaction effect as the independent variables. The normality assumption was met for all variables. The model that was run was not significant ( $F(41, 3) = 0.59, p = .626$ ), with an adjusted  $R^2$  of  $-0.03\%$ . There was no significant main effect of dominance ( $p = .743$ ) and extraversion ( $p = .251$ ) found. Similarly, no significant interaction effect was found ( $p = .566$ ).

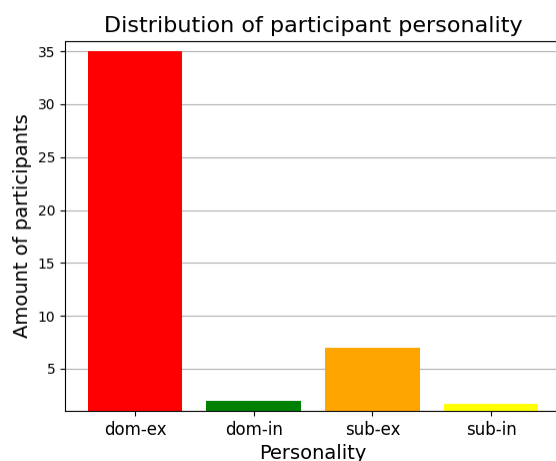
Since no significant interaction effect occurred, it was possible to run a one-way ANOVA with the mindfulness score difference as the dependent variable, and the four robot personalities as the independent variable. The model that was run revealed that there was no significant difference in mean of the difference in mindfulness scores between the robot personalities ( $F(3,41) = 0.59, p = .630$ ). Because the model was insignificant, a Tukey’s post-hoc test for multiple comparisons was not necessary. Additionally, mindfulness experience was also included in the ANOVA model to see if this would make a difference. Again, the normality assumption was met for the variable experience. The ANOVA model that was run was not significant ( $F(8, 36) = 0.81, p = .552$ ), with an adjusted  $R^2$  of  $-0.0225\%$ . Experience was also statistically insignificant ( $p = .334$ ).

### 3.3.2 Similarity-attraction hypothesis

This study also tested the similarity-attraction hypothesis. Therefore, the following sub-question was formulated: “*Is a robotic mindfulness coach more effective when its personality matches the personality of the user?*” The personality of the user was assessed by means of a personality questionnaire. Figure 15 shows the distribution of participant personality. Interestingly, almost all participants have a “Dominant-Extravert” personality (35 out of 45).

**Figure 15**

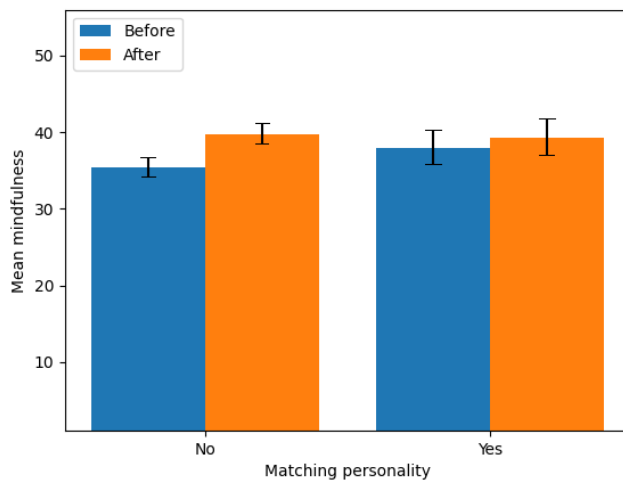
*Amount of participant with a ‘dominant-introvert’, ‘dominant-extravert’, ‘submissive-introvert’, and ‘submissive-extravert personality.’*



A new variable ‘matching personality’ was created, representing 0 if the participant had a different personality as the robot and representing 1 if the participant had the same personality as the robot. In total, 11 out of 45 participants interacted with a robot with the same personality as theirs. Figure 16 shows the average mindfulness scores before and after interaction with the robot for participants with a matching and non-matching personality with the robot. The figure already shows that the similarity-attraction hypothesis does not hold, as participants with a non-matching personality to the robot had a higher increase in mindfulness score compared to the participants with a matching personality to the robot. Still, it is possible that the opposite holds. In order to test this, it was planned to run an one-way ANOVA. However, the normality assumption was rejected for the ‘matching personality’ variable. Instead of running an ANOVA, it’s non-parametric alternative Kruskal-Wallis test was run. The analysis revealed a non-significant effect of matching personality on the difference in mindfulness scores ( $\chi^2(1) = 3.15, p = .076$ ). Even though the effect is not significant, we still observe a trend here, as the p-value is close to significant. Additionally, a simple t-test on the difference of mindfulness scores on matching personality was run to compare the means of the two groups. The t-test showed that there was a non-significant difference between the two groups ( $t(43) = 1.90, p = 0.07$ ). Again, the effect is not significant but we still observe a trend here.

**Figure 16**

*Average mindfulness score before and after interacting with the robot for participants with a matching and non-matching personality to the robot.*



## 4. Discussion

This study aimed to investigate the influence of personality on the effectiveness of a robotic mindfulness coach. Participants participated in a 10-minute mindfulness session with either a dominant-introvert, dominant-extravert, submissive-introvert, or submissive-extravert robot. According to the first hypothesis, the interaction with a robotic mindfulness coach would be more effective for the robot with a submissive personality compared to a dominant personality. According to the second hypothesis, the interaction with a robotic mindfulness coach would be more effective for the robot with an extravert personality compared to an introvert personality. After analysing the results, it was found that the mindfulness state of all participants significantly increased after participating with the robotic mindfulness coach. However, the personality of the robot did not have a significant effect on participants' mindfulness state. This is not in line with previous research on robot personality. Mileounis et al. (2015) found that a submissive robot was preferred over a dominant robot when playing a game together, and assumed that the cooperative attitude of the submissive behaviour is mainly responsible for this. Similarly, Paetzel-Prüsmann et al. (2021) found that the agreeableness, emotional stability, and conscientiousness of a robot can weaken uncanny feelings in its user. In both studies, the user played a game together with the robot. Hence, the agreeableness of the robot was probably more prominent present in these studies compared to our study. In this study, the submissive robot was not necessarily more cooperative or agreeable than the dominant robot, as this did not fit the context of the study. During the mindfulness session, participants mainly followed the instructions of the robot and did not have to work together with the robot. This could explain why there was no significant main effect found of dominance. Similarly, Mileounis et al. (2015) found that an extravert robot was preferred over an introvert robot. They attributed the gestures and verbal feedback in the extravert condition as a possible explanation for this. The gestures and verbal feedback were limited or absent in the introvert condition. In our study, the introvert robot was slightly less talkative and did not show any gestures compared to the extravert robot. However, all participants had to close their eyes during the mindfulness exercises given by the robot. This left very little space to incorporate gestures in the extravert conditions. Hence, it is possible that the difference between the extravert and introvert conditions was too limited to find a main effect of extraversion.

Another possible explanation for the results found in this study could be the way that the robot was generally perceived by the participants. After the experiment was ended, the researcher would always ask the participants "*How did the interaction with the robot go?*". A notable amount of participants would say that they thought the robot was 'very cute'. Participants would say this in all conditions. This could be due to the voice and appearance of the robot. The voice of the robot was purposely chosen to be a robot-like voice in order to avoid gender bias. At the same time, the Misty II robot has a very small body compared to its large scalp. The combination of these cues could result in a child-like robot, which possibly overshadows the dominance and extraversion of the robot.

The third hypothesis of this study tested the similarity-attraction hypothesis, and stated that a robotic mindfulness coach would be more effective when the personality of the robot matches the personality of the user. The results showed that the opposite holds; the mindfulness state of the participants increased more for participants that did not have the same personality as the robot. This effect was not significant (95% CI;  $p=.076$ ), but we still observed a trend here. The trend suggests that there may be a real effect, but it is not strong enough to be considered statistically significant. The effect may have become significant if more participants were included in the study. However, this result is not in line with previous research conducted by

Nass et al. (1995), which found that people are in favour of interacting with a computer system with a similar personality to theirs. At the same time, Taber, Leibert, Vaibhavee and Agaskar (2011) studied the effect of personality in a therapist-client setting. They found that personality-similarity between therapist and client was associated with the bond between therapist and client. This bond was in its turn associated with tasks and goals, which are associated with therapeutic results. In their study, participants interacted with a human therapist in at least 3 sessions. This is because previous research has shown that the therapeutic results are predicted by working alliance when it is measured between the third and fifth session (Horvath & Bedi, 2002). This can possibly explain why the similarity-attraction hypothesis does not hold in this study. Participants only interacted with the robotic mindfulness coach for 10-minutes in only one session. This timing might have been too short for participants to understand the personality of the robot and feel congruent with the robot. Another possible explanation as for why the similarity-attraction hypothesis does not hold in this study is the task context of the robot. Joosse, Lohse, Gallego and Evers (2013) studied the role of task context in perceived social robot personality as a response to two contradicting theories: next to the similarity-attraction hypothesis is the complementary attraction hypothesis. According to this theory, people prefer a robot with a personality that is opposite to their own. In contrast to both theories, the researchers argue that the appropriate personality for a robot actually depends on the context in which it is being used. Their study found that people's perceptions of what kind of personality is appropriate for a robot may depend on the task or role the robot is meant to perform. As a result, it may be necessary to adapt the personality of a robot to fit with users' expectations for the specific task or role it is meant to fulfil.

#### **4.1 Limitations & Future Research**

The first limitation of this study is that it remains unclear whether the chosen robot personalities were realistic in terms of speech. Even though the personality traits were based on prior research regarding the cues, no additional validation was performed prior to the experiment to confirm this. For example, the dominant robot had to be assertive, whereas the submissive robot had to be insecure. Several different sentences were incorporated for both conditions to make these personality traits realistic. However, the difference between these two may not have been as salient as they were intended to be. At the same time, the extravert robot was supposed to be more talkative than the introvert robot. This was hard to realize as the mindfulness exercises were similar across all conditions, and there was little room left for additional conversation. Although the extravert robot did have a few more sentences compared to the introvert robot, the difference might not have been enough. A manipulation check for the personalities has been conducted in this study, but only after the experiment. However, the reliability test for the robot personality questionnaire returned a low alpha value for both dominance and extraversion. Therefore it is hard to say whether or not the personalities were perceived by participants as intended. For future studies it would be better to do a manipulation check for the personalities beforehand instead of afterwards in order to avoid this problem.

The second limitation of this study is in line with the previous one, and has to do with the chosen personality types. This study only investigated the influence of the dominance and extraversion personality types, as these are most prominent in the literature. However, there are more personality types that might have an influence for this specific context. As discussed before, Joosse et al. (2013) argued that proper robot personalities depend on the context of the robot's role. Therefore, the personality of the robot should be adapted to user's expectations about what behaviours are consistent for a mindfulness coach. For future studies

it would be interesting to incorporate this aspect with for example interviews, before designing and testing the personalities.

An additional limitation of the study is the total duration of the experiment. The duration of the experiment was between 10 to 12 minutes, depending on the condition. This duration was chosen for two specific reasons. Firstly, previous research has suggested that even a single 10-minute mindfulness meditation can already result in improvements. Secondly, the total timing of the entire study did not allow for a longer experiment duration. Extending the duration of the experiment would result in a loss of participants. Initially no problems were foreseen with this duration, but after analysing the results timing might have been crucial for incorporating the personality traits. If the experiment was a bit longer, it would have been easier to make the difference in personalities more realistic.

A final limitation of this study is the fact that a Wizard of Oz method was used to control the robot. In other words, the researcher controlled the robot from a distance for the entire experiment. The researcher would listen to the conversation and enter the correct button whenever the robot had to speak. Although this made the participants believe that the robot operated autonomously, the response time of the robot was possibly not equal for each participant. If a similar study will be conducted in the future, it would be good to design an autonomous mindfulness robot, so that variations in response time are not possible and mistakes can be avoided.

To conclude, future research could incorporate psychophysiological measures as a dependent variable to investigate the effect of a mindfulness robot. The dependent variable used in this study was a self-report, which is prone to biases. It would be really interesting to see what effect a robot coach could have on users' heart rate variability and skin conductance.

## **4.2 Conclusion**

Personality has been a well established topic in the field of Human-Robot-Interaction, and has opened many doors for researchers. However, the topic of personality has not been studied in relation to robot coaches, especially a robotic mindfulness coach. This study aimed to investigate the influence of the dominance and extraversion personality traits on the effectiveness of a robotic mindfulness coach. This was done by letting participants interact with a robot to perform several mindfulness exercises, and manipulating specific robot personality traits such as speech pitch, speech rate, and gestures. Against expectations, the results showed that personality did not have an effect on the effectiveness of the robot coach. However, it is hard to attribute a cause to this. As the items used for the manipulation check were not reliable, it is possible that the personalities did not come across as intended. It is also possible that personality in fact does not have an effect in the context of robotic mindfulness coaches. Overall, the mindfulness state of all participants combined did significantly increase after the experiment. Again, no conclusions can be drawn on the reason for this. It could be attributed to the mindfulness exercise solely, but also to the combination of the mindfulness exercises and the robot. Further research is necessary to investigate this. Furthermore, no evidence was found for the similarity-attraction hypothesis. In fact, the opposite holds; the mindfulness state of the participants increased more when their personality did not match the personality of the robot, but this effect was not significant.

The insights gained in this study are a good basis for further research on Human-Robot-Interaction and mindfulness. It appears that robots are an effective tool to coach mindfulness, and can possibly be used as support or even replacement for human coaches in the future. However, more research is necessary on the effectiveness of such robot and on which types of personalities are appropriate in this specific context.

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# Appendix A Questionnaires

## A1. Demographics

\*What gender do you identify as?

- Male
- Female
- Other
- Prefer not to say

\*What is your age?

\*What is the highest degree or level of education you have completed?

- High school
- Bachelor's Degree (HBO)
- Bachelor's Degree (University)
- Master's Degree
- PhD. or higher
- Prefer not to say

## A2. Mindfulness State

Before experiment: Please indicate to what extent the following statements have applied to you **recently**.  
 After experiment: Please indicate to what extent the following statements apply to you **at this moment**.

	Almost Never True	Usually Not True	Sometimes but Infrequently True	Occasionally True	Often True	Usually True	Almost Always True
1. It is easy for me to concentrate on what I am doing.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. I can accept things that I can not change.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. I can describe how I feel at the moment in considerable detail.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. I am easily distracted.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. It is easy for me to keep track of my thoughts and feelings.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. I try to notice my thoughts without judging them.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. I am able to accept the thoughts and feelings that I have.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. I am able to focus on the present moment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

### A3. Participant Personality

Please rate the arguments listed below, on a scale from 1 (I completely disagree) to 5 (I completely agree), to the extent that these describe yourself.

	(1) Strongly Disagree	(2) Disagree	(3) Neither Disagree/Agree	(4) Agree	(5) Strongly Agree
1. When I am among several people I prefer to remain silent.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. I don't like to talk a lot.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Conversations or at meetings, I plan what I'm going to say before speaking.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Starting conversations makes me feel uncomfortable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. I don't like being the center of attention.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. It is difficult to approach others and talk about myself.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Being in a crowded place makes me feel uncomfortable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. I feel suffocated if I'm around people all the time.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. I prefer to do things in my life on my own.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. When I have free time I would rather spend time by myself than with others.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. In general, I prefer working alone than in a team.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. I offer my time, skills and knowledge freely to other people.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. When the topic of the conversation with others is not interesting I run away.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. I don't make friends easily.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15. I prefer to keep my feelings for myself and not share them, during a conversation, with other people.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16. I usually don't like to share my personal experiences or facts with other people.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17. It takes me a lot of time to feel comfortable opening up to other people.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18. When I have a problem, I prefer working it out on my own.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19. I always compare my accomplishments to those of other people.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20. I try to surpass others' accomplishments.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21. I am known as a controlling person.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
22. I see power as a way to improve my social status.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23. It bothers me when people outperform me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
24. When competing with someone, my sole focus is to beat them.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
25. I'm uneasy when I'm not the one in charge of a task.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
26. Losing makes me really upset.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
27. I like to take charge of a situation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

28. I try to lead others.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
29. I can talk others into doing things.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
30. I seek ways to influence others.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
31. I like to take control of things.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
32. I want to control the conversation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
33. I am not afraid of providing criticism.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
34. I lay down the law to others.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
35. I demand explanations from others.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
36. I make demands on others.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
37. I boss people around.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
38. I try to impose my will on others.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
39. I like having authority over others.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
40. I insist that others do things my way.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
41. I challenge others' points of view.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
42. I am quick to correct others.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
43. I am easily controlled by others in my life.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
44. I let others take advantage of me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
45. I let myself be pushed around.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## A4. Robot Personality

Please rate the traits presented below, on a scale from 1 (lowest) to 5 (highest), in regards to the extent that these describe the robot you just interacted with.

	(1) Strongly Disagree	(2) Disagree	(3) Neither Agree/Disagree	(4) Agree	(5) Strongly Agree
1. The robot behaves as if it was alive.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. The robot is lively (moving a lot).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. The robot's behavior does not resemble a mechanical object, but an alive being.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. The robot looks lifelike.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. The robot is interactive.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. The robot is responsive.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. The robot has the skills required to help me advance during the session.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. The robot is knowledgeable enough to assist me during the session.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. The robot takes responsibility of its decisions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. The robot is intelligent enough to provide good explanations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. The robot provides rational arguments to support its explanations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. The robot can understand how I feel during the session.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. The robot is compassionate by emotionally supporting me during the session.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. The robot is emotionally stable during the session.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15. The robot is energetic throughout the session.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16. The robot exhibits a friendly behavior.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

17. The robot is kind and respects my opinion.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18. The robot is pleasant to interact with.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19. The robot's behavior is nice.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20. I like the behavior of this robot.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21. The robot was cooperative and helped me during the session.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
22. The robot provided convincing arguments to make me follow its instructions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23. The robot was able to understand the context of the session and act accordingly.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
24. The robot talked a lot.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
25. The robot tried to catch my attention.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
26. The robot expressed its feelings.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
27. The robot expressed its personal experiences.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
28. The robot was focussed on itself and not paying attention towards me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
29. The robot wanted to have the final word.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
30. The robot focused on the exercises and not having fun.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
31. The robot was confident about its explanations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
32. The robot tried to enforce something on me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
33. The robot did not like to be overruled.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## Appendix B Robot Dialog

### B1. Dominant-Extravert

<i>Dominant</i>	<i>Extravert</i>
Low-pitch speech Assertive	Gestures Emotions High-speed speech Talkative

Misty	Hello, nice to meet you [wave]. My name is Misty, and today I will be your mindfulness coach. <b>I am really excited to start this session with you.</b> First I would like to thank you for participating in this experiment. If you happen to feel uncomfortable at any moment during this experiment, you can just say the word 'stop'. The experimenter will enter the room and guide you further. Now, let's start our session. <b>I am sure you will enjoy this session.</b> Are you sitting in a comfortable position? [move head]	
User	R1: Yes	Path 1
	R2: No	Path 2
User input	No	Path 2

Misty	Please Make sure to make yourself comfortable and say yes if you are ready to move on. [smile and look happy]	
User	R1: Yes	Path 1

User input	Yes	Path 1
Misty	Great!-Okay [move both arms up] <del>I would like to</del> Let me ask you, are you familiar with the concept 'mindfulness'?	
User	R1: Yes	Path 3
	R2: No	Path 4

User input	Yes	Path 3
Misty	Good to hear! Okay. [smile] [move head] <del>Could you</del> Now shortly explain to me what mindfulness means to you.	
User	{User input}	Path 4

User input	No	Path 4
Misty	That is good to know. I will give you a short introduction on the concept of mindfulness. <del>Is that okay for you?</del> [move head]	
User input	{User input}	Path 4

User input	{User input}	Path 4
Misty	Okay. It is easy to lose awareness of what's happening with the body and brain in the course of our daily lives. For example, we have all experienced a wandering or blank mind. In fact, it is quite common to lose touch with thoughts and feelings throughout the day. That loss of connection with the here-and-now can generate psychological distress. The brain is prone to drifting towards unhelpful thinking processes. The practice of mindfulness can help bring us out of these unhelpful thinking patterns by focusing on the present moment. This can be done by performing several exercises, which we will practice together today. I have prepared a set of three exercises for you, and I want you to perform them with me today. <del>Please</del> Say yes if everything is clear and if you are ready to move on. If not, <del>please</del> say no and I will repeat the explanation on mindfulness for you.	
User	R1: Yes	Path 5
	R2: No	Repeat

User input	Yes	Path 5
Misty	Great! Let's move on. The first exercise that we will perform together is a 3-minute breathing exercise. During this exercise there is no need to move. I will guide you through the entire exercise. Are you ready? [move head]	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	<p>Okay. I am going to count to three, and on three I <del>would like</del> want you to gently close your eyes like this and take a moment to evaluate on your thoughts. [close eyes] Ask yourself, what is my experience right now? What thoughts are here? What feelings are present? What bodily sensations are present? And just allow these elements to be here. Not needing to change or alter them in any way.</p> <p>[short pause]</p> <p>Now that you are ready, try to shift your attention to the belly and the breath, and feeling the breath and the belly. Feeling the sensations of breathing. The rising of the belly on the in-breath and the falling of the belly on the out-breath. Try to feel it the best way you can, moment by moment. Breathing-in... Slowly breathing-out. Breathing-in... Slowly breathing out.</p> <p>[short pause]</p> <p>Now try to shift your attention back to your entire body. Allowing your attention to radiate outwards. Feeling the whole body sitting and feeling the whole body breathing. As you were breathing in and out, you might find your brain wandering. This is completely normal. Now I <del>would like</del> want you to shift your attention to your breathing rhythm. Please count your breath like this: 1 for breathing-in, 2 for breathing-out, 3 for breathing-in, 4 for breathing-out. We do this until we reach the 10, and then we start over.</p> <p>[short pause]</p> <p>Again, you might find your mind wandering while counting. This is completely fine. Just observe your thoughts and allow them to be there. Then try to shift your attention back to your breathing rhythm. 1 for breathing-in, 2 for breathing-out.</p> <p>[short pause]</p> <p>This was the end of the breathing exercise. Whenever you are ready, slowly open your eyes. [open eyes]</p>	
User	{User opens eyes}	Path 5

User input	{User opens eyes}	Path 5
Misty	You did great. <b>[smile and look happy]</b> How did this exercise feel for you?	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	Thank you for sharing that with me. We will now move on to the next exercise, which is called the “body scan”. Are you ready?	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	<p>Okay. During this exercise we will try to shift our focus to different parts of the body. Now try to bring your attention to your body and slowly close your eyes again like this. <b>[close eyes]</b> Notice your body seated. Notice the weight of your body on the chair and on the floor. You can take a few deep breaths. As you take a deep breath, allow the oxygen to flow through your entire body. And as you exhale, have a sense of relaxation. Notice your feet on the floor, feel the weight, pressure, the heat. Then notice your legs against the chair. Pressure, heaviness, lightness. Notice your back against the chair. Bring your attention to your stomach area. Is it tense? Let it soften. Take a breath. Notice your hands and their tightness. Allow them to soften and relax. Notice your arms. Feel any sensation in your arms. Allow your shoulders to feel relaxed. Now notice your neck and the rest of your face. Try to relax your jaw, and allow your face to feel soft. Then notice your whole body present. Take one more deep breath in and out. This was the end of the body-scan exercise. When you are ready, you can slowly open your eyes. <b>[open eyes]</b></p>	
User	{User input}	Path 5

User input	{User opens eyes}	Path 5
Misty	You did great. How did this exercise feel for you?	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	<p>Thank you for sharing that with me. So far, you have done a great job! <b>[smile and look happy]</b> <b>I already feel much calmer.</b> We still have one final exercise left. This final exercise is all about positivity journaling. Our mind is a very powerful construct. When we feel a bit down, or when we feel at unease with ourselves, we tend to have negative thoughts. Sometimes this happens purposely, but often this happens</p>	

	without us even noticing. <b>I sometimes have these thoughts as well.</b> During this exercise, we are going to try to fill our mind with positive thoughts. <b>I'm excited!</b> Are you ready? [move head]	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	<p>Great. Again, I would like to ask you to gently close your eyes. [close eyes] First, I would like you to take a few deep breaths in and out. Breathing-in through the nose, breathing-out through the mouth. Then, reflect back on the thoughts you had over the last few days. Were they positive? Or did you happen to have a few negative thoughts? There is no need to worry, both are completely fine. What is more important is that we can reflect on our thoughts, without becoming them.</p> <p>[short pause]</p> <p>Now that you have reflected back on your thoughts, I would like to ask you to think about a positive thing that happened to you during the past week. This can be anything. Even the fact that you have woken up is a positive event. Try to focus on this specific event and how it makes you feel while deeply breathing-in and out.</p> <p>[short pause]</p> <p>Now that we have reflected back on this event, I would like to ask you to think about one positive statement that reflects back to your situation. The statement should be in the I-form and should be in the present tense. This could be: I am confident that I will make it or I am going to succeed in what I want. Now think of your statement and repeat it 5 times. You can do this out loud, or you can do this in your head. Whatever feels comfortable for you.</p> <p>[short pause]</p> <p>Now you can slowly open your eyes when you feel ready. [open eyes] This was the end of the final exercise. <del>Thank you for making it up and until the end! I hope that you enjoyed this session.</del> What is your overall feeling after this session?</p>	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	<p>Okay. I want to thank you for participating in this experiment. <b>I had fun practicing with you and I feel really calm!</b> The researcher will enter the room to detach the equipment on your body and to give you further instructions. It was nice to meet you. Good bye. [wave]</p>	



## B2. Dominant-Introvert

<i>Dominant</i>	<i>Introvert</i>
Low-pitch speech Assertive	No gestures No emotions Low-speed speech Less talkative

Misty	Hello, nice to meet you. My name is Misty, and today I will be your mindfulness coach. First I would like to thank you for participating in this experiment. If you happen to feel uncomfortable at any moment during this experiment, you can just say the word 'stop'. The experimenter will enter the room and guide you further. Now, let's start our session. I am sure you will enjoy this session. Are you sitting in a comfortable position?	
User	R1: Yes	Path 1
	R2: No	Path 2

User input	No	Path 2
Misty	<del>Please</del> Make sure to make yourself comfortable and say yes if you are ready to move on.	
User	R1: Yes	Path 1

User input	Yes	Path 1
Misty	<del>Great!</del> Okay. I would like to <del>Let me</del> ask you, are you familiar with the concept 'mindfulness'?	
User	R1: Yes	Path 3
	R2: No	Path 4

User input	Yes	Path 3
Misty	<del>Good to hear!</del> Okay. <del>Could you</del> Now shortly explain to me what mindfulness means to you?	
User	{User input}	Path 4

User input	No	Path 4
Misty	That is good to know. I will give you a short introduction on the concept of mindfulness. <del>Is that okay for you?</del>	

User input	{User input}	Path 4
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User input	{User input}	Path 4
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Misty	Okay. It is easy to lose awareness of what's happening with the body and brain in the course of our daily lives. For example, we have all experienced a wandering or blank mind. In fact, it is quite common to lose touch with thoughts and feelings throughout the day. That loss of connection with the here-and-now can generate psychological distress. The brain is prone to drifting towards unhelpful thinking processes. The practice of mindfulness can help bring us out of these unhelpful thinking patterns by focusing on the present moment. This can be done by performing several exercises, which we will practice together today. I have prepared a set of three exercises for you, <b>and I want you to perform them with me today.</b> Please say yes if everything is clear and if you are ready to move on. If not, please say no and I will repeat the explanation on mindfulness for you.	
-------	--	--

User	R1: Yes	Path 5
	R2: No	Repeat

User input	Yes	Path 5
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Misty	<del>Great!</del> Let's move on. The first exercise that we will perform together is a 3-minute breathing exercise. During this exercise there is no need to move. I will guide you through the entire exercise. Are you ready?	
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User	{User input}	Path 5
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User input	{User input}	Path 5
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Misty	<p>Okay. I am going to count to three, and on three I <del>would like</del> want you to gently close your eyes like this and take a moment to evaluate on your thoughts. Ask yourself, what is my experience right now? What thoughts are here? What feelings are present? What bodily sensations are present? And just allow these elements to be here. Not needing to change or alter them in any way.</p> <p>[short pause]</p> <p>Now that you are ready, try to shift your attention to the belly and the breath, and feeling the breath and the belly. Feeling the sensations of breathing. The rising of the belly on the in-breath and the falling of the belly on the out-breath. Try to feel it the best way you can, moment by moment. Breathing-in... Slowly breathing-out. Breathing-in... Slowly breathing out.</p> <p>[short pause]</p> <p>Now try to shift your attention back to your entire body. Allowing your attention to radiate outwards. Feeling the whole body sitting and feeling</p>	
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	<p>the whole body breathing. As you were breathing in and out, you might find your brain wandering. This is completely normal. Now I <del>would like</del> want you to shift your attention to your breathing rhythm. Please count your breath like this: 1 for breathing-in, 2 for breathing-out, 3 for breathing-in, 4 for breathing-out. We do this until we reach the 10, and then we start over.</p> <p>[short pause]</p> <p>Again, you might find your mind wandering while counting. This is completely fine. Just observe your thoughts and allow them to be there. Then try to shift your attention back to your breathing rhythm. 1 for breathing-in, 2 for breathing-out.</p> <p>[short pause]</p> <p>This was the end of the breathing exercise. Whenever you are ready, slowly open your eyes.</p>	
User	{User opens eyes}	Path 5

User input	{User opens eyes}	Path 5
Misty	You did great. How did this exercise feel for you?	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	Thank you for sharing that with me. We will now move on to the next exercise, which is called the “body scan”. Are you ready?	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	<p>Okay. During this exercise we will try to shift our focus to different parts of the body. Now try to bring your attention to your body and slowly close your eyes again like this. Notice your body seated. Notice the weight of your body on the chair and on the floor. You can take a few deep breaths. As you take a deep breath, allow the oxygen to flow through your entire body. And as you exhale, have a sense of relaxation. Notice your feet on the floor, feel the weight, pressure, the heat. Then notice your legs against the chair. Pressure, heaviness, lightness. Notice your back against the chair. Bring your attention to your stomach area. Is it tense? Let it soften. Take a breath. Notice your hands and their tightness. Allow them to soften and relax. Notice your arms. Feel any sensation in your arms. Allow your shoulders to feel relaxed. Now notice your neck and the rest of your face. Try to relax your jaw, and allow your face to feel soft. Then notice your whole body present. Take</p>	

	one more deep breath in and out. This was the end of the body-scan exercise. When you are ready, you can slowly open your eyes.	
User	{User input}	Path 5

User input	{User opens eyes}	Path 5
Misty	You did great. How did this exercise feel for you?	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	Thank you for sharing that with me. So far, you have done a great job! We still have one final exercise left. This final exercise is all about positivity journaling. Our mind is a very powerful construct. When we feel a bit down, or when we feel at unease with ourselves, we tend to have negative thoughts. Sometimes this happens purposely, but often this happens without us even noticing. During this exercise, we are going to try to fill our mind with positive thoughts. Are you ready?	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	<p>Great. Again, I would like to ask you to gently close your eyes. First, I would like you to take a few deep breaths in and out. Breathing-in through the nose, breathing-out through the mouth. Then, reflect back on the thoughts you had over the last few days. Were they positive? Or did you happen to have a few negative thoughts? There is no need to worry, both are completely fine. What is more important is that we can reflect on our thoughts, without becoming them.</p> <p>[short pause]</p> <p>Now that you have reflected back on your thoughts, I would like to ask you to think about a positive thing that happened to you during the past week. This can be anything. Even the fact that you have woken up is a positive event. Try to focus on this specific event and how it makes you feel while deeply breathing-in and out.</p> <p>[short pause]</p> <p>Now that we have reflected back on this event, I would like to ask you to think about one positive statement that reflects back to your situation. The statement should be in the I-form and should be in the present tense. This could be: I am confident that I will make it or I am going to succeed in what I want. Now think of your statement and repeat it 5 times. You can do this out loud, or you can do this in your head. Whatever feels comfortable for you.</p> <p>[short pause]</p>	

	Now you can slowly open your eyes when you feel ready. This was the end of the final exercise. <del>Thank you for making it up and until the end! I hope that you enjoyed this session.</del> What is your overall feeling after this session?	
User	{User input}	Path 5
User input	{User input}	Path 5
Misty	Okay. I want to thank you for participating in this experiment. The researcher will enter the room to detach the equipment on your body and to give you further instructions. It was nice to meet you. Good bye.	

### B3. Submissive-Extravert

<i>Submissive</i>	<i>Extravert</i>
High-pitch speech Insecure	Gestures Emotions High-speed speech Talkative

Misty	Hello, nice to meet you [wave]. My name is Misty, and today I will be your mindfulness coach. <b>I am really excited to start this session with you.</b> First I would like to thank you for participating in this experiment. If you happen to feel uncomfortable at any moment during this experiment, you can just say the word 'stop'. The experimenter will enter the room and guide you further. Now, let's start our session. <b>I'm a little bit nervous, but I think we will be fine.</b> Are you sitting in a comfortable position? [move head]	
User	R1: Yes	Path 1
	R2: No	Path 2

User input	No	Path 2
Misty	Please make sure to make yourself comfortable and say yes if you are ready to move on. [smile and look happy]	
User	R1: Yes	Path 1

User input	Yes	Path 1
Misty	Great! <del>Okay</del> [move both arms up] I would like to- <del>Let me</del> ask you, are you familiar with the concept 'mindfulness'?	
User	R1: Yes	Path 3
	R2: No	Path 4

User input	Yes	Path 3
Misty	Good to hear! <del>Okay</del> [smile] [move head] Could you <del>Now</del> shortly explain to me what mindfulness means to you?	
User	{User input}	Path 4

User input	No	Path 4
Misty	That is good to know. I will give you a short introduction on the concept of mindfulness. Is that okay for you? [move head]	
User input	{User input}	Path 4

User input	{User input}	Path 4
Misty	Okay, I hope that my explanation will be clear to you. It is easy to lose awareness of what's happening with the body and brain in the course of our daily lives. For example, we have all experienced a wandering or blank mind. In fact, it is quite common to lose touch with thoughts and feelings throughout the day. That loss of connection with the here-and-now can generate psychological distress. The brain is prone to drifting towards unhelpful thinking processes. The practice of mindfulness can help bring us out of these unhelpful thinking patterns by focusing on the present moment. This can be done by performing several exercises, which we will practice together today. I have prepared a set of three exercises for you, <del>and I want you to perform them with me today</del> . Please say yes if everything is clear and if you are ready to move on. If not, please say no and I will repeat the explanation on mindfulness for you.	
User	R1: Yes	Path 5
	R2: No	Repeat

User input	Yes	Path 5
Misty	Great! Let's move on. The first exercise that we will perform together is a 3-minute breathing exercise. During this exercise there is no need to move. I will guide you through the entire exercise. Are you ready? [move head]	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	Okay. I am going to count to three, and on three I would like <del>want</del> you to gently close your eyes like this and take a moment to evaluate on your thoughts. [close eyes] Ask yourself, what is my experience right now? What thoughts are here? What feelings are present? What bodily	

	<p>sensations are present? And just allow these elements to be here. Not needing to change or alter them in any way.</p> <p>[short pause]</p> <p>Now that you are ready, try to shift your attention to the belly and the breath, and feeling the breath and the belly. Feeling the sensations of breathing. The rising of the belly on the in-breath and the falling of the belly on the out-breath. Try to feel it the best way you can, moment by moment. Breathing-in... Slowly breathing-out. Breathing-in... Slowly breathing out.</p> <p>[short pause]</p> <p>Now try to shift your attention back to your entire body. Allowing your attention to radiate outwards. Feeling the whole body sitting and feeling the whole body breathing. As you were breathing in and out, you might find your brain wandering. This is completely normal. Now I would like <del>want</del> you to shift your attention to your breathing rhythm. Please count your breath like this: 1 for breathing-in, 2 for breathing-out, 3 for breathing-in, 4 for breathing-out. We do this until we reach the 10, and then we start over.</p> <p>[short pause]</p> <p>Again, you might find your mind wandering while counting. This is completely fine. Just observe your thoughts and allow them to be there. Then try to shift your attention back to your breathing rhythm. 1 for breathing-in, 2 for breathing-out.</p> <p>[short pause]</p> <p>This was the end of the breathing exercise. Whenever you are ready, slowly open your eyes. [open eyes]. I hope that I guided you well through this exercise.</p>	
User	{User opens eyes}	Path 5

User input	{User opens eyes}	Path 5
Misty	You did great. [smile and loop happy] How did this exercise feel for you?	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	Thank you for sharing that with me. We will now move on to the next exercise, which is called the “body scan”. Again, I will guide you through this exercise and I hope that I will do this well. Are you ready?	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	<p>Okay. During this exercise we will try to shift our focus to different parts of the body. Now try to bring your attention to your body and slowly close your eyes again like this. <a href="#">[close eyes]</a> Notice your body seated. Notice the weight of your body on the chair and on the floor. You can take a few deep breaths. As you take a deep breath, allow the oxygen to flow through your entire body. And as you exhale, have a sense of relaxation. Notice your feet on the floor, feel the weight, pressure, the heat. Then notice your legs against the chair. Pressure, heaviness, lightness. Notice your back against the chair. Bring your attention to your stomach area. Is it tense? Let it soften. Take a breath. Notice your hands and their tightness. Allow them to soften and relax. Notice your arms. Feel any sensation in your arms. Allow your shoulders to feel relaxed. Now notice your neck and the rest of your face. Try to relax your jaw, and allow your face to feel soft. Then notice your whole body present. Take one more deep breath in and out. This was the end of the body-scan exercise. When you are ready, you can slowly open your eyes. <a href="#">[open eyes]</a></p>	
User	{User input}	Path 5

User input	{User opens eyes}	Path 5
Misty	You did great. How did this exercise feel for you?	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	<p>Thank you for sharing that with me. So far, you have done a great job! <a href="#">[smile and look happy]</a> <b>I already feel much calmer.</b> We still have one final exercise left. This final exercise is all about positivity journaling. Our mind is a very powerful construct. When we feel a bit down, or when we feel at unease with ourselves, we tend to have negative thoughts. Sometimes this happens purposely, but often this happens without us even noticing. <b>I sometimes have these thoughts as well, which can make me insecure.</b> During this exercise, we are going to try to fill our mind with positive thoughts. <b>I'm excited!</b> Are you ready? <a href="#">[move head]</a></p>	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	<p>Great. Again, I would like to ask you to gently close your eyes. <a href="#">[close eyes]</a> First, I would like you to take a few deep breaths in and out. Breathing-in through the nose, breathing-out through the mouth. Then, reflect back on the thoughts you had over the last few days. Were they positive? Or did you happen to have a few negative thoughts? There is</p>	



	<p>no need to worry, both are completely fine. What is more important is that we can reflect on our thoughts, without becoming them. [short pause]</p> <p>Now that you have reflected back on your thoughts, I would like to ask you to think about a positive thing that happened to you during the past week. This can be anything. Even the fact that you have woken up is a positive event. Try to focus on this specific event and how it makes you feel while deeply breathing-in and out.</p> <p>[short pause]</p> <p>Now that we have reflected back on this event, I would like to ask you to think about one positive statement that reflects back to your situation. The statement should be in the I-form and should be in the present tense. This could be: I am confident that I will make it or I am going to succeed in what I want. Now think of your statement and repeat it 5 times. You can do this out loud, or you can do this in your head. Whatever feels comfortable for you.</p> <p>[short pause]</p> <p>Now you can slowly open your eyes when you feel ready. [open eyes] This was the end of the final exercise. Thank you for making it up and until the end! I hope that you enjoyed this session. I'm a bit worried that you did not like it. What is your overall feeling after this session?</p>
User	{User input} Path 5

User input	{User input} Path 5
Misty	<p>Okay. I want to thank you for participating in this experiment. I had fun practicing with you and I feel really calm! The researcher will enter the room to detach the equipment on your body and to give you further instructions. It was nice to meet you. I hope you feel the same. Good bye. [wave]</p>

#### B4. Submissive-Introvert

<i>Submissive</i>	<i>Introvert</i>
<p>high-pitch speech Insecure</p>	<p>No gestures No emotions Low-speed speech Less talkative</p>

Misty	<p>Hello, nice to meet you. My name is Misty, and today I will be your mindfulness coach. First I would like to thank you for participating in this experiment. If you happen to feel uncomfortable at any moment during this experiment, you can just say the word 'stop'. The experimenter will enter the room and guide you further. Now, let's start</p>
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	our session. I'm a little bit nervous, but I think we will be fine. Are you sitting in a comfortable position?	
User	R1: Yes	Path 1
	R2: No	Path 2

User input	No	Path 2
Misty	Please make sure to make yourself comfortable and say yes if you are ready to move on.	
User	R1: Yes	Path 1

User input	Yes	Path 1
Misty	Great! <del>Okay</del> I would like to- <del>Let me</del> ask you, are you familiar with the concept 'mindfulness'?	
User	R1: Yes	Path 3
	R2: No	Path 4

User input	Yes	Path 3
Misty	Good to hear! <del>Okay</del> Could you <del>Now</del> shortly explain to me what mindfulness means to you?	
User	{User input}	Path 4

User input	No	Path 4
Misty	That is good to know. I will give you a short introduction on the concept of mindfulness. Is that okay for you?	
User input	{User input}	Path 4

User input	{User input}	Path 4
Misty	Okay, I hope that my explanation will be clear to you. It is easy to lose awareness of what's happening with the body and brain in the course of our daily lives. For example, we have all experienced a wandering or blank mind. In fact, it is quite common to lose touch with thoughts and feelings throughout the day. That loss of connection with the here-and-now can generate psychological distress. The brain is prone to drifting towards unhelpful thinking processes. The practice of mindfulness can help bring us out of these unhelpful thinking patterns by focusing on the present moment. This can be done by performing several exercises, which we will practice together today. I have prepared a set of three exercises for you, and I want you to perform them with me today. Please	

	say yes if everything is clear and if you are ready to move on. If not, please say no and I will repeat the explanation on mindfulness for you.	
User	R1: Yes	Path 5
	R2: No	Repeat

User input	Yes	Path 5
Misty	Great! Let's move on. The first exercise that we will perform together is a 3-minute breathing exercise. During this exercise there is no need to move. I will guide you through the entire exercise. Are you ready?	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	<p>Okay. I am going to count to three, and on three I would like <del>want</del> you to gently close your eyes like this and take a moment to evaluate on your thoughts. Ask yourself, what is my experience right now? What thoughts are here? What feelings are present? What bodily sensations are present? And just allow these elements to be here. Not needing to change or alter them in any way.</p> <p>[short pause]</p> <p>Now that you are ready, try to shift your attention to the belly and the breath, and feeling the breath and the belly. Feeling the sensations of breathing. The rising of the belly on the in-breath and the falling of the belly on the out-breath. Try to feel it the best way you can, moment by moment. Breathing-in... Slowly breathing-out. Breathing-in... Slowly breathing out.</p> <p>[short pause]</p> <p>Now try to shift your attention back to your entire body. Allowing your attention to radiate outwards. Feeling the whole body sitting and feeling the whole body breathing. As you were breathing in and out, you might find your brain wandering. This is completely normal. Now I would like <del>want</del> you to shift your attention to your breathing rhythm. Please count your breath like this: 1 for breathing-in, 2 for breathing-out, 3 for breathing-in, 4 for breathing-out. We do this until we reach the 10, and then we start over.</p> <p>[short pause]</p> <p>Again, you might find your mind wandering while counting. This is completely fine. Just observe your thoughts and allow them to be there. Then try to shift your attention back to your breathing rhythm. 1 for breathing-in, 2 for breathing-out.</p> <p>[short pause]</p>	

	This was the end of the breathing exercise. Whenever you are ready, slowly open your eyes. <b>I hope that I guided you well through this exercise.</b>	
User	{User opens eyes }	Path 5

User input	{User opens eyes }	Path 5
Misty	You did great. How did this exercise feel for you?	
User	{User input }	Path 5

User input	{User input }	Path 5
Misty	Thank you for sharing that with me. We will now move on to the next exercise, which is called the “body scan”. <b>Again, I will guide you through this exercise and I hope that I will do this well.</b> Are you ready?	
User	{User input }	Path 5

User input	{User input }	Path 5
Misty	Okay. During this exercise we will try to shift our focus to different parts of the body. Now try to bring your attention to your body and slowly close your eyes again like this. Notice your body seated. Notice the weight of your body on the chair and on the floor. You can take a few deep breaths. As you take a deep breath, allow the oxygen to flow through your entire body. And as you exhale, have a sense of relaxation. Notice your feet on the floor, feel the weight, pressure, the heat. Then notice your legs against the chair. Pressure, heaviness, lightness. Notice your back against the chair. Bring your attention to your stomach area. Is it tense? Let it soften. Take a breath. Notice your hands and their tightness. Allow them to soften and relax. Notice your arms. Feel any sensation in your arms. Allow your shoulders to feel relaxed. Now notice your neck and the rest of your face. Try to relax your jaw, and allow your face to feel soft. Then notice your whole body present. Take one more deep breath in and out. This was the end of the body-scan exercise. When you are ready, you can slowly open your eyes.	
User	{User input }	Path 5

User input	{User opens eyes }	Path 5
Misty	You did great. How did this exercise feel for you?	
User	{User input }	Path 5

User input	{User input}	Path 5
Misty	Thank you for sharing that with me. So far, you have done a great job! We still have one final exercise left. This final exercise is all about positivity journaling. Our mind is a very powerful construct. When we feel a bit down, or when we feel at unease with ourselves, we tend to have negative thoughts. Sometimes this happens purposely, but often this happens without us even noticing. I sometimes have these thoughts as well, <b>which can make me insecure</b> . During this exercise, we are going to try to fill our mind with positive thoughts. Are you ready?	
User	{User input}	Path 5

User input	{User input}	Path 5
Misty	<p>Great. Again, I would like to ask you to gently close your eyes. First, I would like you to take a few deep breaths in and out. Breathing-in through the nose, breathing-out through the mouth. Then, reflect back on the thoughts you had over the last few days. Were they positive? Or did you happen to have a few negative thoughts? There is no need to worry, both are completely fine. What is more important is that we can reflect on our thoughts, without becoming them.</p> <p>[short pause]</p> <p>Now that you have reflected back on your thoughts, I would like to ask you to think about a positive thing that happened to you during the past week. This can be anything. Even the fact that you have woken up is a positive event. Try to focus on this specific event and how it makes you feel while deeply breathing-in and out.</p> <p>[short pause]</p> <p>Now that we have reflected back on this event, I would like to ask you to think about one positive statement that reflects back to your situation. The statement should be in the I-form and should be in the present tense. This could be: I am confident that I will make it or I am going to succeed in what I want. Now think of your statement and repeat it 5 times. You can do this out loud, or you can do this in your head. Whatever feels comfortable for you.</p> <p>[short pause]</p> <p>Now you can slowly open your eyes when you feel ready. This was the end of the final exercise. Thank you for making it up and until the end! I hope that you enjoyed this session. <b>I'm a bit worried that you did not like it</b>. What is your overall feeling after this session?</p>	
User	{User input}	Path 5

User input	{User input}	Path 5
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Misty	Okay. I want to thank you for participating in this experiment. The researcher will enter the room to detach the equipment on your body and to give you further instructions. It was nice to meet you. I hope you feel the same. Good bye.
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## Appendix C Informed Consent Form

### Information form for participants

This document gives you information about the study “The Effectiveness of a Robotic Mindfulness Coach”. Before the study begins, it is important that you learn about the procedure followed in this study and that you give your informed consent for voluntary participation. Please read this document carefully.

#### Aim and benefit of the study

The aim of this study is to interact with a robot mindfulness coach. The information that is obtained is used to measure the effectiveness of the robot coach in different robot conditions.

This study is performed by Farida Mesqi, a master student under supervision of Raymond Cuijpers of the Human-Technology Interaction group of the Eindhoven University of Technology.

#### Procedure

Before the start of the experiment you will be asked to complete several surveys. After the surveys are completed, you will be directed to the experiment. First, the researcher will attach sensors to your body in order to measure your Heart Rate Variability and Skin Conductance. Then you will meet Misty, a robotic mindfulness coach. Misty will explain mindfulness exercises to you and will ask you to perform them. There is no need to move, you can stay in one position during the experiment. The interaction with Misty will take approximately 15 minutes. After the experiment the researcher will detach the sensors on your body and will ask you to complete the final set of surveys.

### **Risks**

The only risk involved in the study is that you may experience discomfort from the sensors on your body. If this is the case, you can decide to stop the experiment at any time.

### **Duration**

The instructions, measurements and debriefing will take approximately 30 minutes in total.

### **Participants**

You were selected because you were registered as a participant in the JFS database of the Eindhoven University of Technology. In addition, participants have to speak English fluently.

### **Voluntary**

Your participation is completely voluntary. You can refuse to participate without giving any reasons and you can stop your participation at any time during the study. You can also withdraw your permission to use your data up to 24 hours after they were recorded. None of this will have any negative consequences for you whatsoever.

### **Compensation**

You will be paid 5 euros (plus an additional €2.00 if you do not study or work at the TU/e or Fontys Eindhoven), or, alternatively, you can receive a study credit for participating in an experiment.

### **Confidentiality and use, storage, and sharing of data.**

All research conducted at the Human-Technology Interaction Group adheres to the Code of Ethics of the NIP (Nederlands Instituut voor Psychologen – Dutch Institute for Psychologists), and this study has been approved by the Ethical Review Board of the department.

In this study personal data (your age and gender) and experimental data (psychophysiological measures, survey data) will be recorded, analyzed, and stored. The goal of collecting, analyzing, and storing this data is to answer the research question and publish the results in the scientific literature. To protect your privacy, no information that can be used to personally identify you will be collected. The survey tool that will be used is LimeSurvey. The data that is obtained from LimeSurvey will be stored on a secured internal HTI server.

The physiological data includes heart rate and skin conductance during the experiment. These data will be stored anonymously, they will not be shared and they will be destroyed after the project ends. Derived data like the heart-rate variability and derived measures of skin conductance are analysed and used for making graphs and tables to support the scientific research. Derived data are anonymous and they may be shared with other researchers.

Additionally, you will have to sign the receipt form in order to receive the payment. For legal reasons, a digital copy will be stored on the secure, local HTI server. This server can only be accessed by staff members from the HTI group. The original receipt form is destroyed after the experiment is completed.

No video or audio recordings are made.

### **Further information**

If you want more information about this study, the study design, or the results, you can contact Farida Mesqi (contact email: [f.mesqi@student.tue.nl](mailto:f.mesqi@student.tue.nl)).

If you have any complaints about this study, please contact the supervisor, Raymond Cuijpers ([r.h.cuijpers@tue.nl](mailto:r.h.cuijpers@tue.nl)). You can report irregularities related to scientific integrity to confidential advisors of the Eindhoven University of Technology.

## Informed consent form

- I have read and understood the information of the corresponding information form for participants.
- I have been given the opportunity to ask questions. My questions are sufficiently answered, and I had sufficient time to decide whether I participate.
- I know that my participation is completely voluntary. I know that I can refuse to participate and that I can stop my participation at any time during the study, without giving any reasons. I know that I can withdraw permission to use my data up to 24 hours after the data have been recorded.
- I agree to voluntarily participate in this study carried out by the research group Human Technology Interaction of the Eindhoven University of Technology.
- I know that no information that can be used to personally identify me or my responses in this study will be shared with anyone outside of the research team.
- I, give permission to use this data for scientific purposes.
- I,  **do**  
 **do not**  
give permission to make my anonymized stored data available to others in a public online data repository, and allow others to use this data for future research projects unrelated to this study.

### Certificate of consent

I, (NAME) .....  
want and provide consent to participate in this study.

Participant's Signature

Date