MINDFUL SMOKING CESSATION MEDIATED THROUGH A VOICE ASSISTANT

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ABSTRACT

There is an increased interest to employ technology to help individuals combat mental health issues. With the rise of personal voice assistants, the field of HCI is facing new challenges in how to utilize these effectively in different contexts. We set out to construct a novel design that meditates mindfulness techniques for smoking cessation. We report findings from a mixed study design with nine participants using one of the two variants of the application design during a month-long deployment. The purpose of the prototypes were to explore wheter mindfulness for smoking cessation can be mediated through a voice assistant. In addition to this, the purpose was to explore the differences and similarities of how participants experienced mindfulness techniques, mediated through either a voice assistant on a smart speaker or on a mobile device, to provide insights for future development of similar applications. The paper presents quantitative data of prototype usage, measured mindfulness and measured smoking urges, as well as qualitative data of how the participants perceived mindfulness, smoking urges, their ongoing motivation to quit and their usage of the prototype. We conclude by presenting discussion points which provide further directions for researchers in the field of HCI.

1. INTRODUCTION

In a progressively fast-paced world, it has become increasingly difficult for individuals to pause and reflect on their mental health [1, p. 10], [2], [3]. Reflecting on your mental health and acting on these reflections, has a positive effect on various issues, such as stress, anxiety and depression [4], [5]. While some people seek relief in alleviating these issues through exercising and a healthy diet, others increase their use of tobacco, alcohol and other potentially detrimental substances [6], [7]. Effects from consuming tobacco, are the leading causes of preventable deaths in the world [8], [9]. While 70% of the smoking population wants to quit, only 7% of these succeed each year [10]. According to various sources [1], [11], [12], harmful habits can be alleviated by the practice of Mindfulness.

Using Mindfulness to combat stress was first introduced through Mindfulness-Based Stress Reduction (MBSR). MBSR was introduced in the 1970s by Jon Kabat-Zinn [13] and has sprouted various similar programs that all have their basis in MBSR. One of these is Mindfulness-Based Relapse Prevention (MBRP), which is used for combating addiction to various harmful substances. When looking at the various research that surrounds Mindfulness, it is often suggested to perform the programs in a group session, as this would allow for a facilitator present, that can guide the novel practitioners through the various exercises and relate personally to the group [14].

This creates some constraints for the practitioners, as they need to show up to meetings to be able to practice Mindfulness, which can be hard to manage in a busy modern life. There are alternatives to practice Mindfulness at physical meetings, such as, books that guide you through a session, videoes that likewise guide you, as well as mobile applications. We believe that voice assistants could become an effective supplement to the traditional way of practising Mindfulness, as the users can interact with the device without focusing on their visual modality [15], the Voice Assistant could provide natural language interaction, and could, over time, be an integrated part of the users daily life, as voice assistants become more integrated into the devices around us [16], [17]. In the field of HCI, MBRP has been applied in a variety of contexts, such as self-guided mindfulness smoking cessation apps to alcohol abuse text-based chatbot companions [18], [19]. The commonality between text-based chatbots and voice assistants is apparent, with the latter being essentially a chatbot with text-to-speech and natural language processing capabilities [20]. The literature labels voice assistant systems by many names, such as speech-based conversational agents [21], voice assistants [22],artificial intelligence powered digital assistants [23] and more. For this paper, we will call these systems Voice Assistants (shortened to VAs).

VAs have shown great promise in the user's ability to self-disclose [22]. Self-disclosure is a cornerstone in reflective Mindfulness [24] and would, therefore, potentially make VAs an effective mediator to practice self-guided Mindfulness. With the recent expansion in VAs it becomes progressively necessary to look into the medium of VAs, as callouts from the research community suggest [25].

The ongoing research within the field of voice interaction will help further the understanding of how to develop better voice interactions, as the technology becomes more commonplace. In this work, we adapt the techniques of MBRP[1] to facilitate smoking cessation mediated through a voice assistant on a smart speaker and a smartphone, in order

to identify how different types of interaction affect the support of smoking cessation. To that extent, we aim to answer the following research question:

> *"How does a voice assistant situated in the home of the user, facilitate smoking cessation using mindfulness, compared to an equivalent smartphone application?"*

Our goal for this study was to provide insights into the potential challenges, which can be faced when designing for different technological mediums and the advantages, as well as the disadvantages that this entails.

2. THEORETICAL BACKGROUND

In this section we will present the theoretical foundation of the study. The theories that have inspired the study are Mindfulness, Social Cognitive Theory and Voice User Interfaces. Additionally, we will present related work and our initial pilot study.

2.1 Mindfulness

Mindfulness was introduced to the Western world in the 1970s, by Jon Kabat-Zinn [13], and is essentially a non-judgemental awareness of one's observations, including; bodily sensations, thoughts, feelings and one's changing environment. The two main elements in Mindfulness are *Self-Regulation* and *Orientation*. *Self-Regulation*, is achieved by sustaining attention to current experiences, in order to identify feelings, sensations and thoughts. In the process of learning Mindfulness and thereby becoming more aware, the practitioner learns to alternate between what Kabat-Zinn calls the "*doing mode*", where they experience their body in auto-pilot, to "*being mode*", where they experience and acknowledge their feelings [13]. *Orientation*, is where the practitioner approaches their experiences with openness, curiosity and acceptance, to gain a better understanding of themself [26]. While trying to learn and practice Mindfulness, it is vital to continuously try to investigate one's emotions and understand why these emotions emerge.

Mindfulness is both a skill one learns to master and a practice that can be conducted through various attention exercises, such as focused breathing, meditation, yoga and the equivalent. By practising Mindfulness on a regular basis, the practitioner can achieve control of their stream of consciousness [26]. Achieving this, has been associated with several kinds of *Self-Efficacy*, such as for managing pain and for resisting alcohol relapse [27]–[30].

Mindfulness-Based Relaspe Prevention (MBRP) is mainly practised in weekly group sessions, where participants get to share their experiences with like-minded individuals, mediated by a trained facilitator. The job of the facilitator is to both guide the participant through Mindfulness exercises, but also to facilitate reflections regarding emotions, thoughts and experiences that prompt the participant to engage in abusive behaviour. The goal is to be able to identify individual behavioural patterns and correlate them with abusive tendencies, in order to regulate their behaviour and thereby develop the *Self-Efficacy* needed to withstand the cravings when they emerge. Furthermore, the participants are encouraged to both practice Mindfulness exercises at home (i.e. body scan exercise, sitting meditation, breathing exercises) and keep a personal log of their daily practices, which includes writing down triggers with subsequent thoughts, feelings and sensations that accompanied it [1].

2.2 Social Cognitive Theory

Social Cognitive Theory describes how individuals begin and maintain a given behaviour (i.e. smoking). The theory was developed by Bandura, as an expansion upon his Social Learning Theory [31].

Self-Efficacy is a term in Social Cognitive Theory (SCT) which describes an individual's confidence in their own behavior and their ability to produce successful outcomes

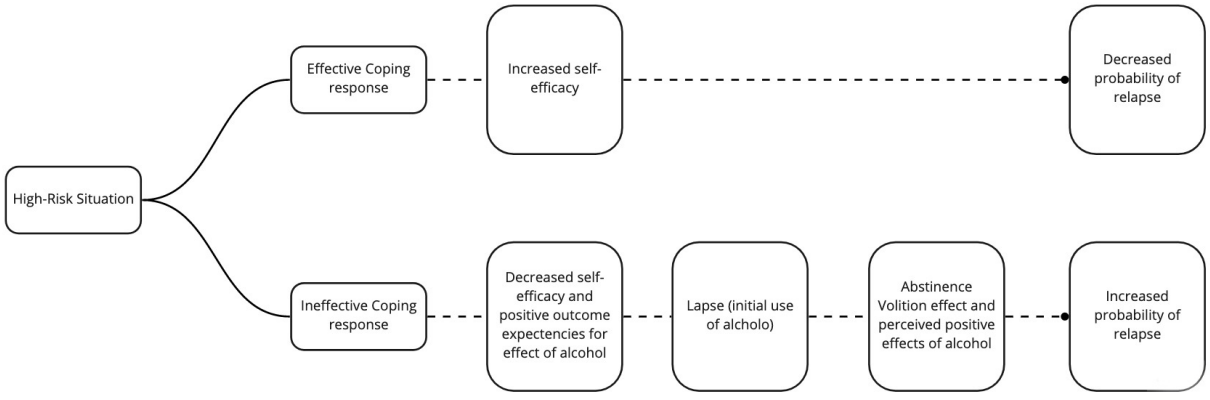

Figure 2: An illustration of the Marlatt's Relapse Prevention Model

[32]. SCT addresses the motivational factors and health behaviours of an individual to promote a behavioural change [33]. According to Bandura [34], *Self-Efficacy* can be defined as the confidence in one's own ability to perform a specific behaviour. *Self-Efficacy* has also been used as a foundation for e.g. Marlatt's Relapse Prevention Model [35]. Marlatt's Relapse Prevention Model is essentially based around the idea that a successful execution in a High-Risk Situation (HRS) leads to an increase in *Self-Efficacy*, thereby leading to more effectively avoiding abusive behaviour in future HRS, see *Figure 2*. HRSs are situations that are risky for the addict to be in and have the potential to lead to a lapse, e.g. attending a party, when the addict is trying to quit alcohol [35]. It is worth noting, that each strategy does not work equally well for all people, and some strategies might work better during a certain period in an individual's learning journey. However, we have exclusively adapted the practices from SCT, that are consistent with the works of Bowen et al. [1].

2.3 Voice User Interfaces

Speech recognition systems were first invented in the 1950s. In their infantile stage, only single letters could be recognized independently. Advances in the field have, however, led to the continuous speech recognition that we know today from VAs on smartphones and speakers with voice assistant capabilities (smart speakers)[36].

In mobile devices with an integrated VA, it is possible to combine the Voice User Interfaces (VUI) with a visual component. This can be an advantage in delivering information, asking for confirmation and hinting that it is the users turn to speak. The modalities can work together in a single application, as in VAs on mobile devices delivering a rich-VUI experience, meaning a combination of VUI and Graphical User Interfaces (GUI)[37].

VUIs have seen little development in the research community, in regards to heuristics and guidelines, compared to their graphical counterpart. Several researchers have made a call for the research community to discuss and study VUI in order to create a solid set of guidelines, as designers of the future are woefully unprepared for the VUI challenges to come [25], [38]. Murad et. al. concluded through an extensive literature review that the current VUI practices correlate with all except one of Nielsen's heuristics, *Consistency,* and additionally adds two categories, namly *Transparency/privacy* and *Social context* [39].

Within our prototype, we employ Nielsen's Usability Heuristics [40] to assess the usability of interactions with the VA. Beyond that, we use the conversational design practices presented by Pearl in order to execute good conversational design [41].

2.4 Related Work

Smoking cessation resources are vast and readily available in Denmark and interventions can be found from the local municipality level. The government in collaboration with cancer organizations and the Danish Health Authorities (DHA) have many resources dedicated to both warn people about the consequences of consuming tobacco and teach the people that are willing to quit, how best to go about doing so [42]–[45]. In the illustrated guide provided by the DHA, there are several techniques for how to deal with smoking withdrawal. One of the sections is dedicated to breathing- and relaxation exercises, for intrusive thoughts and feelings [46].

Besides these governmental resources, the research community has presented various efforts to help smokers quit through technology-assisted smoking cessation. Paay et al.[47] presented a mobile application that utilized self-reflection about smoking habits, as a way for the individual participant to become more aware of their cigarette consumption. Other approaches have also been made. Notably, the use of chatbots for delivering personalized counseling for the users delivered through either auditory- or textual conversations. These chatbots are implemented into standalone devices, as well as an integrated part of various mobile applications [48]–[50]. According to a study by Perski et al. [51], that compared a sample of over 50.000 participants, they found a 101% increase in engagement from participants who tried to quit smoking using a mobile application with an integrated chatbot, compared to the participants that used the same mobile application, but without a chatbot. In recent years, a wealth of commercial mobile applications have become available, that offer their own tailored experience for smoking cessation. Many of these applications have millions of downloads [52]–[54]. These applications follow roughly the same guidelines as the DHA presents, and include features to engage the users, e.g. keeping track of cigarette consumptions, economic tracking, games and achievements. Few of these applications do, however, centre around utilizing mindfulness for smoking cessation. Brewer has adapted mindfulness training and applied it to smoking cessation [55], [56] and has dedicated large parts of his career to researching how to treat addictive behaviour with mindfulness [57]. Brewer has, in addition to their research, published a mobile application [58], that presents a 21-day course with video material utilizing mindfulness principles for guided smoking cessation.

There is a noticeable gap in the literature regarding smoking cessation mediated through VAs, as we were unable to find any studies of similar character. When using a VA, users can interact with the device, without focusing on their visual modality, which can support them in training their attention towards other bodily sensations and mental experiences [13]. Increased attention helps in counteracting the fallbacks experienced when exposed to certain cues, which prompts urges to act on habitual behaviour [1], [56]. VAs have, as previously mentioned, shown great promise in the users ability to self-disclose [22], a cornerstone in reflective Mindfulness [24]. This led us to explore the possibilities of utilizing Mindfulness for smoking cessation facilitated by a voice assistant.

2.5 Pilot Evaluation

We conducted a pilot study with an initial prototype, which consisted of a smart speaker application, delivered through the Google Assistant. The application consisted of two main functions. The first function was a way for users to register their triggers i.e. why they felt that they needed a cigarette. This led the users to perform a Mindfulness exercise before answering what triggered their craving. The second function was open-ended questions about smoking habits in general, which were meant to make the users reflect on their smoking habits.

The purpose of the pilot study was to answer three main questions; whether the users found it difficult to communicate with the system, the necessity of a potential screen for navigating and the naturality of engaging with the system. The results led to insights regarding numerous issues with the system that resulted in changes to our prototype. The changes include the implementation of a visual interface, a log overview and a more extensive amount of training phrases, to name a few. In general, the participants responded positively to both the aspect of Mindfulness exercises and open-ended questions for smoking cessation. A question however lingers in regards to whether using voice interaction exclusively, has any additional values in regards to training Mindfulness in individuals, compared to a rich-VUI.

3. STUDY DESIGN

We conducted a long-term study spanning four weeks. The study was a mixed-study design, with between-subjects [59] and within-subjects factors [60]. The between-subjects factors were VUI and rich-VUI interface usage of a Google Assistant application. The within-subjects factors were the participants' Smoking Urges and level of Mindfulness, which were presented through questionnaires at the start of the study, halfway through the study and upon study completion.

Mindfulness practices have been adapted from MRBP [1], that divides its material into eight courses, with a weekly interval. However, alternate time frames have been employed as these courses have been adapted into a biweekly model as seen in Brewer et al. (2011) [12]. Furthermore, Brewer et. al (2013)[55] suggests that a four week Mindfulness training period is sufficient for an individual to noticeably reduce their cravings towards cigarettes.

We have adapted the techniques presented by MBRP and constructed an application for the Google Assistant with five main functions.

1) *Track my Craving;* This feature allows the user to quickly track their cravings whenever they feel the urge to smoke. By invoking "*track my craving*" the user is guided through a short interaction, where they can state a feeling, thought or experience that led to their craving. The answer will be logged corresponding to a predefined list of words [61]. See Appendix 1 for the list.
2) *Give me an exercise*; This feature guides the user through, one of seven predefined Mindfulness exercises spanning between 1-3 minutes. The purpose of the exercises is to teach the user to practice attention control. The user can practice as much as they want with a minimum of once per day. See Appendix 2 for the detailed exercises.
3) *Give me a question;* this feature is designed to ask open-ended questions to the user. The questions are not meant to be answered but are designed to get the user to practice critical reflection on smoking-related topics in relation to themselves and their own behaviour. See Appendix 3 for detailed questions.
4) *Open statistics;* In the smart speaker interface, it lists the three most prevalent situations. In the smartphone interface, it provides the user with an overview of all their tracked cravings, accompanied by a related timestamp, and total frequency of the types of cravings that have been logged. See Appendix 4 for an overview of the smartphone version of the statistics.
5) A help function, which tells the user what the purpose of each function is and how to use it.

3.1 Participants

The participants *(N=23)* were recruited through various websites namely Facebook, Reddit, Testperson.dk and the Stop Smoking Helpline Forum (Rygestop Linjens Forum), as well as smoking cessation clinics around the region North Jutland, Denmark. Eligibility for participation in the study was that the participants had to be between 18-65 years old. The upper bound was set based on the fact that smartphone usage, with people above 65 years old, drastically decreases when looking into older age groups [62]. The participants should be able to converse in English, as the language for the prototype was in English. They should also be motivated to stop smoking, as we saw this as a motivational factor for continuous use, thus limiting potential experimental mortality. As we were only able to supply five smart speakers, and no smartphones, we determined that the recruitees should at least own a smartphone compatible with the Google Assistant application and preferably a smart speaker. They should, ideally, have some experience with voice assistants, as this would make the participants focus on

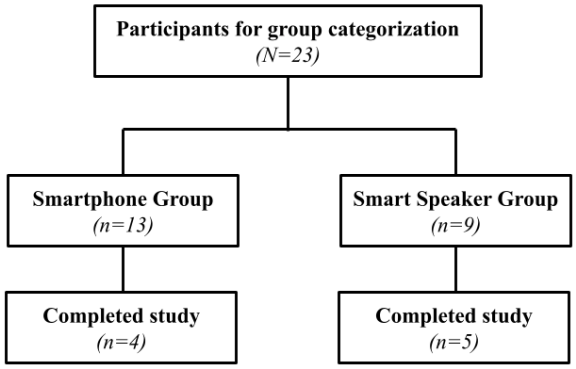

Figure 3: An overview of the participants.

the functionality of the prototype and not of the technology itself. In our pilot study, we experienced that the participants that were not proficient in using voice assistants, had multiple comments about functionality that was out of our control. By introducing the criteria, we tried to exclude such comments.

The mean age of the participants was 25,4 years old. There were 16 males and six females. The participants received no compensation for their participation in the study.

3.2 Measures

The questionnaire that the participants answered contained two established questionnaires. The first was the Five Facet Mindfulness Questionnaire with 15 Items (FFMQ-15)[63], which was meant to assess their level of Mindfulness, meaning, how mindful they felt. The second was the Brief Questionnaire on Smoking Urges (QSU-Brief)[64] with ten items that was used to assess the participants' level of Smoking Urges, meaning, their cravings for a cigarette. We chose these specific questionnaires, as it would help us gain insights into the participants' level of Mindfulness, as well as their craving for a cigarette, so that we could compare the participants' level of Mindfulness when exclusively using a smartphone for accessing the application and the level of Mindfulness for participants using exclusively a smart speaker to access the application.

3.3 Procedure

The conditions for the study was exclusive VUI versus rich-VUI usage of a Google Assistant application, aimed at mediating Mindfulness for smoking cessation. We conducted a long-term study spanning four weeks, where the participants were asked to use the prototype for a minimum of five minutes daily, which roughly corresponds to using all features in the prototype in a row. The participants were asked to answer a questionnaire at the start of the study, halfway through and upon study completion. Additionally, interviews were conducted halfway through the study and at the conclusion of the study period.

We performed an interview halfway through the study, as well as one at study completion. These covered a variety of topics, such as the participants' motivation for using the prototype and their smoking habits during the study, as well as their personal perspective on their level of Mindfulness. We also asked them questions about their potential problems with using the prototype, so we could address the problems in the prototype if they were not too elaborate. The findings from the interviews were analysed using a thematic analysis.

Before conducting the study, we divided the participants into two groups, i.e. smart speaker group (VAg) participants and smartphone (SPg) participants, see *Figure 3* for an overview. There were only four participants that had access to a Google Assistant smart speaker at home. We were, as previously mentioned, only able to provide a limited number of smart speakers, so when we had exhausted our resources, the rest of the participants were categorised in the smartphone group. We determined if a participant would receive a smart speaker, or should use the smartphone, at random.

To avoid experimental bias, we made sure that the participants were unaware of each other, as well as their group categorisation, and only presented the type of interface that they were assigned to. The participants were provided with a handbook, where we introduced them to Mindfulness, a set-up guide, a tutorial, a troubleshooting guide, an overview of the functions and a list of potential High-Risk Situations, that they could log.

4. FINDINGS

The section is divided into three main categories of findings which are quantitative findings, the qualitative findings lastly a summarisation of the two, respectively. The three main durations used throughout this section are: Baseline, which is on the first day of deployment (i.e. start of the study). Midway, which is on the 14th day of deployment (i.e. mid-study), and Post-Study, which is on the 30th day of deployment (i.e. last day of the study).

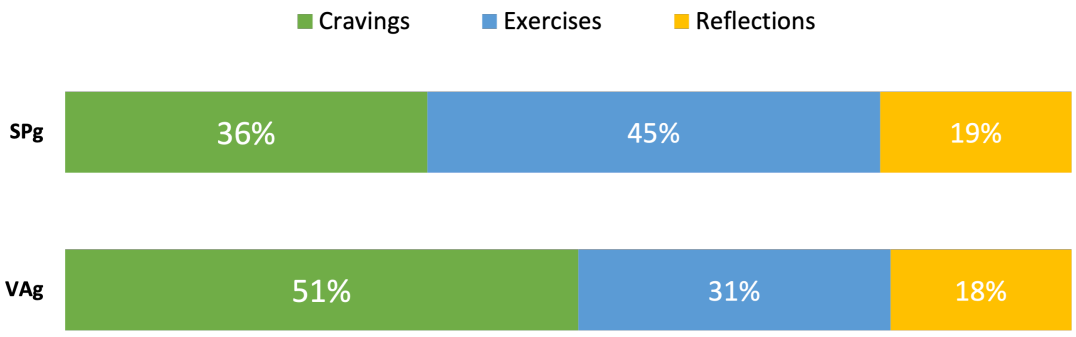

Figure 4.0: Daily "Task Finished" completed by the Smart Speaker group (VAg) and Smartphone group (SPg), divided by Craving Tracking, Exercises and Reflection Questions.

VAg	**Baseline**	**Midway**	**Post-Study**
FFMQ-15	**3.39**	**3.31**	**3.44**
Changes from Baseline	*0.00*	*-0.08*	*0.05*
Standard Deviation	*0.4356*	*0.4536*	*0.3989*
QSU-Brief	**3.12**	**2.32**	**2.20**
Changes from Baseline	*0.00*	*-0.80*	*-0.92*
Standard Deviation	*0.5975*	*1.2215*	*1.1640*

Table 4.0: Measurements from the Smart Speaker group (VAg).

SPg	**Baseline**	**Midway**	**Post-Study**
FFMQ-15	**2.68**	**3.08**	**3.07**
Changes from Baseline	*0.00*	*0.40*	*0.39*
Standard Deviation	*0.4788*	*0.2517*	*0.2108*
QSU-Brief	**2.93**	**1.95**	**2.20**
Changes from Baseline	*0.00*	*-0.98*	*-0.73*
Standard Deviation	*0.4113*	*0.6403*	*1.1662*

Table 4.1: Measurements from the Smartphone group (SPg).

4.1 Quantiative Findings

In this section, we will describe the quantitative data of the study. As mentioned in section *3.*, we had a sample of 23 participants at the start of the study, which were divided into two groups. As the study progressed, we went from a sample of 23, to a sample of nine participants, which makes our dropout-rate *≈61%.* At the end of the study the participants were divided into four participants in the smartphone group (SPg) and five in the smart speaker group (VAg).

4.1.1 Usage Data

The usage-data that has been collected throughout the study is divided into two datasets. The first being the usage statistics provided by Google Analytics, which is occupied with general statistics about the conversations. The second being the "Task Finished"-dataset, collected by the researchers during the study, which details what tasks were finished (i.e. a participant performed a task all the way to the end), what participant finished the task and when the task was performed by date and time.

The total number of conversations for the whole study duration, depicted notable activity when the prototype was deployed and dropped substantially after only one day of use. The numbers depict an increase in usage before the Midway-interview. The activity stagnates after the interview, until the last day of deployment. When looking at the average length of the conversations throughout the study, they are almost identical for the SPg- and VAg participants. The average length of conversations rose through the first week of deployment, where it reached over 150 seconds on average for both groups. The following weeks, the use declined to below 60 seconds for the remaining period. See Appendix 5 for detailed figures.

The "Task Finished"-dataset contains all tasks that are finished by the participants. The VAg participants completed on average *7.40* Craving trackings, *4.40* Exercises and *2.60* Reflection questions. Whereas the SPg participants completed on average *4.38* Craving trackings, *5.38* Exercises and 2.27 Reflection questions. The split is showcased in *Figure 4.0.* See Appendix 6 for detailed table and detailed illustration of their usages.

When comparing the average time of day, and day of the week for a duration of the whole deployment, it becomes apparent that the participants mainly finished tasks on the weekdays with the lowest amount of tasks being finished for both groups on Saturdays and Sundays. Additionally, the numbers show higher usage especially in the morning, i.e. 06:00-12:00, and the day, i.e. 12:00-18:00. See Appendix 7 for detailed numbers.

4.1.2 Questionnaire

The participants were, as mentioned issued two questionnaires (FFMQ-15 and QSU-Brief) at three points during the study. The first at Baseline, the second at Midway and the third at Post-Study. When assessing the data, we started out by performing a Power analysis for a paired samples t-test to determine if the reduced study population size would be sufficient for a reliable statistical analysis. We found that the Power of our study population was *13.7%* points, compared to the *80-90%* points that are recommended for a statistical analysis with minimal errors [65]. We, therefore, chose to report on the number using mean values instead of conducting a statistical analysis, see Table 4.0 and Table 4.1. See Appendix 8 for detailed answers from the participants regarding their FFMQ-15. See Appendix 9 for detailed answers from the participants regarding their QSU-Brief.

When assessing the mean value for the questionnaires, it is important to note that an increase in the FFMQ-15 value indicates that the respondents had an increase in their level of Mindfulness. It is likewise important to note, that a decrease in the QSU-Brief value indicates that the respondents had a decrease in their level of Smoking Urges.

From the measurements from the VAg participants, see Table 4.0 and the SPg participants, see Table 4.1, we found that the SPg participants reported an overall lower level of Mindfulness throughout the study, than their VAg

counterparts. The SPg participants reported the highest change in Mindfulness, as they went from *2.68(StDev = .47)* points to *3.07(StDev=.21)* points, compared to the VAg participants, that went from *3.39(StDev=.43)* points to *3.44 (StDev=.39)* points. From the perspective of MRBP[1], Smoking Urges would be expected to decrease the most for the SPg participants, but this was not reflected in the measurements. The VAg participants reported the highest decrease in their Smoking Urges and went from *3.12(StDev=.59)* points to *2.20(StDev=1.16)* points, where the SPg participants reported a decrease from *2.93(StDev=.41)* points to *2.20(StDev=1.16)* points. In Figure 4.1, the results from the measurements are depicted.

4.2 Qualitative Findings

The findings from the Midway- and Post-Study-interviews held with the participants, were thematically analysed using affinity diagrams according to Lucero [66]. We started by transcribing the interviews, after which each of the researchers independently performed inductive coding where any emerging points of relevance were coded. We clustered the data points into themes according to our research question. Subsequently, we evaluated the themes and merged similar clusters with each other, or split clusters into overarching themes. This process resulted in five themes.

4.2.1 Interview Findings

The findings are structured by five major themes Mindfulness, Smoking Urges, Motivation, Platform and Autonomous Practices. In each topic the answers from the VAg participants and SPg participants from both interviews will be presented in that order, with a following comparison to the quantitative findings.

4.2.1.1 Mindfulness

VAg: From the Midway-interview, we learned that five of the five VAg participants reported feeling a positive change in their overall awareness. This was reflected in their Post-Study-Interview, as expressed by Participant P01: "*Yes, I think I have become more aware and calmer. More understanding towards myself. Yes. More aware of how I feel in my body and with my psyche.*"

SPg: As reported in the Midway-interview, four of the four SPg participants noticed an increase in their overall awareness. This was, however, not reflected in their Post-Study-interview, where only three of the four participants reported an increase in their overall awareness, as expressed by participant P02: "*Sometimes I catch myself smoking a cigarette, because I am bored. I have become more mindful about that*".

Data Comparison: The increase in the participants' overall awareness is supported by the FFMQ-15 measurements, as the VAg participants had an increase from *3.39(StDev=.43)* points at the Baseline-measurement, to *3.44(StDev=.39)* at the Post-Study-measurement. The SPg participants had an overall increase from *2.68(StDev=.47)* points at the Baseline-measurement, to *3.07(StDev=.21)* points at the Post-Study-measurement.

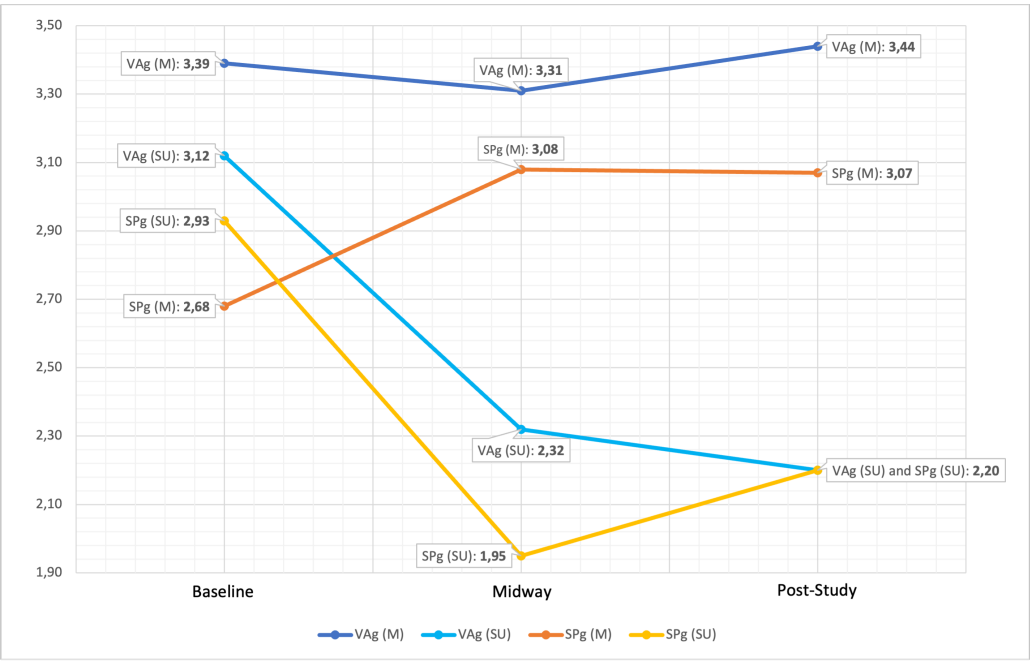

Figure 4.1: Measurements reported by the VAg- and SPg participants.

(M) = FFMQ-15, (SU) = QSU-BRIEF

4.2.1.2 Smoking Urges

VAg: Five of the five VAg participants reported a change in their smoking habits, with all the VAg participants having a reduction in their daily smoking intake, this was reported during the Midway- and the Post-Study-Interview. Three of the five VAg participants quit during the study, with two experiencing a relapse in the last two weeks of the deployment, compared to one participant, that presumably quit entirely before the Post-Study-interview, as expressed by Participant P07: "*Since the last time we talked, I have stopped smoking entirely, I think I quit around 16 days ago.*"

SPg: During the Midway-Interview, none of the four SPg participants reported a change in their smoking habits and only one of the four participants, Participant P03, had noticed a change in their cigarette craving: "*… I have become more aware of the fact that I smoke and do not act on my cravings right away, when I haven't smoked in a while [contrary to before the study].*" During the Post-Study-Interview, this had changed, as two out of four SPg participants experienced a decrease in their smoking cravings. One of the four SPg participants, although not reporting lower cravings, had quit smoking a couple of days before the final interview, as expressed by Participant P04: "*I stopped smoking, I really did it*."

Data Comparison: The VAg participants' change in their smoking habits is reflected in their QSU-Brief measurements as there was a decrease from the Baseline-measurements to the Post-Study-measurements. The VAg participants saw a decrease from *3.12(StDev=.59)* points in the Baseline-measurements to *2.20(StDev=1.16)* points in the Post-Study-measurements. The SPg participants did not report a change in smoking habits in the Midway-Interview. This is not reflected in their QSU-Brief measurements, as they reported a decrease from *2.93(StDev=.41)* points at the Baseline-measurement to *1.95(StDev=.64)* points at the Midway-measurement. Some SPg participants reported a decrease in their smoking habits at the Post-Study-Interview. This is not reflected when comparing the responds to their Midway-measurement, because of an increase from *1.95(StDev=.64)* points at the Midway-measurements to *2.20(StDev=1.16)* points in the Post-Study-measurements. From the Baseline-measurements to the Post-Study-measurements, the SPg participants did, however, decrease their Smoking Urges.

4.2.1.3 Motivation

VAg: Four of the five VAg participants reported that they had experienced an overall higher motivation to quit smoking during the study. Two of the three participants who quit, attributed their lack of motivation to use the prototype to their recent smoking cessation, as stated by Participant P01: "*I think that I gained motivation again after [the last interview]. But it fell again after I quit smoking. There have been a lot of ups and downs.'*

SPg: Four of the four SPg participants had felt their motivation decrease in regards to quitting smoking. Participant P04 expressed this: "*There has happened a lot. I have been very stressed. So this might have been the ideal time to use the app, but there has been so much else happening*."

Data Comparison: Varying motivation to use the prototype was also apparent, when scrutinizing the "Task Finished"-dataset. For the VAg participants, their average finished tasks went from an average of *7.20* at the first week, *2.40* at the second week, to a *3.80* at the third week. The average finished tasks decreased to *1.00* at the last week of deployment. For the SPg participants, their average finished tasks decreased from *4.25* in the first week, *2.25* in the second week, to *2.00* in the third week. The average finished tasks increased to *4.00* at the last week of deployment.

4.2.1.4 Platform

VAg: All five VAg participants reported positive experiences when they were asked how they perceived the prototype on a smart speaker. They reported that the accessibility and visibility within the home was particularly effective, as it served as a reminder to use it combined with swift hands-free interaction. They further stated that, when the smart speaker was situated near their usual smoking spot (by the balcony door or window) in a visible position, it promoted their usage, as stated by participant P01: *"I placed it in the bedroom, but I never used it there. I found that it needs to be very visible […]*" Others focused more on the smart speaker's capabilities to convey Mindfulness exercises and noted that if integrated on a phone, the screen might be distracting as stated by Participant P07: "[...] *I think it depends on the exercise. If it sets the stage for something visual the phone might work, but if you have to focus on other bodily functions, it might become a distraction on a smartphone.*"

Two of the five VAg participants also stated that a smartphone solution would provide a more discreet way of logging cravings, as they would potentially be able to type their cravings instead of verbally register them, or other use in social contexts as seen in this quote by participant P05: "*Maybe if I could log cravings. For example, if I'm out with friends for a beer and they smoke, then I could log if I got a craving.*"

SPg: Three of the four SPg participants found that the prototype was well integrated into the smartphone environment, however, Participant P09 reflected that Mindfulness exercises might work better with a smart speaker than a smartphone: "*Because you use a lot of focus on reading a whole text that is spoken aloud anyway, I think the mindfulness part would work better with voice control, which is to say if you get it read aloud.*"

Two of the four SPg participants only used the prototype at home, even though having access to it at any given point during the day, as stated by participant P09: "*I have not used [the prototype] while I am out, for example when I am out on*

the town or with other people. It is not really my first thought to pull out my phone".

When asked whether a combination of smartphone and smart speaker would work for them, three of the four SPg participants had some idea of how this could be done. One participant, Participant P02, reflected that they would use the prototype combined with a smart speaker, provided that the smartphone was the main interaction platform, and the smart speaker was secondary to it, for the sake of accessibility: "*If had a smart home, then I had to be an addition and not the main product."*

Data Comparison: Two of the four SPg participants reported that the Mindfulness exercises were better suited in a smart speaker environment. When looking at the "Task Finished"-dataset, the numbers indicate that SPg participants used the Exercise-function more frequently than other functions of the prototype, at 45% usage, compared to the 31% usage for the VAg participants.

4.2.1.5 Autonomous Practices

VAg: Four of the five VAg participants reported that they would often take what they have learned from the prototype, namely the Mindfulness exercises, and commit them to memory in order to practise them when their smart speakers were out of reach, for example Participant P01, reflected on how they could use exercises from memory as a substitution for doing a guided mindfulness exercises through the prototype:: "*Right now I'm doing an internship, which means that I have to do a lot of presentations and I am usually a little nervous. Then I used the breathing exercises to calm myself down.*"

SPg: Two of the four SPg participants reported using the techniques they had learned from the prototype, in situations outside the study due to frequent exposure to the exercises, as expressed by Participant P02: "*Sometimes I don't have time to use my phone, but then I would maybe use an exercise here and there. It's entertaining at least.*"

Data Comparison: When looking at the "Tasks Finished"-dataset, we find that the Exercise-function-usage is higher in the SPg participants compared to the VAg participants. When comparing the finished tasks with the interview findings, autonomous Mindfulness exercise practices (i.e. away from the prototype) are more prevalent in the VAg participants' interview data than for the SPg participants.

4.3 Dropout

We had a dropout rate of ≈61% (14 participants). The participants dropped out of the study in various ways. 11 participants by never responding nor installing the prototype and three by using the prototype for some days, eventually contacting the researchers, and informing them that they wanted to quit the study altogether. We reached out to all of the dropout participants. Out of the dropout participants, two responded to follow-up questions about their time in the study and the reason for their departure.

Participant D01 had a hard time interacting with the voice interface, due to the voice assistant not recognising their words, on account of their strong accent. Additionally the prototype would frequently shut down without warning. These technical problems made them quit the study.

Participant D02 also mentioned technical difficulties, with the greatest issue being that the prototype would not recognize their name, which combined with an already irritable state of mind due to nicotine withdrawal, made the interaction quite unpleasant and made them quit the study.

4.4 Summary

In this section, we have summarized our most relevant findings from the four week deployment of the prototype.

From the usage data we found that participants from both the SPg and the VAg interacted with the prototype roughly the same amount of times, and for the same duration. The VAg participants favored the Cravings-function and the SPg participants favored the Exercises-function. The participants used the prototype the most on the weekdays, compared to weekends.

When looking at the participants' level of Mindfulness, measured from the FFMQ-15 questionnaire, the VAg participants had a higher overall measurement value compared to the SPg participants. Mindfulness for the VAg participants increased slightly, where the SPg participants' increased substantially, during the entire study. When we asked the participants about this in the interviews, we found that five out of the five VAg participants and three of the four SPg participants reported higher levels of Mindfulness during their time in the study.

When looking at the participants' level of Smoking Urges, measured from the QSU-Brief questionnaire, the VAg participants had a higher overall measurement compared to the SPg participants. Both participants groups Smoking Urges fell substantially during the study. When we asked the participants about their potentially changed smoking habits in the interviews, we found that five of the five VAg participants reported positive change in their smoking habits, with three out of five attempting to quit, of which two experienced a relapse. There were two of four SPg participants that reported a positive influence on their smoking habits, with one quitting.

Four out of five of the VAg participants reported increased motivation to quit smoking during the study. Two of four SPg participants felt their motivation to quit had moderately increased during the study.

Two out of five VAg participants stated that a mix or an exclusively smartphone platform would be better for some functions, like tracking Cravings. Three of the four SPg participants spoke positively of combining the smartphone- and the smart speaker platform.

Finally, four of the five VAg participants reported using what they have learned from the prototype in their everyday life.

Where two of the four SPg participants used what they had learned from the prototype in their everyday life.

5. DISCUSSION

In this section we will discuss the findings of the study, in addition to our process and the participants. Finally we will give some suggestions for further research into the topic.

5.1 Dropout

With the current set-up we experienced a *61%* dropout-rate, which initially sounds like a lot. But the rate is within the range of normality, when accounting for long-term studies, as the attrition rate is usually reported to be from 30% to 70%, and often increases for longer study durations [67]. Through the answers from the dropout participants, we learned that the participants experienced technical difficulties and became frustrated, which was their reason for dropping out. A solution to a decrease in the dropout-rate could be, by offering potential rewards and, thereby, developed a more personalized relationship with the participants, to increase their motivation for continuous participation in the study [68]. An additional solution could be, to recruit participants in high numbers, to address the dropout-rate, that is to be expected in long-term studies.

5.2 Mindfulness

All nine study participants reported that their level of awareness had increased to some extent since the start of the study. Two of the nine participants mentioned, however, that the increase was exclusive to their smoking habits. The difference in the change of overall awareness between the participants, was to be expected [32].

It is important to note, that translating the techniques and principles of MBRP[1] to a VUI environment [41], has demanded change in the programme in various manners. The selection of techniques were dependent on whether they could be transmitted using the auditory modality. There were some limitations regarding the state of VUI technology, which remains unable to understand conversational contexts, such as sarcasm, and distinguishing between current and previous conversations. We omitted complex Mindfulness techniques, such as facilitated reflective conversations between the facilitator and the participant, and group-based Mindfulness exercises. This could arguably have had an effect on the participants achieving a higher level of awareness.

5.3 Smoking Cessation

The VAg measurements indicate that even though the VAg participant's reported levels of Mindfulness decreased from the Baseline-measurements to the Midway-measurements, they still had a noticeable change in their Smoking Urges. This makes it difficult to assess any results from the measurements alone, as the VAg participants reported an increase in their level of Mindfulness, from the Midway-measurements to the Post-Study-measurements. The SPg participants measurements are also difficult to decipher, as their overall level of Mindfulness increased, but decreased at the last measurement, meanwhile their Smoking Urges decreased and increased during the study.

While the participants mentioned quitting smoking, it needs to be addressed that two of the four participants who mentioned quitting, experienced a relapse during the study, and may have quit and relapsed again, after the duration of the study. It is likewise noteworthy, that quitting nicotine is considered extremely hard to accomplish, with one study claiming that only 70% of the US smoker population wanted to quit, of which 50% attempted to do so and 7% succeeding [10].

5.4 Theoretical Background

As mentioned in section *2.*, we opted to not utilize all the tools available from the SCT framework which regarded causes of behavioral change, such as *Observational learning* [32, pp. 173–174]. This is largely due to the nature of the prototype, as it is expected to be an individual experience, instead of a group experience. However, offering a more collaborative approach might prove useful for some individuals. Marlatt also emphasizes the importance of social support as the eight-week course is structured around group sessions, where the individuals relate and reflect on their own, as well as other's experiences [1].

Employing collaborative strategies, would however require further iterations of the present prototype and could include features such as a social craving tracking scoreboard, a messaging system, rankings and a potential exercise sharing feature [69]. Deciding which strategies would be most effective for both a VUI- and a rich-VUI interface is, however, beyond the scope of this study and requires further research.

5.5 Prototype

As mentioned, there were various general issues with the prototype's implementation. The development environment is intended as a design platform for creating simple drag-and-drop applications, meant for the Google Assistant. This consequently means that most of the custom functionality e.g. storage, login and statistics, are handled through webhooks, that run separately from the conversation logic. This caused issues in regards to version control, as we had difficulties determining which version the participants were running, as we addressed the potential problems that the participants disclosed to us. There were also some issues regarding the storage of user data, where the prototype would delete user storage, as expressed in section *4.3*. Issues were found on Apple smartphones, where the participants mentioned difficulties in setting up the prototype on their standalone "Google Assistant"-app, which was not an issue for the participants that were using a smartphone with Android installed. The prototype was deployed as a beta-version on the Google Assistant environment, which practically means that the application would not be discoverable in the application marketplace. This made it troublesome for the participants with an Apple smartphone, as they needed to access the application through a computer

and agree to become beta-testers, before accessing it on their smartphones, which was not an issue for the participants with an Android smartphone, as they could access the link through their smartphones.

A solution for the various problems that erupted due to the custom functionalities, could be solved by developing on an open development platform (i.e. Mycroft [70]). If switching platforms were a problem, a solution for a variety of the problems could be solved if the application was deployed as a released version. This would additionally make it easier for the participants of all devices, to install the application.

5.6 Platform

The SPg participants mentioned the high-accessibility as a positive, as expected due to the nature of their device. Some SPg participants mentioned, however, that they exclusively used the prototype at home, due to social contexts. The absence of accessibility was mentioned as a drawback by the VAg participants, as they only could interact with the prototype where they had placed the smart speaker. It was, however, reported by the VAg participants, that the visibility of the smart speaker increased usage, because they were reminded to interact with the prototype, simply by laying eyes on their smart speakers. Furthermore, the VAg participants reported that when the smart speaker was placed near their usual smoking spot, their usage increased.

The VAg participants reported higher effects of the Exercises-function, which can be attributed to only receiving guidance through audio, enabling the participants to focus their attention on themselves and their immediate environment. When developing the prototype, we found that the conversational elements in the two platforms needed to be delivered differently. The smartphone environment allowed for more information being conveyed, as well as additional ways of allowing the user to interacting with the prototype, such as suggestions of how to continue in the conversation and menu items.

5.7 Future Work

Our aim for this exploratory study was to act as a stepping stone for future research regarding VUI design in relation to counteracting substance abuse, through the rising under-researched technology of voice assistants. We, furthermore, wish to highlight some of the advantages and disadvantages from facilitating Mindfulness through a VUI, in smartphones and smart speakers.

An issue raised by the participants was the lack of visibility and the lack of reminders, to remind them to use the prototype. It would be interesting to find a solution to this issue by conducting further research on the topic. Utilizing reminders with VUI needs further research, as we believe that they can become a nuisance for the user. Reminders in the context of relapse prevention also needs additional research, as we feel that a reminder could unwillingly become a High-Risk Situation to trigger smoking.

Some participants mentioned the need for a combined smartphone and smart speaker solution. We believe that it would be interesting to address this with further research, as this would allow for utilizing the strengths of each medium, e.g. accessibility and the potential effacing of a screen, when conducting a Mindfulness exercise at home.

From the literature, as well as our participants, we learned that individuals react differently to Mindfulness techniques. To accommodate the prototype to the differences in individuals, it could be interesting to implement tailored experiences. This could be accomplished by delivering relevant techniques and conversations depending on the use and in-app feedback on Exercises and Reflection questions by the users, e.g. when users saw an effect from certain Exercises, their future Exercises would contain similar elements. Future research could also be made in terms of demographic and personality of the users, to research whether certain links could be made to tailor the experience to specific groups. It is important to mention that the demographics of this study were mainly participants below the age of 30, with some experience with VUI and smartphones, and that the participants were motivated to quit smoking. Future research could be made regarding how to facilitate Mindfulness for smoking reduction for people of other demographic backgrounds, motivation to quit smoking and technical abilities.

Mindfulness can, as mentioned in section *2.,* be used to affect other ailments and conditions. Future research could, therefore, explore whether Mindfulness facilitated through a Voice Assistant could be used for other contexts, such as other unwanted habits (i.e. reducing other substances) or affecting psychological conditions (i.e. stress). The prototype's functions were highly dependent on user motivation - meaning that the users had to access the function when they felt they needed to do so. We experienced, as mentioned in section *4.2.1.3*, that the participants who quit smoking, also stopped using our prototype. Further research needs to be addressed of how to incentivize continuous use of the device, after the user has quit. A solution to this, could be to deliver a structured plan of action through the prototype. Either structured as a weekly programme or smoking cessation timelines, where they had to go through certain predetermined content in that timeframe.

6. CONCLUSION

In this paper, we report the efforts to understand the differences between Voice User Interfaces (VUI) and a rich-VUI (a combination of VUI and Graphical User Interfaces), regarding mediation of Mindfulness techniques through the design of a prototype. In summary, our findings showed noticeable differences between how each prototype was experienced for each group of participants, how the participants experienced Mindfulness and how it affected their smoking urges and habits. Through our study, we discovered that Mindfulness techniques can, with initial

signs of effect, be mediated through a VUI and a rich-VUI system alike. We also found, that the type of techniques that are mediated, may work better through one medium, than the other, i.e. awareness and focus techniques were reported to work more effectively in the smart speakers, and features with dense information work better through the smartphones. Furthermore, we found that high accessibility through a smartphone application, does not equate consistent use, and that physical visibility and device placement serves to remind the user of consistent interaction. Lastly, we found that users are willing to memorize and practice techniques that they have learned, if they find them useful. We hope that this exploratory study can serve as a stepping stone for further research into the field of VUI. There are noticeable differences in how the participants experienced the two prototypes, but we can not conclude whether one medium is more effective than the other, as we require significant evidence for that purpose. Further inquiries are needed in the field of mindfulness mediated through voice user interfaces.

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