Supporting or inhibiting motivations to meditate? A semi-structured interview study of the user experience of mobile mindfulness apps

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ABSTRACT
Mindfulness meditation has become popular both as a clinical treatment and within society more generally as a means to support mental wellbeing. This has led to the availability of a large number of mindfulness mobile applications ("apps"), which aim to support the development and maintenance of a mindfulness meditation practice. Although there is considerable research from a clinical perspective into the efficacy of mobile-based mindfulness interventions, there is relatively little research into understanding the user experience of more commonly used mindfulness apps. A semi-structured interview study was carried out with ten participants into their experiences of using such apps as part of their own mindfulness practice. The use of iterative Grounded Theory techniques to analyse data from the interviews allowed for the emergence of a core theme. This revealed that participants generally found their apps helped to support their mindfulness practice; however some aspects of app functionality, such as reminders, progress tracking and app-based communities, were found to conflict with participants’ motivations to meditate and attitudes towards meditation. Deci and Ryan’s Self-Determination Theory, a mature framework for understanding types of motivation and the contexts which foster or inhibit it, was used to analyse the results. A follow-up survey was conducted in order to test the results of the interview study by gathering participants’ responses to the use of notifications, statistics and community. Respondents to the survey were more positive towards these functionalities. A suggested explanation is, due to recruitment methods, the survey respondents represented a different population of users. Implications for the design of mindfulness technology are discussed, and suggestions for further research are examined to clarify the discrepancies between the interview and survey results.

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Mindfulness; Self-Determination Theory; Persuasive Technology.

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Empirical.

1. INTRODUCTION
Mindfulness meditation is a practice central to Buddhist tradition that involves cultivating an ability to pay attention to one’s experience in the current moment [29]. Since the development of clinical mindfulness-based mental health interventions for stress reduction and prevention of relapse into depression in the late 1970s [29], mindfulness has become increasingly practiced in a secular context. In more recent years, mindfulness meditation has found mainstream acceptance in healthcare and society more generally.

The growing popularity of mindfulness has been reflected in a surge of technological products claiming to help develop or maintain mindfulness meditation. Smartphone applications ("apps") such as Headspace (www.headspace.com), Insight Timer (insighttimer.com) and Buddhify (buddhify.com) offer a range of functionalities, including guided meditations, timers, activity tracking, alerting and app-based communities aimed at supporting users’ mindfulness meditation practices.

Much of the research on technology-supported mindfulness has been undertaken from a clinical perspective, concentrating on evaluating the effectiveness of interventions. There has been comparatively little research from a HCI perspective into the user experience of mindfulness technology, such as evaluating how functionalities support users’ needs. The aim of this study was to understand how mindfulness smartphone apps were used by participants, and the extent to which their design facilitated participants’ mindfulness meditation practices. A

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This project report is submitted as an examination paper. No responsibility can be held by London University for the accuracy or completeness of the material therein.
A semi-structured interview study was conducted to examine in depth participants’ experiences of using mindfulness smartphone apps.

The use of a Grounded Theory methodology [11] to analyse interview data revealed that participants did perceive the smartphones apps they were using to be generally usable and effective in supporting their practice. However, an emergent theme suggested that certain functionalities were found to be unhelpful or even counter-productive. Analysis focused on understanding why these functionalities, namely alerting, progress tracking via the use of statistics and app-based communities were viewed negatively by users. Self-Determination Theory [16] a mature and established theory of motivation was used as a framework with which to interpret the interview data, which suggested that participants’ motivations to meditate were not supported by these functionalities.

A follow-up survey sought to test the findings of the interviews in respect of alerting, tracking and community. However, the results did not support the interview findings, in that respondents largely reported more positive reactions to these functionalities. Reasons for this are discussed, including the limitations of the survey, but also the possibility that different user populations were represented in the interviews and surveys. These differing results suggest implications for the design of mindfulness-supporting technology, and highlight potential directions for further research.

2. LITERATURE REVIEW AND BACKGROUND

Overview
Mindfulness-supporting technology has attracted interest from both the clinical and human-computer interaction communities. In order to place the current study in a wider context, recent work from both perspectives is considered. The evidence base for common functionalities used in mindfulness technology is examined, along with recent work critiquing these. Self-Determination Theory and its application within HCI and health behaviour change are also examined.

Mindfulness meditation
Jon Kabat-Zinn describes mindfulness as “paying attention in a particular way: on purpose, in the present moment and nonjudgmentally” [30, p.4]. Bishop et al. have operationalised mindfulness in a clinical context as having two key elements: the self-regulation of attention and development of an openness to one’s current experience [5].

Although mindfulness is not a state of mind that may only be experienced during meditation, it is most often taught via formal practices such as sitting meditations in which practitioners focus their attention on their experience of the current moment, for example by paying attention to the breath (e.g. [29]).

Kabat-Zinn’s work at the University of Massachusetts in the late 1970s led to the establishment of mindfulness-based clinical interventions for pain relief and mental health, such as the group-based eight-week Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Cognitive Therapy (MBCT) programmes [25]. The National Health Service currently recommends mindfulness to improve mental wellbeing [42]. Randomised controlled trials have highlighted the effectiveness of mindfulness-based treatments and found that mindfulness promotes effective emotional regulation, minimises negative affect whilst cultivating positive affect, leads to less reactive behaviour and may also lead to improved physical health as well as an improved sense of wellbeing [13].

Outside the clinical context mindfulness has gained popularity in a number of other areas, including in the workplace [28]. A recent parliamentary group report examining the benefits of mindfulness in promoting greater quality of work life and reducing costs within the NHS [3]. In fact, it could be argued that mindfulness has achieved mainstream acceptance even within the corporate world, with Google recently having appointed a head of mindfulness training [12].

Mindfulness technology
An informal examination of the number of mindfulness apps available on the Apple App Store was carried out at the beginning of the study, in June 2015. Using “mindfulness” as a search keyword term, over 590 apps were identified. Popular smartphone apps include Headspace (www.headspace.com) which provides mindfulness training in the form of audio and video guides in multiple languages, and Insight Timer (www.insighttimer.com), principally a meditation session timer with additional audio content and an app-based community.

Functionalities of mindfulness technology
It is not practical to detail the features of all available smartphone apps here, but those used by participants in the study demonstrated common functionalities. A number of functionalities have been highlighted and described in previous surveys of mindfulness technology. Plaza et al. [47] summarised eight commonly used features in mindfulness apps, cross-referencing these to Klasnja and Pratt’s more general survey into mobile health interventions [33]. These features were:

1. Individual practice and supervised training
2. Tracking and monitoring of mindfulness practice and related health information
3. Access to health professionals and trainers
Klasnja and Pratt describe self-tracking as having a theoretical basis in earlier research from the field of behaviour modification, in which it was suggested that it could encourage positive behaviours, whilst decreasing undesired ones [33]. The popularity of self-tracking may also be linked to the Quantified Self movement, initiated by Wolf and Kelly, editors of Wired, in 2007. The Quantified Self Movement aims to apply data processing to measurable human activities and behaviour [48].

Critiques of self-tracking have suggested that is only partially successful as a strategy, with desired behaviour returning to its pre-tracking level if stopped or the app abandoned [57]. The demotivating potential of tracking has also been shown in a study with young adults into their perceptions of health apps [19].

The use of reminders and alerts has been discussed in both behaviour change and HCI literature. Planning is described as a key strategy for transforming intentions to act into behaviour in theories of behaviour change [35]. Reminders of goals or intentions to act have been demonstrated to increase rates of activity in participants in experimental studies [35]. Fogg [21] describes the use of alerts as triggers to activity as an important factor in his model of persuasive design. However, for alerts and reminders to be effective, they must be appropriately timed [21; 35]. Inappropriate reminders can lead to annoyance or a sense that the user is being “nagged” [19].

Social influence has been shown to be important for recovery and rehabilitation in health care [33]. Interacting with non-professionals who have had similar experiences is also believed to be effective in encouraging behaviour change [35]. Social influence in mobile apps has tended to be implemented via the use of mechanisms that offer encouragement or foster competitiveness [33]. In the health domain, competitiveness, whilst popular with some users has been shown to be demotivating to others. Dennison et al. [19] have shown that some groups of users have also demonstrated a reluctance to share information, particularly on social networks for fear of appearing vulnerable.

Clinical perspectives on mindfulness technology
Studies from a clinical perspective have understandably largely concentrated on examining mindfulness technology in the context of its efficacy as a medical intervention. Studies identified may be classified as randomised controlled trials (RCTs) and design and evaluation of particular technologies.

Randomised controlled trials
Internet-based mindfulness interventions have been considered by a number of authors. RCTs of the efficacy of internet-delivered mindfulness programmes have been conducted by Boettcher et al. [6], Cavanagh et al. [10] and Glück & Maercker [23]. Boettcher et al. and Cavanagh et al. demonstrate that internet-based mindfulness programmes had a statistically significant effect on improving mindfulness and reducing anxiety, stress and depression symptoms. Glück & Maercker’s study was less conclusive but suggested that mindfulness programmes could be successfully delivered online and help alleviate negative affect for regular users.

Design and evaluation of technologies
Beyond running and examining RCTs, clinical research has also considered design and evaluation of mindfulness technology, although again from a clinical rather than human-computer interaction perspective. Some studies have used quantitative methods to examine the efficacy of the technology. For instance, Ly et al. [38] consider the effectiveness of a smartphone application designed to support Acceptance and Commitment Therapy (ACT) which employs mindfulness techniques. Ly et al.’s study was not able to draw any significant conclusions about the efficacy of their application in terms of how it supported participants to live according to their values, a primary aim of ACT. However, it highlighted that the user experience of the application was largely positive and suggested that smartphones may become an increasingly important way of delivering mental health interventions.

Other studies have sought to broaden their focus to include qualitative methods to understand the user experience of specifically designed mobile applications. Ahtinen et al. designed and evaluated an ACT-supporting smartphone app, Oiva, in a one-month field study, supplemented with...
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Morris et al. [39] describe the evaluation of a mobile app to encourage greater self-awareness of emotions, using experience sampling and interviews. Although their app was not specifically designed to support mindfulness, in increasing self-awareness its aims coincide more generally with a mindfulness practice. The study revealed that the app was well-received and used by participants to log mood.

Clinical research on mindfulness technologies offers insights into the efficacy of mindfulness as a treatment and has made some progress towards understanding the user experience of using technologies. However, for understandable reasons, it does not share principal concerns or methodological approaches of HCI.

HCI perspectives on mindfulness technology

From a HCI perspective, studies on mindfulness technology have generally concentrated on design and evaluation of both new and existing technologies. Some studies have evaluated novel and exploratory design artefacts intending to promote or support mindfulness. Thieme et al. [58] evaluate the use of a tactile physical object aimed at promoting mindfulness, the Sphere of Wellbeing, with a community of hospital-bound women suffering from borderline personality disorder. The artefact produced was the output of a user-centred design process, which included collaborative design with the women affected. However, the study does not report on the extent to which the artefact was used or how it was evaluated to discover if it supported its users’ ongoing needs.

Vidyarthi and Riecke [60] discuss the Sonic Cradle, an immersive environment for calming and encouraging mindfulness of the breath. This exploratory interview-based study demonstrated the possibility of creating an interactive environment which simulates an experience similar to mindfulness meditation. Gromala et al. [24] describe an experiment with a virtual reality based tool intended to teach participants Mindfulness-Based Stress Reduction techniques to deal with pain. Assessing participants’ levels of pain using pre- and post-experiment questionnaires, they show the effectiveness of virtual reality-based methods compared to more traditional audio-based training.

Despite the promising findings of these innovative studies and their potential to influence the design of further generations of mindfulness-supporting technologies, they have generally focused on technologies not readily available to the majority of users.

Evaluative studies of existing widely available technologies, such as smartphone apps, are less common in HCI literature. Laurie and Blandford [36] describe a semi-structured interview study with users of the Headspace mobile app. This demonstrated that users had difficulty finding time to use the app in their day-to-day lives, and that usage was influenced by a number of factors, from perceived self-efficacy, affective state, social norms and relationships [36]. The study was focused on Headspace only and participants were new to the app, using it for the first time during the study. The concentration on one technology makes it difficult to generalise the findings to other similar apps. Additionally, as the authors acknowledge, users’ experience of the technology is likely to change as their meditation practice develops [36].

Evaluating the user experience of mindfulness technology

A number of methods, then, have been used to evaluate mindfulness technology: from controlled experiments to qualitative studies. Although clinical researchers have aimed to measure the effectiveness of mindfulness technology via RCTs, this is not an effective method for HCI practitioners. As Hekler et al. [26] suggest, HCI studies are usually smaller scale, so RCTs are not an appropriate evaluation method.

Klasnja et al. [33] question whether HCI researchers can effectively assess whether a technology has achieved its aim of effecting behaviour by running shorter-term evaluative studies during the early stages of a technology’s development, as behaviour change is a longer-term process. As an alternative they highlight the importance of qualitative studies to understand why a technology may be successful or otherwise [33].

Evaluating with reference to theory

Hekler et al. [26] suggest that existing behavioural theory can have a role for HCI researchers in interpreting qualitative data. For instance, researchers might use coding schemes based on theory to assess particular functionalities, such as whether users’ sense of self-efficacy is increased by the technology [26]. Laurie and Blandford [36] describe the use of the Reasoned Action Approach (RAA) to interpret the results of the interview study with Headspace users. Whilst RAA was found to be useful in explaining participants’ experiences, it could not account for all participants’ experiences, it could not account for all differences theory to interpret quantitative and qualitative data to understand the motivations of different types of users of a fitness app, Freeletics. TPB was chosen for its predictive and explanatory models of human behaviour, and when combined with theory of individual differences,
allowed for the identification of user types whose differing needs have implications for the design of the technology considered.

Extant theory, then, may be a useful tool with which to interpret data and to understand user motivations and behaviours.

**Self-Determination Theory**

As described below, analysis of qualitative data followed a Grounded Theory methodology and, as such, a standpoint of “theoretical agnosticism” [27] was adopted throughout the initial stages of analysis. However, as themes emerged from the data, extant theory was examined in order to assess whether it could explain or clarify these themes.

Participants in the interview study demonstrated high levels of self-motivation to meditate. Motivation has been shown to be an important factor in effecting behaviour change [32; 51]. Spring et al. [56] describe motivation as an “engine that drives the entire behaviour change undertaking” (p.35). Therefore, it was considered that analysing results with reference to participants’ motivations could help explain their attitudes and behaviours.

Deci and Ryan’s Self-Determination Theory (e.g. [16]) was selected as a theory or “conceptual framework” [26] with which to interpret the results of the interview study. Self Determination Theory (SDT) is a mature and tested framework (e.g. [14]) for considering the contexts in which individuals’ motivations to engage with activities are either promoted or inhibited by the context in which they undertake them. The interview study results are considered within the context of SDT in section 5.

SDT is described by Deci and Ryan as a “macrotheory” [17] and consists of a set of sub-theories which describe different types of motivation and their effect on effectiveness and personal wellbeing [17]. A number of sub-theories were found to be of particular relevance to the study: Cognitive Evaluation Theory (CET); Organismic Integration Theory (OIT) and Relationships Motivation Theory (RMT). CET suggests that, by addressing individuals’ psychological needs for competence and autonomy, their intrinsic motivation to carry out actions is encouraged [18]. OIT considers that motivations exist on a continuum between amotivation, through more regulated extrinsic motivations, to fully autonomous intrinsic motivations [16; 18]. Extrinsic motivation can be defined as acting in order to obtain reward and status, whereas intrinsic motivation can be considered as carrying out an activity for its own sake [17; 52]. The continuum of motivations highlights subtleties in differences between types of motivation and does not assume that all autonomous motivations are entirely intrinsic. RMT posits that, alongside autonomy and competency, relatedness, a sense of meaningful connection to others, is a primary psychological need, which when met leads to a greater sense of wellbeing [15].

SDT has been used as a framework with which to design behaviour change interventions [51]. For instance, studies have shown that supporting patients’ autonomy can help them internalise the goals of the treatment, leading to more effective outcomes in terms of continuing to take medicine and maintaining weight loss [51]. SDT has also been applied to mindfulness in order to explain why it facilitates wellbeing, suggesting that developing greater awareness may lead to improved self-regulation in order to act in accordance with one’s values and psychological needs [8].

SDT has also recently been used by HCI researchers in a number of different design and evaluation contexts. Burgers et al. [9] use it as a framework for understanding game player motivation, suggesting that both negative and positive feedback can motivate sustained game play by challenging or encouraging players’ sense of competence. The study suggests that players can aim to increase their competence if challenged by negative feedback; but if encouraged, can experience an increase in their sense of competency and autonomy [9]. Olney and Cade [44] used SDT principles to promote users’ intrinsic motivation in the design of a tutoring system in which students co-created instructional materials by reflecting on reading materials and reviewing each others’ work. Naderi et al. [41] describe their work on a questionnaire to measure extrinsic motivation amongst those involved in crowdsourced “micro-tasks”. The aim of the questionnaire was to assist in the design of incentives for crowd-workers that increase intrinsic motivation, thus improving the quality of their work and sense of wellbeing [41]. Schneider, Hill and Blandford [53] analyse the findings of a semi-structured field study using SDT in order to propose improvements to the design of a patient-controlled electronic health record system. Patients with avoidance oriented styles of coping were shown to be less motivated to use it. By drawing on SDT, they recommend design changes which promote competence in using the system, autonomy in choosing if and when to use it, and relatedness by fostering a digital support network [53].

As an established framework with which to examine motivation, SDT has been used in a number of different contexts, including in some work by HCI researchers. However, despite the primacy of motivation in effecting behaviour change [56], it has not been extensively used within HCI research to analyse users’ experiences of behaviour change technology more generally, and mindfulness technology specifically.

**Contribution of the study**

This study aims to address gaps in current HCI research into mindfulness technology by (1) understanding users’ experiences of commonly-used mindfulness smartphone apps through the use of semi-structured interviews; (2) using established extant theory about motivation (SDT) to
analyse the data, in order to examine how the design of aspects of current technologies do not support user motivations to meditate; and (3) using the study’s findings, supported by theory, to suggest design changes to better support users’ motivations to meditate.

3. METHOD

The study was carried out in two stages. The first, a semi-structured interviews formed the main part of the research. In total, twelve interviews were carried out with ten participants. Grounded Theory techniques [11] were used to analyse the findings of the initial interviews. This allowed for the identification of emergent themes and further iteration of the interview scripts to explore these. Following analysis of the data and the identification of the core theme, a second stage consisted of a follow-up online survey. This aimed to test the findings of the interviews by asking a series of short questions about respondents’ experiences of alerting, tracking and community functionalities that interview participants had shown ambivalent attitudes towards. The survey is considered in section 6.

Initial research directions

Initial research questions for the study were (1) how do people choose and evaluate mindfulness apps? (2) what particular user experience issues do people encounter when using them? The research questions were deliberately broad, allowing for the emergence of more specific topics within them to emerge through the use of semi-structured interviews.

As the research evolved through analysis of semi-structured interview data and iteration of interview scripts, the question of choice and evaluation of apps became secondary to emerging topics around ambivalence towards certain functionalities.

Semi-structured interviews

Participants

Ten participants took part in the semi-structured interviews, with two earlier participants taking part in further interviews. Four female and six male participants were recruited. Four participants were aged between 18-24 (three female, one male); three between 25-34 (one female, two male) and three between 35-44 (all male). A more detailed breakdown of participants may be found in Appendix A.

Recruitment took place via two principal methods: through friends and contacts of the researcher and via internal recruitment mechanisms at UCL (emails to student groups organised by computer science school administration and the Psychology Subject Pool). Participants were either known as users of mindfulness apps or had to complete a brief screening survey to ensure they were eligible for the study. Due to the specialist nature of the study and constraints of the researchers’ time and resources it was difficult to recruit a wide range of participants.

The study was approved by the UCL Research Ethics Committee. Before taking part in the study participants were fully briefed and asked to complete a consent form. Participants were paid £10 for taking part in the study.

Materials

In order to take part in the study, participants had to have been using digital mindfulness technology. No further constraint was placed on the type of technology, although all participants used smartphone apps. Participants were asked to bring their smartphones loaded with the apps they had been using. For reasons of privacy the researcher did not look at participants’ phones in the sessions but encouraged participants to use them as prompts should they need to remind themselves of any aspects of functionality during the interviews.

Procedure

Participants were asked questions around a number of topics to learn about their meditation practice, choice of technology, user experience issues and perceptions of the role that the technology had played in assisting them to develop or sustain a mindfulness meditation practice. The same basic script was used for all initial interviews to ensure the same topics were covered, although some questions were more open to elicit a range of experiences. In line with Grounded Theory methodology [11] scripts were iterated upon following data analysis of the initial interviews allowing for the exploration of emerging themes. Additionally, interview scripts were not designed with any bias towards existing theory, allowing themes to arise inductively [11].

Two participants who had been interviewed early in the study took part in further interviews in order to explore the emergent themes in greater depth with them.

Interviews were recorded with the participants’ consent and transcribed for data analysis.

The coding structure applied to the data was iterated upon a number of times, via initial and focused coding. Initial interviews were transcribed and coded “line by line” to derive the original codes [11]. Subsequent interviews were transcribed and coded using constant comparative methods [11] to compare data with data and the derived codes with the data. Finally, the entire set of interviews was re-examined in order to compare the data with the iterated codes and to derive the final set of codes.

4. RESULTS

Use of Grounded Theory methodology allowed for the formation of categories inductively, rather than from
forcing data into preconceived categories [22]. The core theme that arose from the categories is examined below, that participants demonstrated an ambivalent attitude towards mindfulness technology. Whilst finding that technology was generally useful in supporting participants’ mindfulness meditation practice, aspects of it were found to be in conflict with participants’ motivations, attitudes and behaviours in relation to meditation.

In order to understand the extent to which technology supported participants’ motivations, attitudes and behaviours, these are first briefly examined below. This is followed by considerations of categories relating to how technology positively supports participants’ practices and how participants perceive the role of technology in developing or maintaining a practice. Lastly, categories are explored relating to the areas in which the design of the technology appears to be misaligned with participants’ motivations, attitudes and behaviours.

4.1 Understanding participants’ motivations, attitudes and behaviours

Reasons to meditate

Spiritual reasons
Participants described a number of different reasons why they developed and maintained a mindfulness meditation practice. Despite mindfulness’s origins as a practice rooted in Buddhism, only two participants cited spiritual motivations to explore meditation, and for one this appeared a secondary concern.

“It was for health reasons but I was also drawn to the spiritual aspects of meditation through Buddhism, so reading around that. I did a Vipassana retreat in Thailand ... it was quite tough.” (P10)

“My life goes more to finding peace and happiness in myself and then from there it goes from happiness and peace to others so I’ve always found it’s an essential thing, it should be part of my life... My mental health is the most important thing for me”. (P6)

“I was in hospital for about 9 months and in that time they recommended meditation.” (P5)

Improved attention and awareness
Two participants reported using meditation to improve their ability to improve their attention and awareness. One participant felt her attention scattered by too many demands and activities:

“I generally don’t get very stressed, I don’t have the natural propensity to it. For me it’s more like my mind tends to shoot off in a million different directions everywhere. Like that movie Up. I have a million different hobbies, and all these things I need to get done at work. It’s more of a focus thing than a stress thing.” (P2)

A second participant similarly reported that she felt that she was unable to keep her attention focused on her direct experience when travelling, and that she developed a mindfulness practice to improve her awareness:

“I started mindfulness as I wanted to be more aware. I was backpacking and thinking I’m here in this amazing spot but my mind is wandering. I didn’t want to be looking through a camera.” (P3B)

Attitudes towards meditation
Participants expressed different beliefs about what mindfulness meditation was, which sometimes departed from more formal definitions.

Perhaps unsurprisingly, more experienced practitioners demonstrated a subler understanding of the purpose of meditation and three of these expressed how meditation had become more of an attitude towards life, rather than a discrete activity.

Health and wellbeing
The most common reason for meditating expressed by participants was a desire for improved health and wellbeing. Four participants described wanting to address a mental health issue they were suffering from. Their discovery of meditation was largely self-motivated, with only two participants reporting having had it recommended to them by a medical professional.
“It works and it’s something I identify with. It’s part of [my] lifestyle. It makes sense.” (P1A)

“This is more like a long term attitude towards yourself, putting question marks and evaluating how you feel, try to focus on the things you’re worried about.” (P3A)

“…I’ve tried to describe [meditation] in a popular way but I’ve come back to a mindset you can approach at any point of the day—you can travel into work meditating.” (P10)

Two participants who were less experienced expressed a more ambivalent attitude to meditation. One of these had been directed by a medical health professional to take part in meditation sessions as part of a therapy programme in hospital, rather than exploring it in a more self-directed fashion as had other participants.

“I was sceptical about meditation—I found it hard to concentrate. I find it easier when it’s not so structured. In the groups [it was about] breathe in, breathe out. I didn’t find that very helpful, I found it frustrating.” (P5)

Another had only recently started exploring meditation as a way to cope with a change in life circumstances and expressed an uncertainty as to whether he would carry on with the practice if he did not notice any obvious results.

“I want to see how it goes. If I don’t have problems any more, I won’t. That depends on how I feel. If it really helps me and I feel it makes some improvement in my life I might go on.” (P7)

Behaviours
Ability to meditate was affected by a number of environmental factors, including available time to meditate and the importance of an appropriate location to practice in. Due to demands on time, lack of suitable place to meditate or other changes in life circumstances, participants expressed the need to be flexible about when, for how long and even where they meditated.

“When I do get stressed and have a lot of work I don’t find the time which is probably not very good.” (P5)

At the moment, [I meditate] as and when I get the time. Ideally I want to get back to a more regular schedule but various schedule changes, like I have to get into work earlier than I used to, things like that. It makes it more difficult to get quiet time.” (P1B)

“London is a bit busier… but I still to try to meditate every day. But I have tube sessions, so I have 10 minutes listening to Headspace on the tube.” (P6)

Importance of location
Having an appropriate location was felt by four participants to be an important factor affecting their ability to meditate.

“The main issues have not really been technical obstacles—the non-digital stuff like having the time and quite enough space, that sort of thing.” (P1B)

“For me meditation is home, when I’m alone, when I can focus on what I want. I don’t think you can meditate when you’re walking to school, because you’re distracted.” (P7)

“The place needs to be fresh and calm, e.g. not in the kitchen, a shared space. You need to communicate to others, so they don’t put the TV on.” (P3B)

“When it’s going well I do it at home. Sometimes I do it on public transport which is of limited value compared to doing it at home.” (P8)

Change in life circumstances
Due to issues with recruiting a broad range of participants, over half of those interviewed were current or recent students. Five participants reported on how a change in their life circumstances, such as moving to a new city or starting a postgraduate course had also affected their meditation routine. One participant summarised the effect of external factors on the ability to meditate thus,
“Meditation, it depends on you, the time of your life. It’s like climbing, depends on factors in the environment.”

(P3B)

4.2. Technology supports participants’ mindfulness meditation practices

Participants reported positive experiences of using mindfulness-supporting technology and expressed perceptions that the technology assisted them in developing and maintaining their practice.

Finding technology usable

Four participants commented on the usability of the smartphone apps they were using, commending them on their simplicity and “user friendliness”.

“It’s a very clear interface, it’s not particularly fancy as an app. Sometimes that’s not a bad thing. It probably suits a meditation app that’s it uncluttered. There’s nothing that’s ambiguous in the design. It’s very straightforward.” (P1A – Insight Timer)

“I like the app, how it works, I find it very friendly I would say.” (P3A - Buddhify)

Headspace was the most commonly used smartphone app participants used, with seven out of ten participants using it either exclusively or alongside other technologies. Headspace users found it well designed and usable, reflecting the fact that it is one of the more mature technologies in the field.

“The app is very simple, that’s what I like about it.” (P7 – Headspace)

“Headspace as an app: it’s really straightforward to use.” (P2 - Headspace)

One participant explicitly mentioned changing from using one app (Mindfulness) to Headspace due to finding the latter’s user interface more usable.

“[I used] Mindfulness. I think they also have an English version. You can do guided meditations, silent meditations. I think the interface is a bit … it’s not as good as Headspace so I switched.” (P6 – Mindfulness and Headspace)

Trusting technology

Having trust in the technology they were using was important to four of the participants interviewed. Trust was expressed as having confidence in the reliability that the technology was functioning as expected, as well as feeling that the motivations of the app’s creators fitted with participants’ own attitudes and beliefs about meditation.

Reliability of technology

One participant reported that one reason for on-going use of his preferred smartphone app, Insight Timer, was partially due to its perceived reliability.

“I’ve never had a problem with it. It never crashes. Some apps, they get an update and they won’t load again and you have to delete it. I’ve never had any issues and I think that’s important. Especially with a meditation app, you do want to have confidence in it”. (P1A)

One participant expressed concern about the correct functioning of the Headspace app on her phone, although this did not dissuade her from continuing to use it:

“During the meditation he goes silent for quite a long time and that’s probably good to get you to focus on … clearing your mind but sometimes I’m like, oh god, is the phone dead? Have I missed something? … really long spaces. Sometimes I have to pick up the phone and check it. There’s no background noise whatsoever, it’s just completely blank.” (P2)

Trusting app creators’ motivations

Four participants expressed that usage of their chosen technology was influenced by perceptions that the values and intentions of the technology’s creators aligned with their own attitudes and beliefs about meditation.

One participant stated that the developer of Insight Timer was a practitioner himself, and that this gave the app a sense of integrity.

“When I remember the developer is also a practitioner. There’s something about that. If an app was good enough from a larger company I may use it but only if I perceive some integrity to the operation.” (P1A)

When asked about why they had chosen to use Headspace, two participants reported that they had been impressed by
the company’s founder, Andy Puddicombe, giving a TED talk [49].

“He really won me over on the TED talk. His back-story, he was a monk. He had a really calm voice, I thought I could listen to that, I’m definitely interested in that.” (P2)

“One of the TED talks I listened to many times. That sentence really resonated with me when he says that ... basically, you take pills when you have a pain in your wrist or something but you don’t take time to find solutions to the great ill... people are stressed and they’re not ok and they don’t sleep but it’s not about that, your body’s telling you you need to do something about it, but not taking pills.” (P3A)

One participant did express some concern about the amount of money that Headspace was making for its creators, admitting that it did lead her to question the integrity of the application.

“I’m a little put off by the amount of money he’s making, he’s not this holier than thou Buddhist monk, he’s making a fortune off it! He’s selling meditation to corporations. It puts me off a little bit. It shouldn’t matter but...” (P2)

Another participant did not see any direct contradiction between creating technology for mindfulness and making money from it, as long as this was being done for the right reasons,

“If you’re mindfully building a business and you’re doing it to help other people and improve their lives and wellbeing then that’s fine I think.” (P10)

4.3. Perception that technology has assisted with developing a meditation practice
Seven participants reported that they felt that technology had directly supported their development and maintenance of a meditation practice, citing the convenience of using the technology and the support and instruction it provided.

Convenience of mobile apps
Three participants reported that the convenience of having a smartphone app facilitated their sessions.

“Part of the process is fire up the app on a phone... early on a cold morning it’s quite tough to get up. Having the app on the phone sweetens it a bit.” (P1A)

“There’s no set-up required: do this, you must be wearing these clothes...in this type of space.” (P2)

“I think so [Headspace helped with my meditation practice]. I don’t think it has been the most major player but it’s definitely been a nice convenient way.” (P6)

“In a way I feel like meditation shouldn’t always be guided so for me it’s currently a nice interactive convenient way of doing it while I’m having my busy life in London.” (P6)

In addition to the app itself, one participant reported more generally on the convenience of using mobile technology,

“It’s quite useful to have the app on my phone as I have my phone with me anytime, it’s very useful, just open my phone. You have the phone with you anytime.” (P7)

Three participants reported that they felt that technology was directly responsible for supporting and instructing their practice. One participant had developed her own unsupported meditation practice, but reported that at times when she required more support she would use technology during her sessions,

“Once you have the voice of someone telling you what to do it gets easier ... there’s some therapy in there.” (P3A)

Another participant found that the technology helped improved his discipline to sit and meditate,

“It’s the discipline—if someone’s ordering me through my phone to sit down and do it, I’m less likely to go off and have a cup of tea.” (P8)

One participant reported experiencing a breakthrough in developing her practice after watching a guided meditation on YouTube.
“I was shown a video on YouTube and it was called Release or something. It’s someone saying release, and it encourages you not to zone out completely but to acknowledge your thoughts and if you focus on a certain word and it can help. After that, after realising I don’t have to ignore my thoughts but just kind of focus, it helped.” (P5)

One participant drew a parallel with his smartphone app being a technological equivalent of the literary device of the “McGuffin”, a term coined by Alfred Hitchcock to denote an object with no inherent value itself, but one which progresses a story’s plot (e.g. [40]).

“I think it definitely does encourage me. The [concept] of the McGuffin... you don’t need the phone to do the meditation but it’s the thing that kind of helps with the idea of meditating. It makes it easier.” (P1A)

**4.4 Ways in which technology conflicts with participants’ motivations, attitudes and behaviours**

Despite reporting positively on ways in which technology supports the development and maintenance of their meditation practices, it is also clear that some aspects of the mobile applications’ design conflict with participants’ motivations and behaviours.

Participants reported particularly negative experiences with typical app feedback mechanisms, such as alerts, notifications, reminders and the gathering of statistics. Some more experienced meditators also expressed concerns that they felt there was an explicit contradiction between the aims and practice of mindfulness and the delivery of mindfulness programmes through digital technology. A further area of concern became apparent in that current technology does not effectively support changing user needs as practitioners progress from novice to more experienced meditators.

**Alerts, notifications and reminders**

Prompts to take action, such as carrying out an activity, are common features of smartphone apps [46] These “cues to action” [46, p.3] often take the form of notifications and reminders displayed on the phone screen, inviting the user to carry out her meditation session. Other forms of notifications discovered during the research included invitations to start using the app to establish a meditation practice if the user had yet to engage with it, delivered via smartphone alerts (e.g. Calm) or email (e.g. Headspace).

Participants expressed strong negative responses to reminders and notifications, finding them too simple to reflect the complexities of maintaining a regular practice, and as a result, potentially demotivating.

**Notifications do not support the need for flexibility in planning sessions**

Notifications and reminders were reported as being generated at the same time of day. This did not support participants’ need to be flexible about their practice, either due to demands on their time or participants’ affective state.

“Calm is very bad at predicting the time of day I want to meditate. Every day is different.” (P3B)

“I never managed to get a consistent time of day to do it, because of demands on my time. It [receiving notifications] wouldn’t have helped.” (P9)

Two participants reported on the intrusive nature of the notifications and the fact that the primary motivation to meditate should come from them and not the technology,

“To me, I don’t need anyone telling me that I have to do it. I don’t like it when an app has a notification telling me, hey it’s 4pm, it’s time to [meditate]. I don’t like someone telling me I have to meditate. I decide!” (P3A)

“No ... I don’t like those kind of notifications. Meditation’s when you want to do it, when you feel you want to do it. It’s not a medication you take before you go to bed. I don’t want to be reminded.” (P7)

**Notifications can be demotivating**

The lack of any contextual awareness when generating notifications led to some participants feeling demotivated if they were unable to act. Other participants reported that dealing with notifications became another chore, adding to the stream of constant notifications from other apps.

“If it’s something like you have to do and you know you can take care of it, it’s fine. When it’s a reminder that it’s something you could have done but you don’t have the time to do it, it’s another thing to cancel off on the phone. It should have been a reminder but it’s another chore to deal with, that sort of thing” (P1B)

“What would have been really helpful is that if those notifications ... if they had been more context-specific or location-specific, or time-specific and it wasn’t just part of my daily stream of emails I had to churn through.” (P10)
One participant could not recall if he had ever received notifications, or if he had actively disabled them. When asked why he might have disabled notifications he highlighted the demotivating potential of them.

“If I failed [to meditate] or maybe if the reminder came through with me not having done it for a day then there would be disappointment in oneself. Otherwise I can imagine being quite irritated by what I imagine would be their means of reminding you.” (P8)

The potential stressful nature of notifications was highlighted by one participant.

“Notifications can be quite stressing. Setting a reminder for something... if you can’t do anything with that reminder, it can be another stress trigger.” (P1B)

Activity tracking is perceived negatively

As with other mobile health applications (e.g. [19]), the mindfulness apps used by participants collected data on user activities, such as amount of time spent meditating, allowing them to track their activities and progress.

Responses to activity tracking by apps were overwhelmingly negative. Only two participants spoke favourably about the use of these statistics, and one of these also recognised how demotivating they could be in some contexts.

“Personally I like that kind of feedback. It’s a little bit like this trick used by writers, which is to have a big calendar above their desk where they write and every day you write you put a cross through the date and if you don’t write you don’t put a cross, and the idea is to keep the crosses going. I suppose it’s a bit like that. You have some feedback to show.” (P1B)

This sentiment was echoed by another two participants, with participant three the most outspoken about the use of statistics.

“There’s something I associate with having to hit targets that I don’t want to do with meditation.” (P2)

“Why do you need statistics about how you’re doing, improving? I don’t like the fact you get rewarded. I don’t think it’s really right.” (P3A)

Activity tracking can demotivate users

As with notifications and reminders, some participants highlighted the fact that in certain contexts statistics could demotivate them.

“If you’re meditating not as much as you’d like it could feel .... it could make you more pessimistic about not finding the time. It’s quite a personal thing how you see those stats.” (P1B)

This was again highlighted by participant 9, who when asked whether he used the statistics function of his chosen app, Insight Timer, replied,
“No. Because if I felt I wasn’t meditating enough, it would have been a bit depressing.” (P9)

There is no clear meaning to statistics gathered in activity tracking
Some more experienced meditators questioned what could meaningfully be deduced from quantified activity tracking. As outlined above, these participants had a subtler understanding of mindfulness as a mindset or approach to life rather than it being a discrete activity. However, even a novice meditator (participant 7) questioned what could be learned from these statistics:

“I just use Headspace when I need it, I don’t want to see some numbers there. They may or may not represent me, it’s just my mood that represents me.” (P7)

One participant admitted to finding the use of statistics patronising as well as meaningless to him.

“Well, yeah… I mean… you sort of just think ‘so what’, I suppose it’s interesting. It’s not like we’re little children who are going to jump for joy because we’ve spent 90 minutes of the last 3 weeks sitting silently … There’s something a little bit patronising about thinking that the feedback of your behaviour will somehow give you such a reward that you’re going to carry on doing it.” (P10)

One participant reflected on the fact that technology could not accurately capture how “mindful” he had been outside of using the app,

“You can log you meditated for this many minutes but if you tried to meditate but you didn’t it just comes up as a blank, even if you’ve been mindful whenever you didn’t meditate.” (P1B)

“If you’ve asked me how many times I’d sat and meditated and used Insight … that’s not taking into account I still use the John Kabat Zinn recordings, and there’s no way of logging [that].” (P1B)

App-specific community and peer support not used by participants
All of the smartphone technologies used by participants had “social” functionality, either the form of a wider community of app users, as with Insight Timer and Buddhify, or a peer support mechanism where users can “buddy up” with friends or other users to help motivate each other as in Headspace. As with statistics and reminders, this functionality again was either ignored or actively disliked.

Two participants expressed opposition to using community aspects of the technology in principle. Speaking about her experiences of using Headspace, one participant reported that she had ignored this functionality and during the interview, opened the app to examine how this worked.

“I don’t know what you can do, I’m so against it. Let’s have a look, you can add buddies. ‘It’s a great way of tracking each other’s progress’. I don’t even know how to do it.” (P2)

When questioned why she was so opposed to it, the participant replied that meditation was a private activity for her and she didn’t “want anyone else around” (P2).

Speaking of one app that she had abandoned (Sattva), one participant described that this has been due to the enforced nature of the community functionality.

“What I didn’t like.. you had to make friends on the platform and that would help you meditate. You had a 7 day, 10 day programme, I don’t really remember. I don’t think my friends need to be there! This is not something I specifically needed. Most of my friends do not meditate.” (P3A)

Participant 5, who reported the most ambivalent attitude towards meditation as a practice, described that the inherent competitiveness in a community or “buddy” system could become demotivating for her.

“For me, I’d find it hard if someone seemed they were benefitting a lot more than I was and I’d start comparing myself a lot. If someone’s getting the benefits and it’s still not working for me I’d find it even more frustrating. I’m quite competitive so I wouldn’t find it very helpful.” (P5)

Participant 10, who had found the implementation of activity tracking unhelpful and patronising, also had the same attitude towards the community aspects of the technology.

“Am I going to sit down with my friend and say, ‘oh, will you be my meditation buddy with me?’ It’s like, it’s...
expecting people to behave in a childish, simplistic, predictable way. But it has the potential, as with all the social aspects that the Internet has, to get people competing with each other and, maybe some people would engage with that. Personally I couldn’t bear such behaviour.” (P10).

Perceived contradictions between meditation and technology
Three participants, all more experienced meditators, expressed a potential conflict between the purpose of meditation and using technology to support a mindfulness practice. Participants expressing this view highlighted a contrast between the simplicity of the mindfulness practice and its aim to improve awareness and attention, and the potentially distracting nature of current technology.

“If you were to take technology out of the equation and ask someone to describe mindfulness, it’s very far removed from a lot of things we associate with modern technology. So it’s about just being present in the moment, when you get down to it. It’s a very reasonable concept and if you then ask someone to explain to you what is technology, you’re suddenly getting into all this complexity and, you only have to mention smartphones and people start thinking about notifications, people addicted to their email, Twitter, this whole kind of funfair of distraction so to put those two things together, on the face of it, it seems like a very odd combination.” (P1B)

“Having a screen goes against meditation—for me meditation is you forget about other senses, your physical body.” (P3B)

One participant saw meditation as a spiritual pursuit, whilst technology was primarily concerned with commercial interests,

“There’s too much commodification in our society. Meditation is more spiritual and personal. It may be polluted via an app.” (P8)

Technology has limited value to more experienced meditators
More experienced meditators reported feeling that the mindfulness technology they were using had limitations, either as they became overly familiar with their app’s guided meditations, or that they viewed its ultimate purpose as facilitating a technology-free practice.

One participant expressed boredom with using Headspace as she only had access to ten guided meditations on a non-subscription basis.

“I use the freebie version of Headspace. It gets old after a while.” (P2)

This was echoed by another participant who had stopped using the Mindfulness app and changed to Headspace.

“Another point would be with the Mindfulness app, it was too much repetition of the same kind of thing. I got annoyed by knowing what they were going to say every time.” (P6)

Participant 10 found Headspace started to have less use to him after using a paid-for version for a period of around a month and did not even finish all of the sessions.

“I got towards the end of the 30 and then I just stopped ... I could have carried on using it for a bit longer. By then I had learned what I thought I was going to learn from it and thought I could carry on myself now.” (P10)

The aim of moving away from technology during a practice was also stated by participant 8, who suggested that over-reliance on technology could inhibit the continued development of a practice.

“In public health tech does have a role, but the goal should be not to use it. Be self-motivated and creative with your own practice. Have the freedom not to follow instructions.” (P8)

Two more experienced participants suggested that technology was most useful as a temporary support to a practice, rather than a tool that had to be used in every session.

“To be honest I’m starting to get done with it again and want to start doing silent meditation on my own again ... I know the rewards are much higher from doing silent meditation and I want to go back to that or I want to explore something new so I’m getting off of Headspace again.” (P6)
“Sometimes I do need guidance, I need some support [so] I use Calm for ten minutes. There’s a lady’s voice I really like, it’s like therapy.” (P3B)

5. DISCUSSION: SEMI-STRUCTURED INTERVIEW STUDY
The semi-structured interviews revealed that a conflict existed between participants’ attitudes, motivations and behaviours and design of aspects of the technologies used. In this section the findings of the interviews are discussed with reference to theories of motivation, namely those associated with Self-Determination Theory (SDT) [16; 18; 17].

Motivations and attitudes
All interview participants, with the exception of two (P1 and P5) had initially developed or sustained a meditation practice in a self-directed manner. P1 and P5 had been introduced to the practice via medical professionals. Whilst P1 had long since adopted the practice as an integral part of his lifestyle, P5, a more novice meditator, demonstrated a continued ambivalence towards the practice, as expressed by her view that she continued to find aspects of the practice frustrating. However, all participants demonstrated high levels of motivation to meditate, as shown in their statements about why they chose to start and continue meditating.

Intrinsic and extrinsic motivations
It may be too simplistic to consider that participants meditate as they are intrinsically motivated to do so; that is that they simply meditate for the sake of meditating. All participants described meditating to obtain a goal, whether that was a desire for improved health and wellbeing, attention or awareness; or for more general reasons of personal development. In some of the SDT literature, acting for reasons of personal development is described as being intrinsically motivated [e.g. 17; 52]. However, whilst clearly not being overtly extrinsically motivated, meditation could nonetheless be seen as being a type of extrinsically motivated activity with which the participants have partially or wholly identified.

This type of extrinsic motivation can be referred to as having an “identified” or “integrated” regulation style, that is it is similar to intrinsic motivation, being more autonomous than controlled [18]. Participants were still meditating for a reason rather than having fully internalised what John Kabat Zinn identifies as one of mindfulness’s commitments, “non-striving” in which the activity is not carried out for any reason other than being oneself more fully, “trying less and being more” [29].

Competence and autonomy
SDT suggests that fully intrinsic, or internalised or integrated extrinsic motivations are encouraged through support for the basic psychological needs of autonomy, competence and relatedness [16]. Relatedness will be considered separately, but autonomy and competence are considered to be interrelated [16].

Competence, if loosely understood as the ability to perform an activity successfully, may be a controversial concept in relation to mindfulness. Mindfulness is a practice in which an individual’s attention is concentrated on her current experience and in which she openly accepts what she is experiencing [5]. Part of the practice is adopting attitudes that emphasise qualities such as “non-striving” and “letting go” [29]. In this sense being “successful” in meditation is not a useful, nor appropriate term. A more useful definition of competence in relation to mindfulness may be a perceived sense of self-efficacy, such as that described in Bandura’s Social Cognitive Theory [2]. The greater the sense of an individual’s perceived self-efficacy, the more likely they are to commit to achieving their goals [2].

Participants reported that the technology they used did increase their sense of competence. Both novice and experienced meditators found that technology facilitated their practice. More novice meditators described situations in which technology supported them through simply being available when they wanted (e.g. P5), or helping them more fully engage with the practice (e.g. P7). More experienced meditators described a more nuanced relationship with the technology, either using it as a temporary support during times when they found the practice difficult (P3), or viewing it as a stepping stone to a technology-free practice (e.g. P6, P8, and P10).

SDT posits that competence may be developed under conditions of both external as well as internal regulation. However, it is argued that if individuals have a sense of autonomy, that is if they perceive their behaviour to be self-determined, they will feel more satisfied and be more intrinsically motivated to engage with the activity. In turn this will increase their sense of competence [17].

Simplistic reminder mechanisms such as alerts issued at set times of the day can be viewed as infringing an individuals’ sense of autonomy by creating external pressure on them to act, at times that they are unable or unprepared to. Some participants directly reported that receiving notifications led to a sense of frustration at their inappropriateness (e.g. P3 and P7) or how an inability to act on them could lead to feeling demotivated (e.g. P1 and P12).
Similarly, attitudes towards the use of statistics can be considered in the context of their impact on participants’ needs for autonomy. The design of the statistics in two of the more popular apps, Insight Timer and Headspace, emphasise time spent meditating, including number of days in a row the user has engaged in sessions with the app. For instance, Insight Timer includes the concept of “milestones”, which are “achieved” following ten or fifty days’ consecutive usage of the app.

Participants perceived the narrative of statistics to be one concerned principally with targets, progress and rewards (extrinsic motivators). This was at odds with their beliefs about meditation and the reasons for which they had developed or sustained a mindfulness practice. Participants also highlighted the demotivating potential of statistics, particularly if they had not been consistently engaging with the practice or their technology. SDT suggests that the introduction of rewards more associated with extrinsically motivated activities can diminish autonomy, which in turn negatively affects intrinsic motivation as the perceived “locus of causality” moves from being internal to external [17]. A similar shift in this locus of causality can be effected by the presence of perceived surveillance or evaluation [17]. The interview findings also appear to confirm the findings of Dennison et al.’s [19] study in which participants reported feeling that, where statistics revealed a gap between goal and activity, they felt a sense of being evaluated (“told off”) by the app.

"Relatedness"

Writings on mindfulness emphasise the value of group practice, either in classes or on focused retreats. This is recommended in order to gain reassurance about and perspective on one’s practice via peer support and teaching (e.g. [31; 30]). The community aspects of the technologies used by participants attempt to provide an online equivalent of peer support. However, they were largely rejected by participants as having little practical or motivational use.

Some participants did not demonstrate any particular desire for relatedness, viewing meditation as a private activity (e.g. P1, P3). Ambivalence towards community could also be ascribed to the simple design of the functionality which does not encourage a sense of relatedness. For instance, Insight Timer allows the exchange of simple messages such as “thanks for meditating with me” and the adding of “friends”, but little beyond this. Additionally, as P5 and P10 highlighted, the design of community features may provide a narrative of competition rather than support through the sharing of activity and statistics.
Limitations of motivational functionalities in mindfulness apps

Mindfulness apps have used existing mobile health technology paradigms such as alerting, social influence and self-tracking without much attention to whether these are evidence-based or have been appropriately implemented. Whilst the implementation of motivational and feedback strategies may be difficult in any health-related domain, technology designed for mindfulness has its own peculiar set of challenges. Mindfulness meditation is an ongoing practice, rather than a discrete activity, such as running. For this reason tracking mindfulness quantitatively is inherently problematic. The aim of developing a mindfulness practice is to become more mindful generally [29; 30], bringing the attitudes and insights gained by formal practice to one’s daily life. Additionally, as identified by some participants, there is some contradiction between a practice which cultivates “non-doing” or “non-striving” with the gathering of quantitative measures aimed at demonstrating what one has achieved.

Limitations of the study

Recruitment of participants for the qualitative study was challenging, due to the specialist nature of the research. Due to the availability of recruitment tools, UCL students proved easier to engage with than other user groups, with six out of ten participants coming from this group. Therefore, there is a potential bias towards a particular subset of users. In order to understand trends in mindfulness technology design and user experience more generally, and for reasons of ecological validity, participants were interviewed about technology they had already been using. Despite not specifying a particular technology that participants should be using, this group predominantly, but not exclusively, used Headspace. Therefore, in order to generalise the results, more research with users of other technologies should be undertaken. Lastly, as with any semi-structured interview study there is a danger that what participants say they do is not what they actually do [50]. Other qualitative methods such as diary studies or triangulation using a number of methods may be one way of mitigating the problems of solely relying on interviews.

6. FOLLOW-UP SURVEY

A follow-up survey was conducted to test the findings of the interview study. The results from the survey differed from those of the interview study in that, where participants were aware of their app’s notification, statistics and community features, these were generally more positively received. Possible reasons for this are discussed below.

Method

The survey was conducted over a period of three weeks and drew 90 responses, of which 79 were eligible and completed.

Participants

Participants were recruited via social media (Facebook and Twitter) and an Insight Timer community group (Insight Community). The survey drew responses from a range of countries, with the United States and United Kingdom most represented. Distribution of ages and genders was not spread across participants, with the majority being within the 35-44 age range; there were also over twice the amount of female as male participants. Participants were invited to take part in a draw for a £40 (or equivalent in the participant’s national currency) Amazon voucher by supplying their email address. This address was only used to contact the respondent if they were successful in winning this.

Figure 6.1 Survey participants by country

Figure 6.2: Survey participants by age range
Procedure
Participants first filled out a brief screening survey to ensure that they both had a mindfulness meditation practice and used technology to maintain it. Eligible candidates (n=79) were then taken to the survey asking questions about app functionality. In addition to completing questions about this they were asked some basic demographic questions.

Design
The online survey was designed in and hosted by Survey Gizmo. It examined respondents’ attitudes towards alerting, statistics / tracking and community functionalities of mindfulness apps. The survey was piloted with three users in an initial iteration. They were asked if they used a specific functionality and were invited to describe their reasons for doing or not doing so in free text boxes. However, it became clear from the pilot that some respondents would not fill this in. Conversely, it highlighted the possibility that the use of free text boxes could generate large amount of qualitative data. Therefore, the survey was redesigned to allow respondents to select terms on semantic differential scales [50], using adjectives and their antonyms placed on a five-step scale. Some of the adjectives used were terms that had been used by interview participants.

Results
The most popular app cited by respondents was Insight Timer (58 responses). This is unsurprising considering that the majority of responses to the survey came after promoting it on a general interest group within the Insight Timer app. The survey had also been promoted via other channels, primarily on social media which attracted users of other technologies, but far fewer than Insight Timer. Headspace was the most used app amongst interviewees (used by seven out of ten participants), but in the survey was used by fewer than half of the number of Insight Timer users (25 users or 32% of respondents used Headspace).

Use of alerts and notifications
Participants were asked whether their app used notifications to remind them to meditate. Responses were split almost evenly between yes and no, with 16 participants unsure if this functionality was offered.

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1 Survey Gizmo: surveygizmo.com
A relatively low number of participants reported having received a notification (n=20). These were invited to indicate how they found the use of notifications by their app. Participants selected options from a series of five-point semantic differential scale using positive terms and their antonyms:

- Pleased – Irritated
- Encouraged – Discouraged
- Helped – Nagged
- Relaxed - Stressed

Responses to notifications from this group were largely positive. Positive responses in the following charts are taken as selecting the first two points nearest the positive term, neutral as point three, and negative responses as points four and five.

**Figure 6.6: Have you ever received a notification reminding you to meditate?**

**Figure 6.7: Responses to the use of notifications on a five-point semantic differential scale (n=20)**

**Use of statistics**
Respondents were questioned about whether their chosen smartphone app gathered statistics. A large majority were aware their app had a statistics feature (66 respondents).
Out of the total number of respondents, 57 reported looking at statistics, with only 9 reporting that they did not.

**Figure 6.8: Does your app gather statistics on how much you've meditated? [n = 79]**

<table>
<thead>
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<th></th>
<th>Optimistic</th>
<th>Neutral</th>
<th>Pessimistic</th>
</tr>
</thead>
<tbody>
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<td>65%</td>
<td>31%</td>
<td>4%</td>
</tr>
<tr>
<td>N</td>
<td>4%</td>
<td>65%</td>
<td>31%</td>
</tr>
<tr>
<td>Don't know</td>
<td>4%</td>
<td>31%</td>
<td>65%</td>
</tr>
</tbody>
</table>

**Figure 6.9: Do you look at the statistics your app gathers? [n = 57]**

<table>
<thead>
<tr>
<th></th>
<th>Relevant</th>
<th>Neutral</th>
<th>Irrelevant</th>
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<td>13%</td>
</tr>
<tr>
<td>No</td>
<td>12%</td>
<td>75%</td>
<td>13%</td>
</tr>
</tbody>
</table>

**Figure 6.10: Please rate how you find the use of statistics to measure your mindfulness practice (n = 57)**

Of the 57 participants who reported that they looked at their app’s statistics, the majority responded positively towards them on a five-point semantic differential scale with the following positive terms and antonyms:

- Optimistic – Pessimistic
- Relevant - Irrelevant
- Helpful – Unhelpful
- Competitive – Uncompetitive

The criteria for defining positive, neutral and negative responses is as described for notifications above.
**Community and peer support**

The majority of respondents (62) were aware that their app had a community or peer support feature, as opposed to six who stated that theirs did not, and a further 11 who did not know.

![Bar chart](image1.png)

*Figure 6.11: Does your app have a community or peer support feature?*

The participants who had stated that they did use this feature (49) were asked for their responses towards it on a five-point semantic differential scale using the following terms and antonyms:

- Encouraging – Discouraging
- Positive – Negative
- Relevant – Irrelevant
- Supportive - Patronising

![Pie chart](image2.png)

*Figure 6.12: Do you use your app’s community feature? (n = 62)*

*Figure 6.13: Please rate how you find your app’s community features (n = 49)*
As with notifications and statistics, responses to this functionality were largely positive.

Discussion
The results of the survey show that the population surveyed did not demonstrate the same ambivalence towards the use of notifications, statistics and community functionalities as did the interview participants.

One reason for the discrepancy in results between the two groups may be explained by the recruitment method for the survey. Due to issues with recruiting participants, the survey was advertised primarily via social media and app-based communities. The principal social media tool used for recruiting was Twitter, with links to the survey being tweeted by mindfulness experts and app creators, such as individuals associated with Insight Timer and Buddhify. When these routes did not elicit a large number of responses, a link was placed within a general Insight Timer group which gathered a larger number of responses from Insight Timer users. Therefore, the audience for the survey was largely self-selecting. Users of Insight Timer in particular were more likely to use community elements of the app as they had to be using the groups to find the link to the survey. Also, the community feature of Insight Timer is far more prominent than that of other apps such as Headspace which may further bias the results. Although running web-based surveys may be a natural data collection tool in HCI [37], they are prone to this selection bias or “volunteer effect” [20].

It is possible, then, that the interview participants and survey respondents represented different types of users with differing motivations. It is not possible to prove this, although it does suggest a direction for future research. A recent study [54] focused on identifying different types of users of a running app who had different motivations, drawing on Schwartz’s human value theory (e.g. [55]). This suggests that different clusters of users require different functionalities, or the ability to choose options most appropriate to their needs [54]. One way of assessing the extent of differences between the two groups would be to conduct interviews with a selection of survey respondents. Unfortunately, due to constraints of time, this was not possible in the current study.

Limitations of the survey
Although the semantic differential scales used in the survey matched positive adjectives and their antonyms, little context was available to understand how participants interpreted the terms. For instance, when considering how participants found the use of statistics, the majority of those who consulted them described finding them as “encouraging” rather than “discouraging”. However, the survey was unable to explain how respondents found them encouraging. Also on the question of statistics, the majority of participants indicated that they found them “competitive” rather than “uncompetitive”. Whereas this may appear to align more closely with the findings of the interviews, there is no contextual information to understand whether users thought that competitiveness was positive or negative.

With little contextual information about the participants it is difficult to understand their motivations to meditate. The majority of participants reported having been meditating between one and five years which suggests that they were as highly motivated as the interview participants. However, this is an untested assumption. One possible way of testing participants’ motivations would have been through the use a motivation scale (e.g. [61; 59]). However, at present there does not appear to be one specifically tailored to assessing motivations in this domain.

7. IMPLICATIONS FOR DESIGN
Considering the interview findings in the context of Self-Determination Theory, it is possible to arrive at some high-level guidelines for the design of mindfulness technology. However, due to the implications of the survey findings, further research is recommended in order to test these.

Monitoring and feedback
Activity tracking in the form of statistics was shown to be problematic for mindfulness due to a lack of a clear or appropriate meaning. SDT’s predictions that individuals’ sense of autonomy is undermined by the use of strategies more associated with extrinsic motivations was largely borne out in the interviews.

If monitoring is to have any value to users then it should be aligned more with the principles of mindfulness meditation and support their autonomy and competence. For instance, users could be prompted to record their affective state or mood, thus encouraging them to become more self-aware. The act of becoming more self-aware may increase users’ perceptions of self-efficacy and motivations to continue with the practice.

Buddhify has already made some steps towards this by including a mood log alongside more traditional statistics, although it is simplistic, offering users scales to rate mindfulness, concentration and “balance”. Mood logging may be useful in fostering more self-awareness if designed appropriately and used in conjunction with more sensitive reminder mechanisms [4].
Developments in wearable technologies also offer further possibilities for self-tracking, which when combined with other logging mechanisms may help to improve awareness both of mood and the contexts that contribute to it. Some development has already been made in this area. For example, Spire\(^2\), a wearable device, pairs with a user’s smartphone to measure a user’s breathing to assess how tense they are. Spire integrates with the smartphone’s location sensor, photos and calendar to help users understand the contexts in which they have been more tense or relaxed.

SDT suggests that positive feedback can enhance intrinsic motivation \([52]\). Feedback mechanisms could include encouraging narratives, based on more advanced self-monitoring to suggest how mindfulness is assisting users. This may be particularly useful for novice meditators who have yet to develop identified or integrated motivational styles. The delivery mechanisms for this feedback should be carefully considered, so as not to cause stress or frustration.

The delivery of any reminders or cues to action should also be carefully considered. As the study shows, simple time-based alerts are not helpful as they cannot anticipate the multiple factors users encounter when planning to meditate. This also has the effect of providing the perception of an external locus of control, thus weakening users’ autonomy. Reminders could be more context- and time-specific and based on learning more about users’ behaviour patterns. However, due to the complexities of planning sessions, it may be that reminders continue to be problematic, however sensitively they are handled. The designers of Buddhify acknowledge the problems of reminders and suggest that users should move the app to their home screens to act as a more “passive” reminder.

Community

The community aspects of technology were disliked by interview participants, who either did not deliberately seek out others on the platform or found the implementation of this functionality competitive or even patronising. Monitoring of group activity within Insight Timer when recruiting participants for the quantitative study, and the increase in response rates after posting the survey link in a group “room”, along with results from the survey itself, indicate that some users do engage with them. However, the survey results were not able to show how these users were using this feature. Further research is needed to fully understand this and to inform any recommendations for the design. As general guidance, designers should consider that even if community features do not foster a sense of relatedness, they should be implemented in a way that supports users’ sense of autonomy and competence. For instance, instead of simply sharing statistics they could offer ways in which to share motivational messages between users.

Facilitating mindfulness

In addition to considering more nuanced tracking and feedback mechanisms, app designers should also consider the primary purpose of the technology. Some interview participants indicated that they viewed the usage of apps as

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\(^2\) Spire. https://spire.io
a stepping stone to a technology-free practice. More experienced meditators also reported becoming bored with the technology due to the repetition of guided meditations.

Designers, then, should view their technologies as facilitators, rather than drivers of a mindfulness practice [45]. In any case, reliance on technology should not be encouraged as users tend to abandon apps which may then disrupt the continuation of the behaviour they have been designed to foster [57].

Designers should consider ways in which the technology can encourage an independent practice, for example via messaging or tutorials. Additionally, the interface could be made to adapt over time, making some components (e.g. the simple meditation timer functionality) more prominent than other supporting functionalities, such as guided meditations or progress feedback.

8. CONCLUSION
A semi-structured interview study with ten participants revealed that, whilst users of mindfulness-supporting smartphone apps found them to be broadly supportive of their practice, the design of certain features did not support their motivations to meditate. Self-Determination Theory was used as a framework with which to analyse the interview results. This suggested that the current implementation of notifications can negatively impact users’ sense of autonomy by creating an external locus of control, with the app instructing them to act at times at which they are either unable or unwilling to. The meaning of statistics was viewed by participants to be related to extrinsic motivators such as targets and rewards and, as such, in conflict with their attitudes and beliefs about meditation. The community features were similarly negatively viewed, suggesting that they do not foster a sense of relatedness.

The follow-up survey challenged the results of the interview study, with participants responding more positively to notifications, statistics and community. This may have been due to survey participants being drawn from a different user population. This suggests that further research is needed to identify different groups of users with different motivations. Although it is possible to suggest high-level design guidelines based on the findings of the interviews, any further research will enable these to be challenged and developed.

Self-Determination Theory proved a useful framework with which to analyse users’ motivations to meditate and to suggest reasons why they demonstrated negative reactions to the implementation of motivational functionalities. However, if further research is taken into identifying different groups of users, it may not be an adequate framework in itself to understand the motivational differences between groups. For instance, it could be combined with other theories of individual differences, such as Schwartz’s human value theory [55] in order to create a richer understanding of different groups of users and their motivations to meditate.

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## APPENDIX A: INTERVIEW PARTICIPANTS

<table>
<thead>
<tr>
<th>#</th>
<th>Gender</th>
<th>Age</th>
<th>Time spent meditating</th>
<th>Occupation</th>
<th>Apps used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>35-44</td>
<td>16 years</td>
<td>Computer programmer</td>
<td>Insight Timer</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>25-34</td>
<td>3 years</td>
<td>Master’s student</td>
<td>Headspace</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>18-24</td>
<td>5 years</td>
<td>Master’s student</td>
<td>Buddhify&lt;br&gt;Calm&lt;br&gt;Headspace,&lt;br&gt;Sattva</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>18-24</td>
<td>1 year</td>
<td>Undergraduate student</td>
<td>Insight Timer</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>18-24</td>
<td>1 year</td>
<td>Undergraduate student</td>
<td>Headspace&lt;br&gt;YouTube videos</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>25-34</td>
<td>5 years</td>
<td>Master’s student</td>
<td>Mindfulness&lt;br&gt;Headspace</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>18-24</td>
<td>Less than 1 year</td>
<td>Undergraduate student</td>
<td>Headspace</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>35-44</td>
<td>12 years</td>
<td>Medical professional</td>
<td>Headspace</td>
</tr>
<tr>
<td>9</td>
<td>M</td>
<td>35-44</td>
<td>8 years</td>
<td>Computer programmer</td>
<td>Insight Timer</td>
</tr>
<tr>
<td>10</td>
<td>M</td>
<td>25-34</td>
<td>10 years</td>
<td>User experience designer</td>
<td>Headspace</td>
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</table>