EXPERIENCE DESIGN OF DIGITAL PERIOD TRACKERS

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Contents

Abstract

The aim of this thesis is to identify and address the main challenges around **designing digital period trackers**. These challenges will focus mainly on (i) the range of **user groups** and their motivations and challenges in period tracking; (ii) the **social climate** in which these technologies operate and their effect on social attitudes and stigma surrounding periods; and (iii) the issues surrounding **data, ethics, privacy and trustability**, particularly in an intimate health use case. The research incorporates a literature review, cross-analysed with insights from 14 in-depth user interviews, which identified 5 main user groups according to tracking motivations. From the challenges identified in this analysis, solution concepts were co-created with users, which forms the basis of a test dashboard interface to test user preferences. Finally, the findings are summarised as industry-relevant, actionable recommendations for the designing of period trackers, comprising of Key Questions and a Three-Step Guideline.

Keywords:
Menstrual tracking; Experience Design; Digital Women's Health; User-Centred Design; Data presentation; Social Taboos

1 Introduction

Femtech encompasses technology geared specifically towards women's health[1]. It's set to be a rapidly growing industry, estimated to be potentially worth $50 billion in the next seven years (Das, 2019). On a social scale, focusing on women's health after decades of treating it as a "niche" and undervalued research area has a profound message about increasing diversity in tech innovation (Das, 2019; Gordon, 2019). Opening up the conversations surrounding women's health using digital innovation also has added potential advantages of changing social attitudes (i.e. removing stigma) from traditionally taboo subjects such as menopause, menstruation, and reproduction (Dubow, 2019).

Digital period trackers is one of the product areas in this field. Usually, period trackers offer the basic functionality of tracking periods (and often other period-related symptoms), as well as giving a predicted forecast of the user's next period(s) and fertility, based on their previous data. The industry for these products has since gained immense traction since they first started becoming available in 2009 (Dolan, 2019): menstrual tracking apps are the fourth most popular health-related apps and the second most popular in female adolescents (Moglia et al., 2016). This is unsurprising, given its huge market potential (those experiencing periods, from menarche to menopause). Now, with increasing digital capabilities in artificial intelligence (AI) and machine learning (ML), and increasing development and usage of smart wearables, period tracking and predictive accuracy is growing more robust. One example is Flo[2], the first publicly AI-powered period tracker app which uses neural networks to increase accuracy of its cycle predictions. According to their website, the use of AI in combination with comprehensive symptom tracking can increase their prediction accuracy by up to 54.2% compared to "*traditional* [non-AI] *methods*".

However, there are numerous challenges to be addressed in designing smart interfaces for products that aid women in period tracking, especially from a user experience perspective, no matter the specific use case they may have. The app market already contains many hundreds, if not thousands, of existing examples (Pai, 2019), which can potentially be used as case studies from which to learn from.

This research project will be focused on hypothesizing, testing and formulating guidelines on designing digital period trackers, based on specific challenges identified through different research methods.

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[1] The term "femtech" was coined by entrepreneur Ida Tin
[2] https://flo.health/faq/accuracy

1.1 Research Question

The overarching research question which will be explored in this thesis is summarised as:

"What criteria can we follow to best design for users of digital period trackers?"

Period tracking refers to the recording and monitoring of menstrual cycles, with future cycle dates predicted using either averages or more advanced algorithms. This project does not focus on advancing the technology behind these predictions, but on the functionality of the interface which records and presents information to users.

For the purposes of my research, "best design" pertains to maximising usability as mapped out by Hertzum's (2010) different "images of usability". In his argument, there are six different images or dimensions of usability which must be taken into account: UNIVERSAL, SITUATIONAL, PERCEIVED, HEDONIC, ORGANISATIONAL and CULTURAL. The most relevant images to consider for users of period tracking apps are universal, situational and cultural[3].

The UNIVERSAL image of usability emphasises inclusivity of all possible user groups of the technology. This is based on fighting the tendency of designers to underestimate variability in user judgements (Tversky & Kahneman, 1974). This does not necessarily mean that the best solution would be a one-size-fits-all period tracker; however, part of the overall research question will involve investigating the different user groups (and in fact, how best to divide users groups) and the similarities and differences between their skills, expectations and behaviours.

The SITUATIONAL image of usability suggests that the solution must take into account the entire sociotechnical situation in which the user's period tracking (both data input and consumption of results) takes place. In this sense, several extraneous factors must be considered - not only regarding the user's mental models but the specific context in which they may be tracking periods. This raises questions about: why are they tracking periods? What constraints and opportunities in their life might affect them tracking periods, such as their lifestyle or different contraceptive methods they might be using? And so: how would the technology synergise with these situations?

Finally, CULTURAL usability investigates how user interface graphics, language, and formatting vary in different cultures as they have different sociographic environments. Specifically regarding period trackers, one of the main challenges facing the cultural usability involve the social attitudes surrounding menstruation, which the user is immersed in. Not only do attitudes differ across geographical cultures but they may also differ among different spheres of the user's life - for instance, they may be more open to discussing periods with friends and not colleagues.

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[3] The remaining images (PERCEIVED, HEDONIC, ORGANISATIONAL) are deemed less relevant as they are more applicable to other types of technical systems.

Considering these images of usability, and applying them to the design of usable period trackers, raises the following more specific subquestions:

Subquestion 1: *What are the different user groups of period trackers?* How do they differ in goals and motivations?

Subquestion 2: Especially considering the increasing use of predict period trackers to user states, *how do we present the information in a way that the user can interpret, in order to ensure that they are perceived as sensitive, trustworthy (and in terms of data management: secure), and yet reasonably manage the expectations of the product*? Are there other case studies of trackers from which we can learn design lessons?

Subquestion 3: Ultimately, the use cases that we are tackling in period tracking can often be sensitive for the users. *Can the development of their interfaces be used to open up the conversation and remove the stigma, for instance, in the language and tone conveyed in the interface?* Could the additional features that technology allows (such as sharing cycles with peers) actually aid in the removal of stigma?

1.2 Thesis Overview

The research methodology in this project was based on the principles of the user-centred design process (ISO 241-210, 2010). This widely-adopted framework places end-user needs at the heart of the design and development process for digital systems and comprises four general stages (as illustrated in Figure 1): *[1] Specify use context; [2] Specify user requirements; [3] Generate design solutions* and *[4] Iteratively test and evaluate designs*.
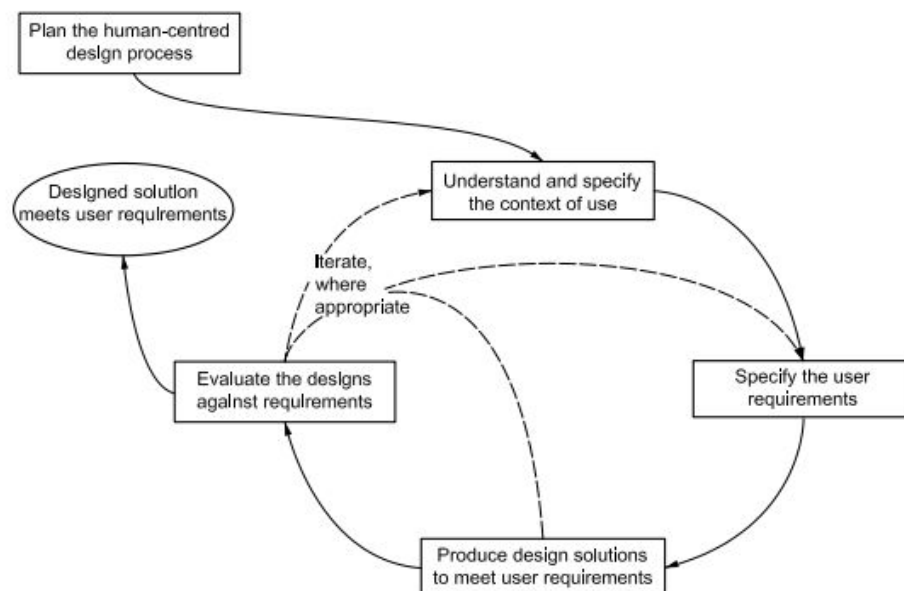
Figure 1: ISO 9241-210 (2010) guideline on human-centred design process

The stages of this thesis were mapped out according this framework: in order to *specify context use,* a **Literature Review** ([Chapter 2](#)) on the relevant topics was conducted to determine the landscape for period tracking design: how it is done with existing products, as well as their current technical capabilities. This formed a basis for the next stage: *specifying user requirements*. This comprised of a **User Group Analysis** ([Chapter 3](#)) to define who the different user groups are, as well as differences in their motivations and challenges.

The next stage, **Solution Concepting** ([Chapter 4](#)) again built on the previous findings, distilling the user requirements into clear challenges to be solved and *generating design solutions* with users in response to these challenges. Finally, **Solution Realisation** ([Chapter 5](#)) gave the opportunity to realise these design solutions and evaluate them with users, and thus giving more concrete evidence towards (or re-evaluating) the use contexts and requirements. Finally, the insights from each stage are summarised in the **Discussion** ([Chapter 6](#)) in accordance with the original Research Questions outlined in Section 1.1, and the thesis relevance, limitations and grounding for future work is presented in the **Conclusion** ([Chapter 7](#)).

2 Literature review

User experience of digital period tracking is a new field from a research perspective, although a review of what does exist is presented in Section 2.1.2. There are also relevant insights to consider in related topics such as patient-AI and digital health interaction (Section 2.2), as well as social attitudes to periods and fertility (Section 2.3).

2.1 Period tracking interfaces

Regarding the design of digital period trackers, there are several sources that give insights into the current landscape of period tracker experience design: (i) firstly, how market leader apps design their interfaces and the general consumer response to them; and (ii) scholarly research exploring the general use of digital period tracking tools and their strengths and shortcomings.

2.1.1 Current application design

The most popular applications currently, according to a Future Marketing Insights report (2019) are either independent mobile-based applications such as *Clue*, *Natural Cycles*, *Flo*, or *Kindara Fertility*. A review of these applications suggested that most period-tracking applications have the following basic functionalities: (i) recording period dates, as well as a range of associated symptoms; (ii) prediction of upcoming periods as well as, often, ovulation. This prediction is conducted using a range of techniques, including calculations based on traditional Fertility Awareness Methods[4] (used in apps such as *Kindara*) as well as unique algorithms (such as *Dot*, which uses Bayesian regression models[5]).

Different period tracking applications vary in terms of target market and subsequently, in business model, tracking features, and design elements (Weigel, 2016). The target markets are defined in different ways (Bradley, 2019). Some products market themselves towards users with definitive singular goals, such as *Fertility Friend*, which is targeted specifically for those who are trying to conceive. This is made clear from its direct, no-frills approach to fertility tracking, comprehensive fertility-focused tracking features (see Figure 2). and integration with a dedicated forum of users to discuss conception. Other products also design themselves explicitly for users in certain life stages, such as *MagicGirl* for preteens and teens who have recently started periods. These are both visually designed for younger users, with bright colours and fun characterisation of symptoms, and in terms of functionality would be more suited for less experienced users with very basic menstrual health information available from the app.

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[4] Fertility Awareness Method is a drug-free method usually used for birth control, incorporating the user's basal body temperature (BBT), cervical mucus consistency and charting of menstrual cycles, to predict fertility patterns [Source: Planned Parenthood].
[5] https://www.dottheapp.com/dot-is-science
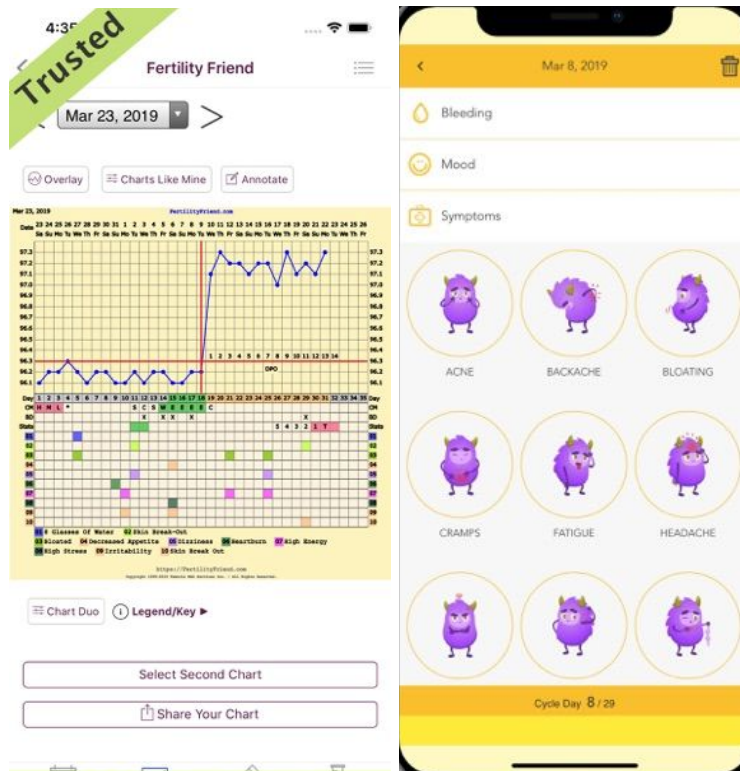
Figure 2: The Fertility Friend app (left) is targeted to people who are specifically trying to conceive. The functionality and visual design is comprehensive and functional. [source: Fertility Friend].
MagicGirl (right) is targeted to teens and preteens, which is reflected in its playful visual design [source: MagicGirl]

In addition, it is worth noting the general trend on self-tracking technology moving towards user health-monitoring systems rather than standalone apps. Repa (2019) suggests that users are gravitating towards ecosystems which incorporate tracking and incorporating lots of different and hitherto indirectly related metrics, such as Apple Healthkit, Fitbit and Garmin (Caddy, 2019).

2.1.2 Scholarly research

Published literature regarding digital period tracking exists, but focuses mostly on tracking periods for fertility monitoring. For instance, Starling et al. (2018) conducted a web-based survey of over one thousand women who use or intend to use "fertility tracking applications", and explored their awareness of the technicalities of fertility awareness methods in relation to menstruation cycles. In general, their research points towards a *high level of trust* among women in the efficacy of apps to prevent unwanted pregnancy, despite the fact that the majority (65.4%) of users had only "some knowledge of fertility and reproduction" and 16.5% had "very little knowledge". This highlights how the presentation of the fertility application's prediction accuracy is important. This is further illustrated in the case study of Natural Cycles (see Figure

3), whereby the reliability of the algorithmic predictions could have been misconstrued or misrepresented, and resulted in unwanted pregnancies (Sudjic, 2018).
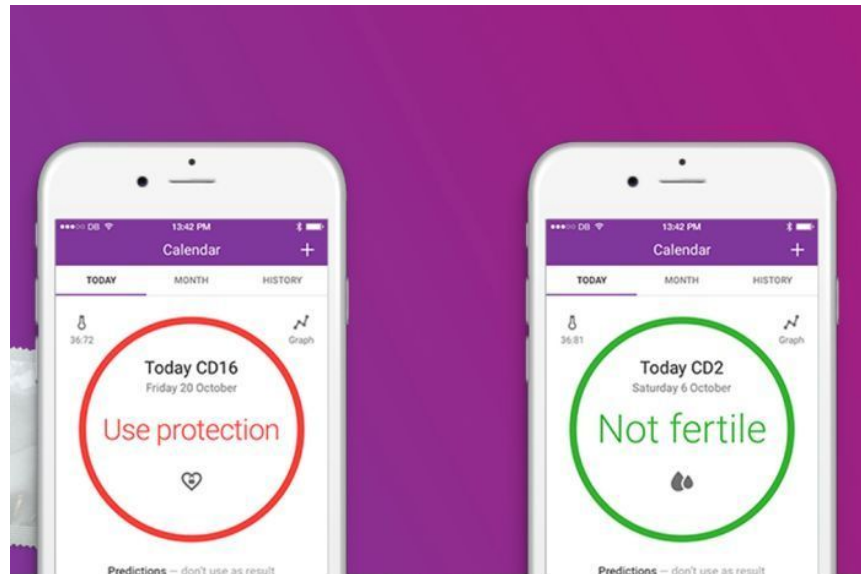
Figure 3: Natural Cycles gives binary predictions on fertility. This could give users a false sense of security, in that following the recommendation of the app will ensure that they avoid unwanted outcomes such as pregnancy. [Source: Natural Cycles]

Another study by Gambier-Ross et al. (2018) explores the intentions of users of period trackers, or as they refer, Fertility Tracking Apps (FTAs). They identified that the majority of users simply want to observe their cycle, as illustrated in figure 4. In this case, one of the strengths of current applications is that as a standard primary functionality, they allow users to do this using calendar or graphing visualisations (see Figures 2 & 5). However, the generic primary user intentions are an interesting finding when compared to Lupton's (2015) observation that most period tracking apps fixate on fertility as the *assumed* area of focus for users. Her research on how period tracking apps shape the "quantified sex" (a paraphrasing of the "quanitified self", which refers to the tendency of people to self-track health metrics[6]), and hyper-focusing on females as reproductive beings rather than multifaceted humans. Considering this, it could be suggested that period trackers should focus less on fertility and instead on a more general approach to period tracking.

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[6] A summary of this can be found in Section 3.2

Motivation for using Fertility Tracking Apps

*Figure 4: Graphical representation of **Gambier-Ross et al.**'s (2018) survey results on the motivations for using fertility trackers (N = 241, all female. Only 89 of them actually used fertility tracking apps)*

As well as the general motivations for using FTAs, Gambier-Ross et al. (2018) also explore the different features of existing applications which 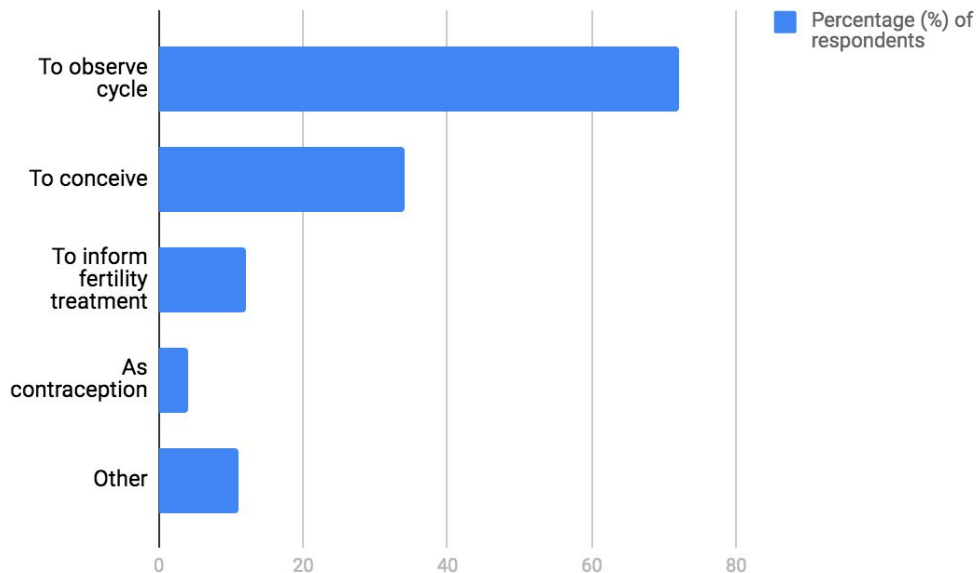users find particularly useful or not. One of the highlighted conclusions from Gambier-Ross et al. (2018) is the differing motivations underlying the use of FTAs. They suggest that it would be valuable in future to "*explore the more sophisticated subgroups of FTA users and their interrelationships",* rather than simply the generic groups that many FTAs assume users fall into (either avoiding or seeking pregnancy).

Focusing more specifically on the shortcomings of current period tracking apps, Epstein et al. (2017) investigated the design of "personal informatics tools" through a study on menstrual tracking. Coding customer reviews of existing applications, conducting a survey and follow-up interviews lead them to make general conclusions on motivations for tracking, how they are tracked, and the main issues associated with tracking. From their survey, about 50% track and predict periods using a phone app - the rest use digital or paper calendars, contraceptives, early symptoms as indicators, remembering, or do not track at all.

One of the key areas for improvement in current applications, as identified by Epstein et al. (2017), is the **lack of customisation** in apps. There is a general need for more functionality in applications to allow users to report, for instance, different kinds of contraceptives they may be using, or life circumstances such as stress or diet changes. While many applications allow tracking of a wide range of linked symptoms to periods, they somehow miss the ability to report obvious high-level circumstances which would have an impact on menstrual cycles.

While some applications market themselves to those with specific singular use cases, as previously mentioned, there is a lack of recognition that many users have motivations to track their cycles that could **change over time** (sometimes drastically). In this case, the way in which apps should then change to accommodate these changing needs can be impactful. For instance, they suggest that a user "tracking to avoid becoming pregnant would probably prefer her app overestimate her ovulation window." and vice versa for a woman actively trying to conceive.

Another issue with current period trackers which has been identified is their **lack of inclusivity** towards all potential users of their applications, who are not necessarily insignificant in size. Not only do Epstein et al. (2017) note that many applications alienate users with irregular periods or non-heteronormative users in their interface design, both in terms of data input and presentation. Many accounts of current applications alienating large swathes of the population have been raised in social media; for instance, Delano (2015), who is gay and has relatively shorter-than-average menstrual cycles, documented her experience with popular applications in detail and strong dissatisfaction. Despite a popular reception to her article, it seems that the issues raised have still not been fully addressed, three years later (Tiffany, 2019).
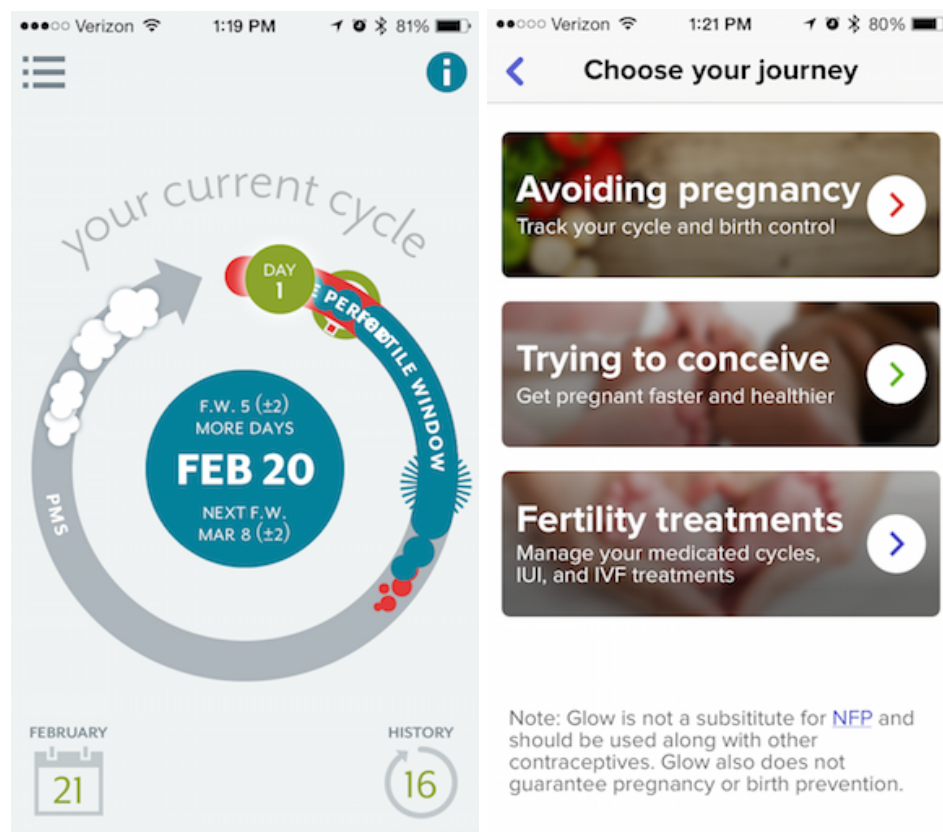

Figure 5: Leading period tracking applications making heteronormative assumptions about user. Clue (left) shows a compulsory fertile window, and is unable to properly visualise abnormally short menstrual cycles.

Glow (right) assumes during its user onboarding that its users are both fertile and heterosexually active with a fertile partner. [Source: Delano, 2015].

 This was echoed in the findings of Gambier-Ross et al., they noted that a number of user groups (e.g. those with irregular periods) feel that current FTAs were not in fact being met:

"Most apps are designed for narrow user groups, women who are healthy; are sexually active; are heterosexual; have regular periods; and have no fertility issues." (Gambier-Ross et al., 2017)

"...the reality is that many health apps try to shove users and their bodies into strict categories. Some don't track abortions, or even irregular periods; others have algorithms that don't factor in non-male partners."
(McHugh, 2019)

These shortcomings may be a result of a variety of reasons; for instance, there may be insufficient tracking technology which is only modelled on certain users; or limited cultural attitudes of product development team. Regardless of reason, this user exclusion has potentially harmful social impact: by promoting and catering only for a normative female body, users who do not fit within these boundaries in some way are "erased" and told indirectly that they should not exist (Delano, 2015).

2.2 User Data

Digital period trackers are advancing in their abilities to predict periods and model personalised menstrual cycles more accurately. A number of applications already apply machine learning (ML) techniques such as Hidden Markov Models to enhance predictive accuracy of the user's cycle phase (Chen, Kitazawa & Togawa, 2009). Research is also being carried out to increase scientific understanding of menstrual cycles, and hence the accuracy of period trackers, in a number of ways. Much of this research arises from (i) the increasing availability of data on menstrual cycles (not only periods but also related symptoms) gained from the use of digital period trackers to date (Symul et al., 2019); (ii) the increased drive for more research funding in this field; and (iii) better understanding of different ML techniques that can be applied. For instance, experiments applying mechanistic models on real menstrual cycle datasets have suggested that there are individual, personalised female hormonal cycles which can be modelled using gaussian processes (Urteaga et al., 2017).

With these increased predictive abilities, the issue of data input and output from the system becomes more prominent. General desk research as well as expert interviews have pointed to two themes in this area that are important to consider: Data Privacy & Security; and Patient-Machine Learning Interactions and Efficacy of Predictions.

2.2.1 Data Privacy and Security

Following media coverage of security issues about personal health data, such as fertility and hormonal symptoms, shared to menstruation apps (Monella, 2018; Quintin, 2017), this is a potential area which could significantly affect the user trust and uptake of digital period trackers, and should be carefully considered. For instance, one case of a menstrual tracking app sharing user data with Facebook raised wider concerns over the possibility of users' data being shared with third parties that could use the information against their best interests (Statt, 2019; Schechner & Secada, 2019). Some applications, meanwhile, are relatively transparent in communicating how their user data is being used in research, such as Clue (Felizi & Varon, 2016).

"People, they share data about the most intimate parts of their lives. They talk about their mood… their pain... their sex lives… you've got to have ethical conversations about what you're going to do with that data."
(Ida Tin, Founder of *Clue*)[7]

This topic carries impact on the design of user interfaces for period trackers. Clarity on how the data is stored, distributed, protected and used may not be at the forefront of every user's mind, but could still carry significance in the tracker's overall trustability. However, this area would benefit from user research to clarify their general attitudes in this respect.

2.2.2 Ethics & Efficacy

Increasing use of machine learning has significant impact on the accuracy and reliability of predictions which can be offered by digital period trackers. This, combined with increased adoption of smartphone usage and pervasion of technology in general, will likely enable an increased usage of digital period tracking as a whole.

However, while the efficacy of predictions, as suggested by clinical trials, is improving to the point that one period tracker (Natural Cycles[8]) has gained FDA medical approval as a contraceptive method, their effectiveness and reliability has been questioned. In the specific case of Natural Cycles, clear cases of its ineffectiveness were highlighted in public media (cases of unwanted pregnancies; for instance, Sudjic, 2018: "*I got pregnant when the predictions of fertile and infertile changed back and forth in one day, turning from green to red, after I had unprotected sex.*"). This drew attention to the importance of how digital period trackers are presented as a medical tool, especially when research by Starling et al (2018) suggests that there is a high level of trust amongst women in the accuracy of apps to prevent unwanted

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[7] Tiffany (2019)
[8] https://www.naturalcycles.com/en

pregnancy (based on a survey of over 1000 women who do, or intend to, use fertility prediction applications). An example of this is illustrated in Figure 6.
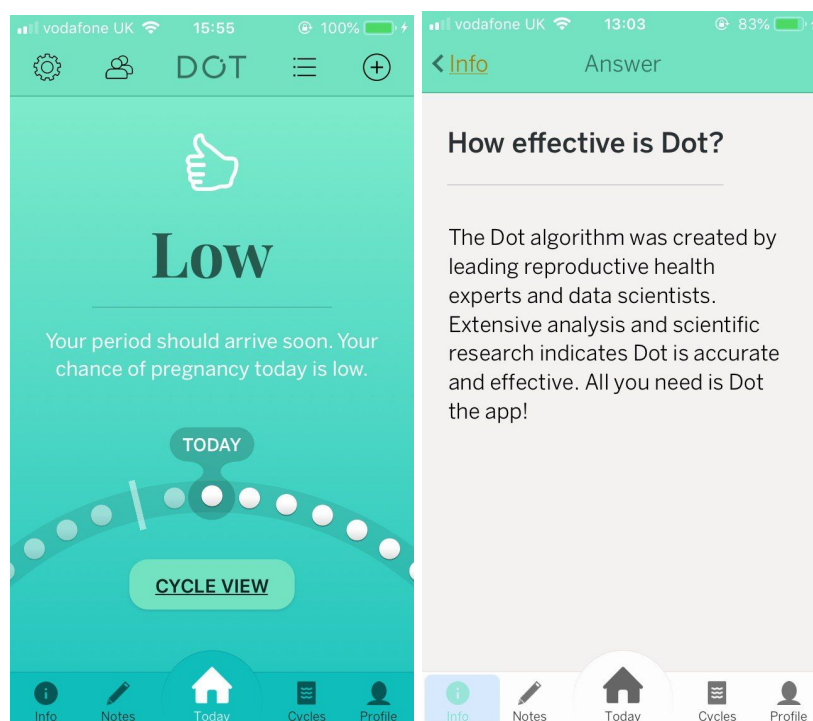
Figure 6: Misleading and vague information about the fertility predictions of period tracker Dot could be misinterpreted, leading to high-impact consequences such as unwanted pregnancy. While "extensive analysis and scientific research" is mentioned, there is no reference to any more information about this (such as concrete predictability figures) from the app.

In addition, research conducted on roughly 100 free digital menstrual cycle trackers found upon searching the Apple iTunes store suggested that they are by and large inaccurate (Moglia et al., 2016). However, many period trackers present a non-quantified, often binary prediction of fertility or menstruation on certain days, which could give users a misleading message on how confident the prediction really is. As the predictions are likely to increase in personalisation and subsequently accuracy, there is also the likely need to further consider the trustability and explainability of algorithms, or at least a reliable representation of confidence: "*for both ovulation and period arrival, designers should consider and evaluate interfaces that present probabilities as an alternative to unreliable binary predictions*" (Epstein et al., 2017). This carries significant impact in terms of implied messages communicated to the user, their assumptions, and subsequent life actions, from whether or not to have unprotected sex to planning future holidays.

In addition, Epstein et al. (2017) suggest that predictions and recommendations should also change according to the user's wishes. For instance, if they are trying to conceive, a tracker should overestimate their fertile window, to maximise the chances of conceiving - and then vice versa for those who are actively avoiding pregnancy. This does, however, bring into play an

ethically charged question of where the probability cutoff points lie, and how they might affect different users' behaviours.

2.3 Language & social attitudes

Research into designing digital period trackers also has significant links to how these products might impact social attitudes surrounding menstruation. Within the UK, there is still a taboo around discussing periods openly, with 37% of women admitting they would not feel comfortable discussing periods with male friends in a YouGov poll (Phillips, 2017). This "period shame" has direct detrimental effects on menstrual health as a whole (Willis, 2017). Frost & Sullivan (2018) argued that this same cultural and social stigma can prevent women's health applications like digital period trackers from reaching their full potential as informative predictors, as users are not engaging as much with the applications as they could be, and limiting the data available. Meanwhile, period tracker interface design may also play a significant part in shaping these social attitudes, for instance by normalising conversations about menstruation (Dubow, 2018).

The specific experience design of period trackers plays a crucial role in both reflecting and influencing how the user perceives periods (their own and/or as a whole concept). Especially in the symbolism and language used regarding periods, the system can either reinforce unrealistic patriarchal ideals (Felizi & Varon, 2016) or empower users to learn more about menstruation and see it in a more positive light (Nordfeldt & Widen, 2017). For instance, Feliz & Varon (2016) suggest that describing accidental period leaks onto clothing as "shameful" can reinforce the idea of periods as shameful in general.

2.4 Literature Review Summary

Overall, current period trackers are providing both opportunities and costs for users at a societal, and more personal level. There is a need for research that takes a holistic approach to meeting user needs, without business constraints, and with more consideration towards the increasing technological capabilities of future period trackers.

3 User Group Analysis

3.1 Analysis methods

The goal of this stage was to (a) identify and divide the potential users of digital fertility trackers into cohesive groups and (b) identify the tasks, motivation, journeys, pain points, digital preferences of each user group. In essence, this information informs the *context of use* and *user requirements* as part of the aforementioned user-centred design process, and relates directly to Research Subquestion 1.

The first step involved exploring the **Theoretical Background** (Section 3.2) regarding user motivations. This involved conducting desk research into self-tracking behaviours of consumer health product users, psychographic modelling of motivations and speculating how these frameworks fit with period tracking. This was also combined with a brainstorming workshop exercise with user experience and human factors experts to create hypothetical user groups.

The next step was to formulate, arrange and conduct interviews with a range of users to validate these hypothetical user groups, and further investigate their motivations, challenges and attitudes regarding period tracking. The decision to conduct interviews, rather than an anonymous questionnaire (which would likely have involved a wider set of participants, and more quantitative data) was taken because at this stage, more broad exploration of attitudes was required to determine what the research focus would be. Questionnaires would require assumptions about user groups to be made already, and there would be no flexibility to immediately inquire further about certain topics if they arose (as with interviews). In this vein, the interviews were *semi-structured*, as suggested by DiCicco-Bloom & Crabtree (2006), with a goal to generate hypotheses, as opposed to testing them a priori. Certain key aspects of the interview methodology were specifically chosen to help with this, as outlined in the Interview Methods (Section 3.3.1).

The raw interview data was not analysed in isolation but rather in terms of its concurrence with the pre-existing findings and assumptions made during the Theoretical Background study. In this way, *triangulation* was used to converge the findings, as recommended by Wilson (2006) as a way to increase the validity of findings and avoid overlooking important issues. The exact method of *Thematic Analysis* on the raw interview data was based loosely on Glaser & Strauss's (1967) Grounded Theory approach: the reflection on interview findings was ongoing, and informed the discussion of subsequent interviews, although the formal overall analysis and identification of broad themes was undertaken after all interviews were conducted. Certain key insights and relevant quotes were drawn from the data to highlight common themes from between separate interviews ("open coding" from Strauss & Corbin, 1990), as well as any convergence between interviews and findings from the literature. These are highlighted in

accordance with their themes, as outlined in **Thematic Analysis Results** (Section 3.3.2) as well as the other relevant **Miscellaneous Topics** (Section 3.3.3).

As a final step, to summarise and easily communicate the findings from the user group analysis research, **Personas** (Section 3.3.4) were created to encompass different user groups and their underlying motivations and challenges when using period trackers. The creation of the personas was guided by Pruitt & Grudin's (2003) suggestion that a persona should be "*an interaction design technique to augment scenario-focused usability methods*". In this sense, the personas were formed as a basis for these findings, but also evolved and grew as the research project proceeded, according to user testing and feedback. The personas were also used as a communication tool for participants in the co-creation workshop in the next stage.

3.2 Theoretical background: user motivations

User Grouping Literature Review
A literature review into consumer health user modelling techniques was used to form a basis of how period tracker users might be divided. One industry standard for user modelling in the health domain is through psychographic modelling, which encompasses "softer" attributes rather than simply hard facts about the user:

"Psychographics focuses on understanding cognitive attributes, such as customer emotions, values, and attitudes … specific information around a person's interests, hobbies, emotional triggers, and lifestyle choices, among other data." (Al-Razouki, 2017)

Behavioural insight research has identified that once distinct psychographic categories have been identified, healthcare products can then be customised to each user category to match their likely behavioural responses. This is the goal of the user group analysis: to create user groups which may require different, customised period trackers. In this way, the principles of psychographic modelling informed the methods of the user group analysis.

Research on the "quantified self", which refers to the tendency of people to self-track health metrics, also provided a starting point for user motivations on period tracking. For instance, Gimpel, Nißen & Görlitz (2013) proposed a five-factor framework to quantify the drivers (or "use-impulses" behind self-tracking. Specifically regarding fertility tracking, Lupton (2015) suggests that the increase in self-tracking of female health metrics perpetuates users as "digital reproductive" data units rather than humans, and care must be taken on the wider societal impacts of this.

User Grouping Workshop
With these concepts in mind, a **preliminary workshop** was conducted to form initial user groupings from a more holistic and less industry-focused perspective. The motivation behind

starting from scratch, from a more bottom-up approach, was to try and consider all possible use cases, rather than only the ones that are most obvious, or impactful, or profitable.

This preliminary workshop was conducted in collaboration with senior human factors engineers and UX designers of different age groups and genders (for expertise in user-centred design as well as different perspectives), in order to give more breadth of perspective. It consisted of listing any potential motivations that users may have to track periods, and affinity mapping these motivations (by placing them along different groups and axes) to generate common themes.

The results of this phase were realised as several distinct categories of users with different underlying motivations for using digital period trackers, as shown in Figure 7. These common motivation themes were used as a basis for the next stage (user interviews): [1] Period as personal fertility-related indicators; [2] Comorbidity with other symptoms for chronic health issues; [3] Life-planning (such as holidays and work) & general health issues; [4] Communicating to others (such as and [5] Pattern spotting especially for those with irregular periods.

FERTILITY   FEM HEALTH   GENERAL HEALTH   LIFESTYLE

Prolonged use

Short term use

Sticky notes (approximate readings):

- I want to avoid unwanted pregnancy (as an extra precaution)
- I want to use fertility trackers as a sole form of contraception
- I want to check when I should be getting my period so that I can check that I'm not pregnant
- Additional community support for those TTC (trying to conceive)
- I want and know when I'm most fertile
- My partner is TTC and I want to know when she is fertile
- As a doctor, I want to track my patient's cycle for health reasons
- I just gave birth and want to ensure that my health is good (back to normal)
- I have irregular periods and want to track them / understand the pattern
- Want to predict symptoms such as lethargy / headaches / bloating
- Community support for conditions such as Endometriosis etc.
- I want to know I am approaching the menopause
- I am on menopause HRT and want to know if this helps symptoms
- Trying a new Mooncup, tampon, sanitary towel etc. and want to know when it is most appropriate
- Want to understand more about flow rate, timing, etc.
- I am going through a gender change and want to track how hormones are affecting my body
- I want to understand other physical symptoms e.g. headaches, cramps etc.
- Know how affects my mood
- I want to predict my mood
- I have a separate health condition and I want to see how my period changes with it (cross monitoring)
- Trying a new form of contraception will impacts monthly cycles + to track spotting etc.
- Just started and want to see establish any patterns
- I want to know when period is to plan my life e.g. holidays
- I want to know how my cycle will affect my work productivity
- I want to know/predict how my period affects my sports performance
- I like data and want to know as much about myself as poss. (the quantified self)
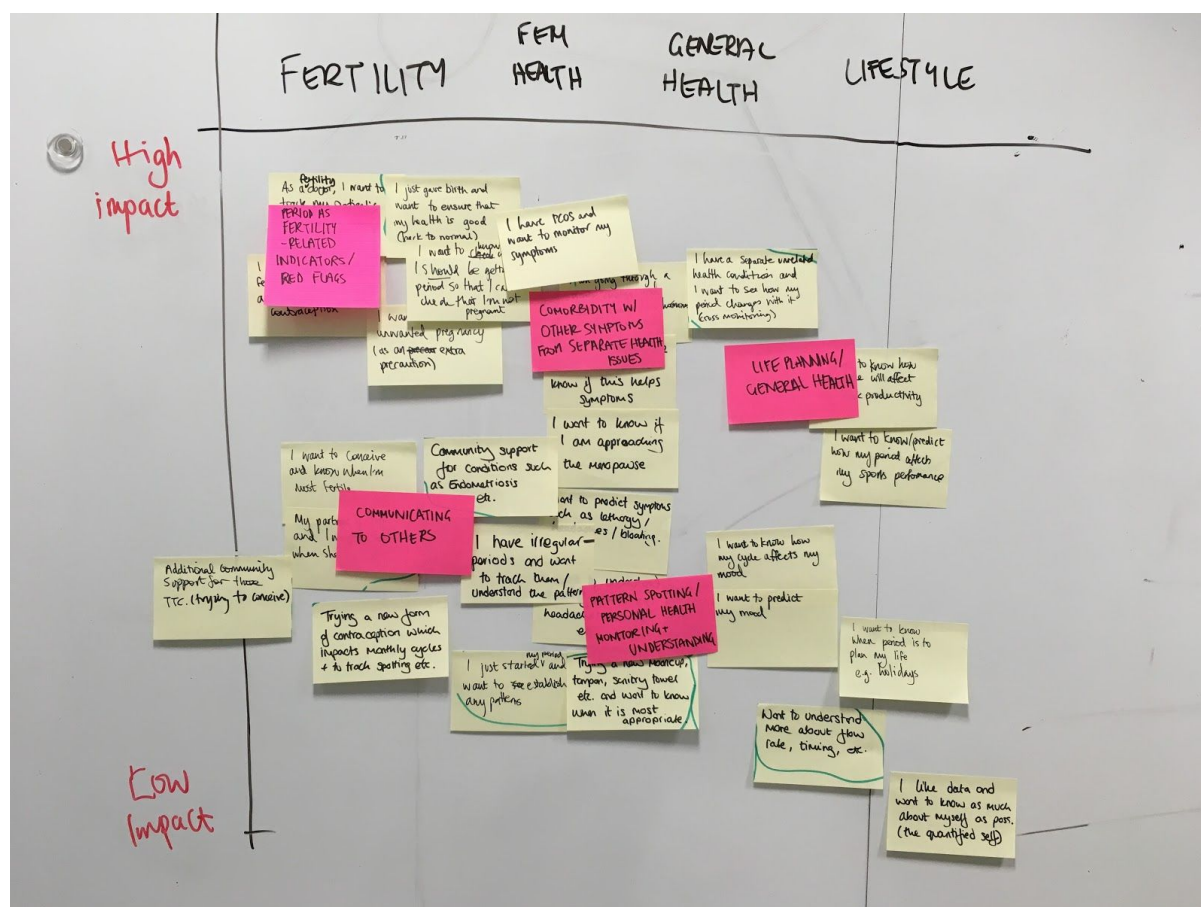
22

Figure 7: Illustration of affinity grouping of motivations for period tracking.
Axes 1 (top): How long user is likely to use FT for that particular motivation?
Axes 2 (bottom): What is the potential impact of the FT, on the user's lives, for that particular motivation?

3.3 User group analysis

3.3.1 User motivations

The aim was to gather insights from between ten to fifteen users (as advised by a human factors expert); in the end, fourteen took part. The Informed Consent Form and Data Handling Procedure can be found in Appendices 2 and 3 respectively. The age range was between 22 and 51, and all participants identify as female. Participants were recruited from several sources, including the Researcher's personal and professional networks and employees from within the host company. All participants had expressed an interest in tracking periods, and the recruitment advertisement can be seen in Appendix 4.

An Interview Guide (Appendix 1) was prepared, with question themes and sample topics of discussion as opposed to a list of questions (*semi-structured interview*). Participants were sent

this Interview Guide before the interview, and asked to reflect on the topics, but without the need to formally prepare answers.

The interviewer was able to participate in the interview in a more *reflexive* way, contributing to the discussion with examples, personal experiences or thoughts. This was done, as far as possible, to facilitate more mutual trust and respect, rather than to lead the discussion in a certain direction, and was kept to a minimum. Care was taken to be as neutral as possible and participants were encouraged to lead in answering questions (any personal insight will be contributed after the answer has been given by participant, and only if appropriate). In order to keep discussion more fluid and dynamic, rather than constrained to the interview guide, and creating as much insight as possible, the interviews were audio-recorded. This allowed the interviewer more freedom to participate in the discussion without needing to transcribe interview findings during the process.

Similar to a grounded theory approach (Glaser & Strauss, 1967), discussion topics *evolved throughout* the process of user group analysis, as the researcher reflects on each interview and recognises sub-themes emerging from each one. The data analysis was done at the same time as collection, and interview questions or themes may also change or expand slightly during the series of interviews being conducted.

Participants had varying tracking habits, and not all of them were currently using a digital period tracker. In fact, two of the participants had never used a digital method (one no longer had periods, and the other felt that analogue or paper methods were enough for her needs). At the time of interview, most of the participants recorded no health metrics other than those related to menstruation.

Their motivations for tracking fell into the categories pre-identified in the Theoretical background study on user motivations (section 3.2), which is illustrated in Figure 8. Some preferences, such as the tracking habits, of users differed between categories. This gives partial validation to these categories as the basis for dividing different user groups.

Motivations for tracking
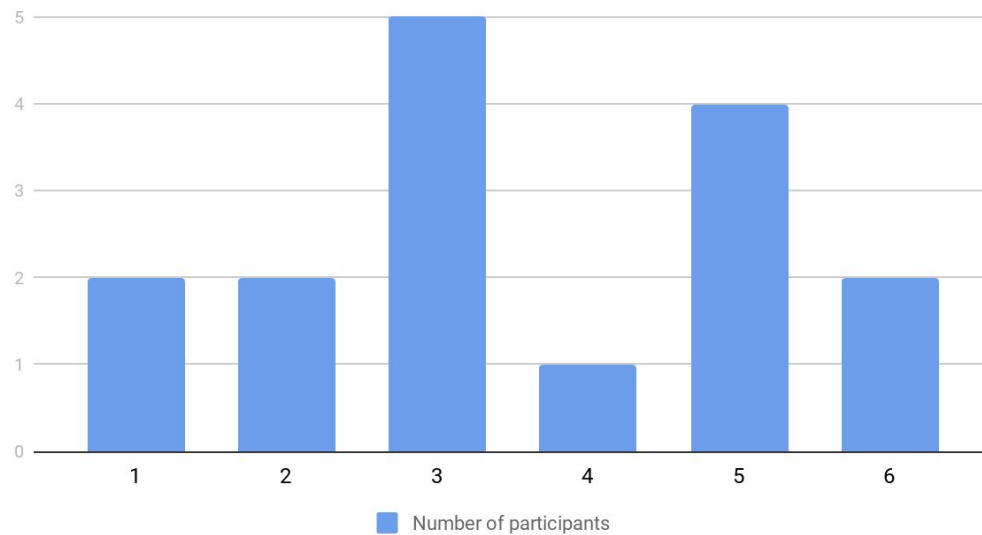
(1)   Period as personal **fertility-related indicators**
(2)   Comorbidity with other symptoms for **chronic health issues**
(3)   **Life-planning**/ general health issues
(4)   **Communicating** to others
(5)   **Pattern spotting** especially for those with **irregular periods**
(6)   **Not currently tracking**

Figure 8: Division of users interviewed among motivation categories. N=14 (some fell under more than one motivation category)

3.3.2 Thematic analysis results

Theme 1: Personal attitudes about periods

In line with findings from desk research (Chapter 2.3), there was a clear general **discomfort around openly discussing periods** as well as a sentiment that existing period trackers and other menstruation products **frame menstruation in a particularly negative way**.

1A: Existing discomfort around discussing periods

Most participants were in agreement that there still exists a taboo around talking about periods particularly in the workplace. Some were personally not uncomfortable with discussing periods, but felt the external discomfort from others in their lives: *"I've got some friends... when they talk about their periods they whisper."* and *"I strongly believe that a lot of people think things are abnormal that are completely normal… We need to talk about these things to just normalise [them]".* This either led them to get negative reactions when they tried to open up the topic in conversation, or stopped them ever bringing up periods in general situations. Others felt in

themselves a discomfort and unwillingness to discuss periods with others, regardless of whether or not they had brought it up: *"For me it's a sensitive topic… The [period tracking] app helped me learn about myself in a safe space."* The mention of having a "safe space" for someone unwilling to discuss periods is echoed in theme 2A.

<u>1B: Menstruation seen in an overly negative way</u>
Regarding personal attitudes towards periods, one of the overarching sentiments from participants was a resignation and in some cases an embracing of periods as a natural and perhaps even welcomed process: *"I wouldn't want to not have [periods]. I like the cramps sometimes, I know it sounds bizarre, but its like yeah my body's doing it's thing!"*. This is somewhat contrary to the aforementioned shame or discomfort in discussing periods: *"I'm not feeling shameful, it's just uncomfortable because of the many accidents I've had in my life."*

Linked to this, participants suggested that period trackers might do well to help bolster the more positive attitudes towards periods, and encourage users to embrace it: *"I wish they'd put more of a positive spin on it, not just negative stuff like 'are you feeling bloated', 'are you feeling sluggish'"*.

<u>How might we…?</u>
As a way to further distil the challenges identified in the thematic analysis of interview data, they were reframed as "How might we…" statements, to directly question the solutions which might be generated when addressing these challenges. For theme 1, the statements identified were:

How might we…

… Reframe the concept of menstruation as a natural and positive thing (when appropriate)?

… Trigger more conversations about periods in everyday life?

Theme 2: Opportunities to educate

In line with Weaver's (2019) recommendation that designers often focus too heavily on improving the weakest areas of their product, and not enough on building its existing strengths, it is important to consider what users already value about the period trackers they use. One of the key benefits is that it often provides a non-judgemental way for users to **learn about themselves** and a significant process in their lives (menstruation), and optionally to **educate others** in their lives about menstruation too.

<u>2A: Educating user (person experiencing periods)</u>
While digital period trackers were already regarded as providing a "*safe space to learn about* [themselves]" in their own right, participants were forthcoming with suggestions on how they would like the trackers to further educate users, *while* they are using the product: *"It also would*

be cool for Amazon to show me different pads or mooncups [before period starting], it could be used to educate someone too."

This stems from a general feeling (and several anecdotes) from participants who feel that even those who menstruate might not be as well educated about their own menstruation processes, sometimes to their own detriment: *"I definitely have friends who were told by their mothers that the amount of pain they're going through is normal."* This often came about from the themes discussed in 1A: if people in general aren't talking about periods, there is no sense of *"Knowing what is and isn't normal".*

One specific example that one participant brought up was also related to how the tracker could aid in her self-understanding about fertility: *"I'm not ready for kids, but I want them one day… Building up some of this history would be helpful for that purpose. [Especially as] my mum had major fertility issues… a situation that could be really helpful is if you could be like, 'hey, I want to start trying [for a baby] in 6 months, when should I get off birth control'?".*

<u>2B: Educating others in the users' lives</u>
Participants were keen to see the increased use of technology in period tracking to showcase a more honest reality of menstruation, especially in conjunction with chronic conditions, to others who (i) do not menstruate or (ii) do not experience painful or significant menstrual symptoms: *"Men should know about it more… it's been established somehow that periods must just hurt… for us [with endometriosis[9]] during 4-5 hours a week in a month, it really stops our lives... you can compare it to a heart attack."*

This reality-showcasing might come about in several ways, but the concrete example often discussed was the ability to share menstrual data with others who also use period trackers or companion applications: *"if the app is making users more likely to talk about it, then the next step is that everyone is more likely to talk about it."..."Maybe tech can lead the change".*

However, sharing this information with other people in the user's lives may have a risk in perpetuating stereotypes: the common misconception that females may only be angry due to periods. There was a particular eagerness to avoid these stereotypes and perhaps use the shared information to enlighten people: *"I would use technology to show men how hurtful this process can be... so this 'OMG she has her period that's why she acts like this' **** could change."*

<u>How might we…</u>

… Give easy access to reliable informative advice on menstruation in appropriate situations?

… Use digital technology to showcase the reality of menstruation to those who are not

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[9] Endometriosis is a condition during which uterus tissue grows on other areas such as the ovaries. It can be extremely painful, especially during periods [source: NHS].

menstruating, or those who might experience painless menstruation?

Theme 3: Lack of customisation

Finally, one of the major shortcomings identified from the interviews, and in line with the literature review, was the lack of flexibility in customising the period tracker to meet users' specific needs. This indicated a lack in being able to indicate two types of information: (1) **extraneous linked factors** like contraception type, and (2) changeable **life situations** like pregnancy or menopause, but also fixed and relevant contextual information like endometriosis.

3A Cannot (easily) indicate extraneous linked factors

An area in which period trackers in general need more in-depth customisation is in being able to indicate different types of contraception, so that their side-effects (which can often majorly impact periods and menstruation symptoms in general) can be considered or at least recorded: *"I would want options like just started the pill, just got the coil, just taken emergency contraception, everything to do with my period in terms of contraception… these things affect you so much."*

For many users, it is an "*frustratingly*" obvious missing functionality which could add value in different ways: *"you can't indicate what type of birth control you're on. Like if you forgot to take your pill one day… what if you got pregnant, you could go back [to the app] and say that could be why."*

Others suggested that if they were able to simply indicate different contraceptives and related information in period trackers, they could have made obvious inferences and correlations which would have been extremely useful: *"I have more painful periods with the coil, but I had to discover that myself, I couldn't from the app."*

3B Cannot (easily) indicate situations like menopausal

A consequence of being unable to customise period trackers is that it will not present information to users in a suitable way, or force them to irrelevant information: one user complained that her *"last app kept telling me my fertile window, that's not what I'm interested in"*.

Another suggested that the range of options in customising period trackers should *"meet the diverse range of users, whether you're trying to conceive or about to reach menopause. For me, I'm banging on the door of [menopause], but on the mirena [coil] so don't have a period… I don't know if I have gone through it"* and another pointed out that *"circumstances change all the time and sometimes they're in a grey area"*. This links back to the SITUATIONAL image of usability outlined in Chapter 1.1, whereby the system functionality must change to accommodate the user's changing contextual circumstances, not vice versa.

How might we…

… make the logging of symptoms as seamless as possible in people's lives?

… allow users to better customise the period tracker to their own situation (e.g. life stage, fertility, contraception usage, relevant health conditions)?

… present information to users in a way that is congruent to their situation?

3.3.3 Miscellaneous topics

Regarding data security and privacy, and the potential issues as outlined in Section 2.2.1, most users were largely unconcerned about the security of their own data, and in fact were particularly keen to have their data contribute to research: *"The world can be shocked that approximately one week a month, I have blood…. I'm happy if they're using my data to learn more"*. Some were concerned if their data was being used for commercial purposes such as targeted marketing. However, others were unperturbed by even this possibility, often due to a general feeling of having less control over personal data as a whole: *"increasingly I'm becoming more laissez faire about [improperly handled data]."*

In contrast to findings from Starling et al. (2018, as outlined in Section 2.1.2: Scholarly Research), there was not a high level of reliance on period trackers as a method of contraception. This may have been a result of better general awareness and education of the participants of this project. One user, for instance, said they would not use their tracking app alone because it is too *"generic and designed for the masses. [They] can't take into account individual ovulation cycles. How can they be 100% confident about egg release days… when it's not black and white"*. Conversely, several users were either strongly reliant or had been reliant on period trackers such as Fertility Friend[10] to aid in conceiving.

3.3.4 Personas

Personas (see Figure 9a, b and c) were created to draw together insights from the user group analysis. These personas were used in the next phase (Design Solution, Chapter 4). They do not necessarily cover all user groups, but are based largely the interview participants and their challenges, in order to provide some focus for the next stage (Solution concepting).
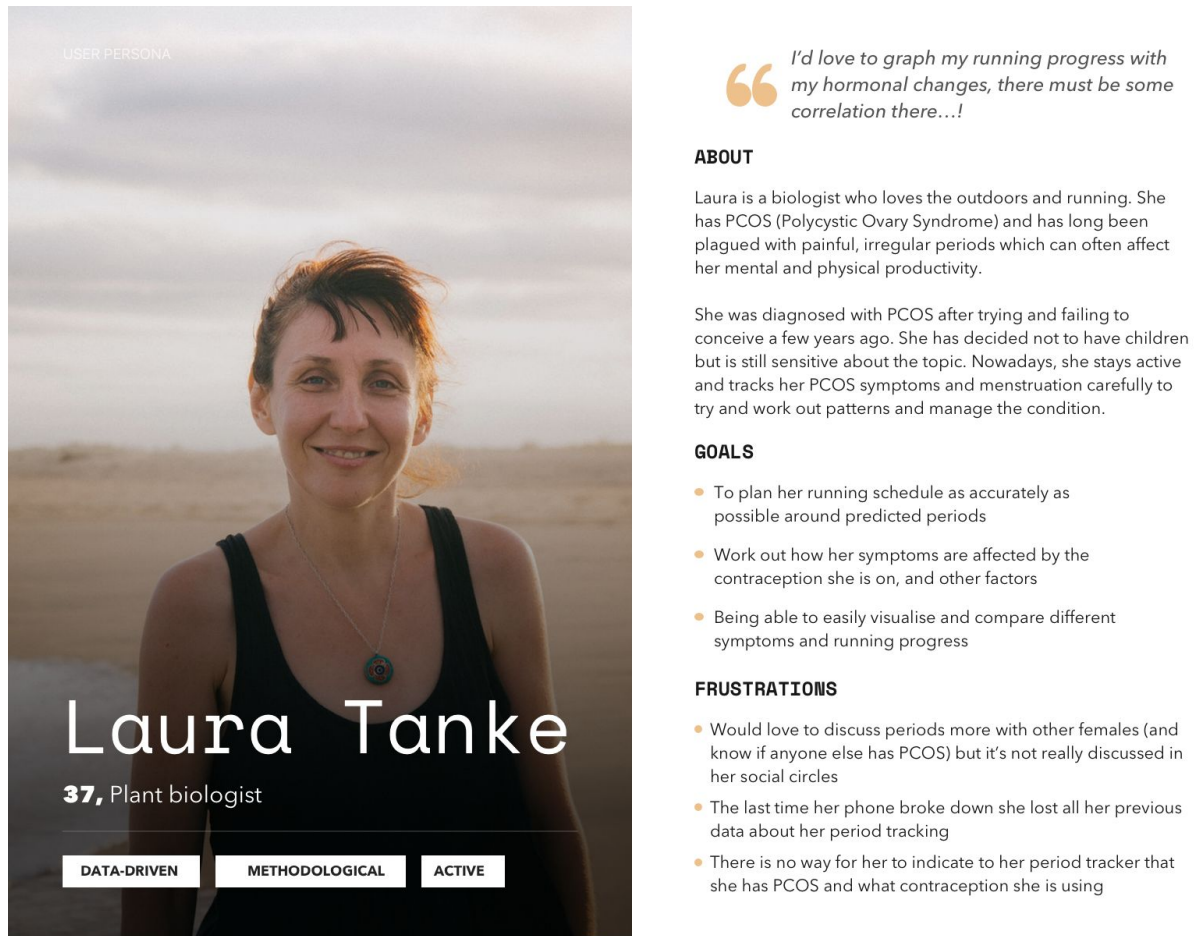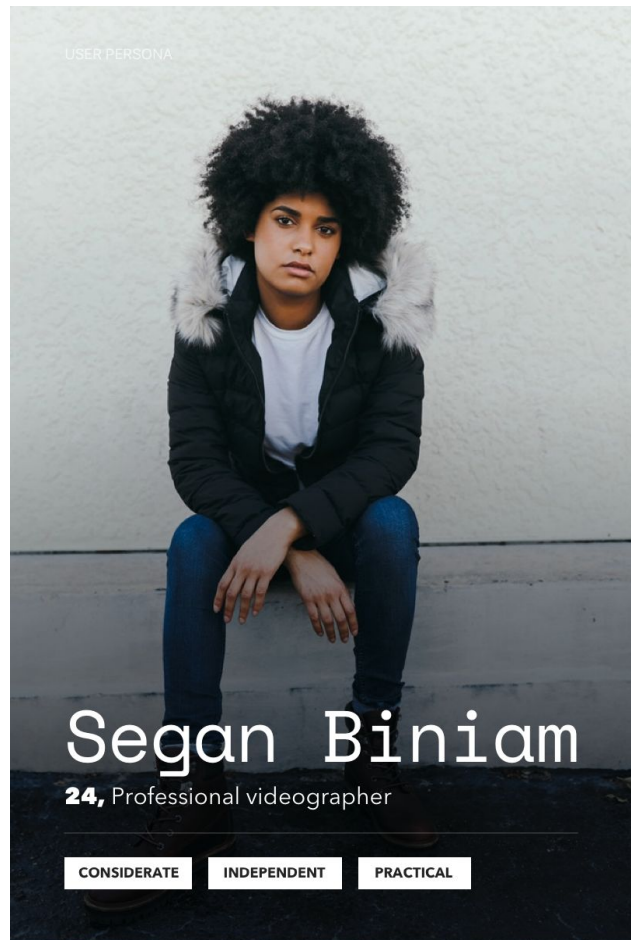
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[10] https://fertilityfriend.com

Laura Tanke

37, Plant biologist

| DATA-DRIVEN | METHODOLOGICAL | ACTIVE |

> *I'd love to graph my running progress with my hormonal changes, there must be some correlation there…!*

ABOUT

Laura is a biologist who loves the outdoors and running. She has PCOS (Polycystic Ovary Syndrome) and has long been plagued with painful, irregular periods which can often affect her mental and physical productivity.

She was diagnosed with PCOS after trying and failing to conceive a few years ago. She has decided not to have children but is still sensitive about the topic. Nowadays, she stays active and tracks her PCOS symptoms and menstruation carefully to try and work out patterns and manage the condition.

GOALS

- To plan her running schedule as accurately as possible around predicted periods
- Work out how her symptoms are affected by the contraception she is on, and other factors
- Being able to easily visualise and compare different symptoms and running progress

FRUSTRATIONS

- Would love to discuss periods more with other females (and know if anyone else has PCOS) but it's not really discussed in her social circles
- The last time her phone broke down she lost all her previous data about her period tracking
- There is no way for her to indicate to her period tracker that she has PCOS and what contraception she is using

Figure 9a: Persona 1, Laura, illustrates themes 1A and 3B

USER PERSONA

Segan Biniam

24, Professional videographer

CONSIDERATE   INDEPENDENT   PRACTICAL

> *I travel a lot… It's majorly useful to know when my period is coming up, so I can pack properly.*

ABOUT

Segan works in events video production, and so travels frequently. She is always busy and short on time. However, she appreciates well-designed software with an eye for minimal aesthetics and simple interactions.

Segan is open to talking about periods with her friends, but in her family it's more of a taboo subject. She would love to get more people comfortable with talking about it, especially as it took her a long time to get comfortable too, having been bullied at school for getting her period very early.
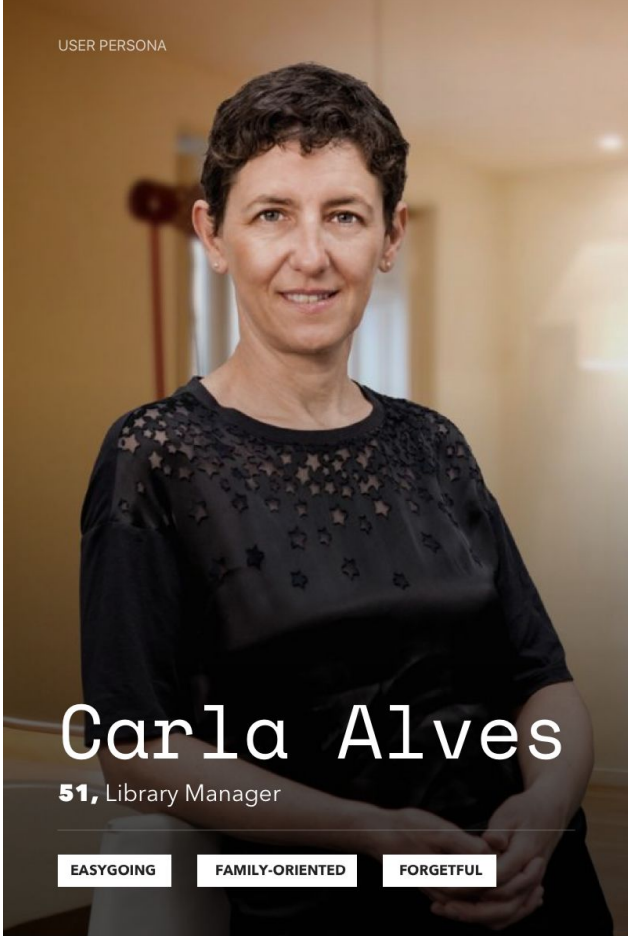
GOALS

- Wants to track periods in as simple way as possible - just stop/ start
- Would love to see it become more mainstream to openly track and discuss periods as if it were similar to other health metrics like steps.

FRUSTRATIONS

- Wishes that periods weren't seen as so negative.
- Having to remember to open an application to check and track her periods
- Sometimes is too busy to mark period dates and struggles to remember them accurately later.

Figure 9b: Persona 2, Segan, illustrates themes 1A/B and 3A

USER PERSONA

At my age, I could be starting menopause now. I should probably be keeping track of the signs.

ABOUT

Carla has always been very open to talking about periods with other females in her family, including her two daughters. She likes keeping records, and is hoping that in tracking her data she can also give her daughters a rough idea of what they might expect in their own lives.

In addition, Carla would like to be able to keep an easy-to-summarise overview of her periods to be able to show her doctor as she now gets standard checkups with them fairly often. However, she doesn't user her smartphone a lot so often forgets to track her periods.

GOALS

- Keeping track of menstruation to track menopause

- Easily gather data to share with doctor(s)

- Store data to later share with daughters and for family health records

FRUSTRATIONS

- Doesn't like constantly having to learn new digital platforms

- Doesn't like having to turn on her smartphone and mark symptoms when she has her period

Carla Alves

51, Library Manager

EASYGOING   FAMILY-ORIENTED   FORGETFUL

Figure 9c: Persona 3, Carla, illustrates themes 2A/B and 3B

4 Solution Concepting

4.1 Solution concepting theory

In the previous stage, the groundwork for the user groups and their challenges regarding period tracking was conducted. In this stage, users will be consulted during a **co-creation workshop** to create digital solutions in response to these challenges. The final deliverable of this workshop was a set of distinct solution concepts.

The motivation behind this user-centred design method is that it has several advantages. Sanders (2003) suggests that by involving users themselves in the early formative design process, we can get deeper insights into their motivations and experiences (*tacit/ latent* knowledge), even beyond what they can simply speak about (*explicit/ observable* knowledge). By encouraging people to actively create solutions, we can build on what they know, feel and dream on a more holistic level, as shown in figure 10.
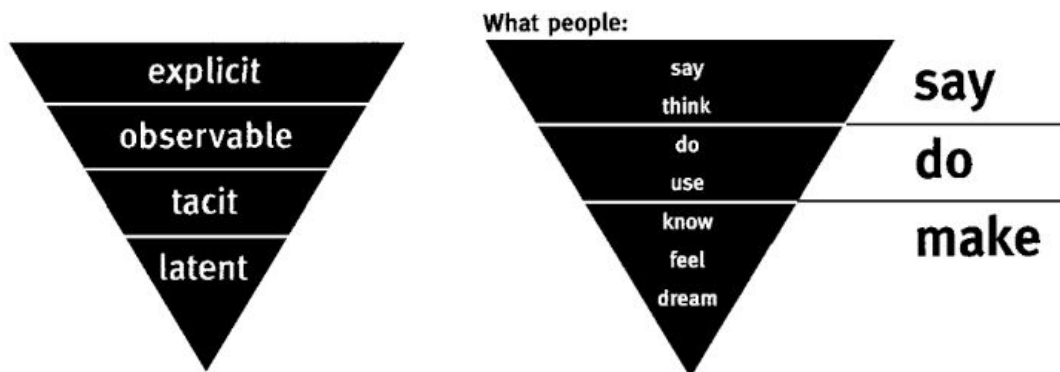

Figure 10: levels of insight from users and how to access them [Source: Sanders, 2003]

The plan for the co-creation workshop was formulated with reference to participatory design principles, online guidelines[11] and reviewed by senior UX colleagues. This has been outlined below.

4.2 Co-creation Workshop Methods

Participants were largely comprised of engineers and business developers, facilitated by the Researcher. This was to ensure there is a broad range of views, but not so many that participants would find difficulty in communicating effectively.

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[11] https://toolkit.mozilla.org/method/participatory-designco-design-worksession/

The workshop itself involved five stages over 1.5 hours, and had the following outline.

(1) Breaking the ice [5 mins]

The workshop started with a short introductory exercise to familiarise each other with names, backgrounds, and a more general outlining of the workshop goals. 4 out of 6 of the participants had previously had individual interviews as part of the project, so were more familiar with the goal of the research. In terms of ethical consent, this was implied through participation.

(2) Challenge identification [15 mins]

The schedule then moved to a discussion of challenges identified within period tracker design, and an identification of problem space. Participants were invited to choose which theme they wanted to focus on for the workshop.

Materials used at this stage were personas and themes from the user interviews, as outlined in section 3.3.3. To make the hypotheses clearer, they were also reframed into "How might we…?" statements[12]. The participants were also invited to add their own How Might We… statements.

(3) Idea generation [30 mins]

Participants were then asked to brainstorm ideas, by writing them on post-it notes and presenting them briefly to others. The emphasis here is on quantity of ideas over quality, and brainstorm rules will apply: no criticism of ideas, and no "ownership" of ideas. In terms of methods, participants will be timed and asked to produce post-it suggestions.

(4) Idea refinement [30 mins]

Next, participants were asked to individually choose ideas based on feasibility and constraints. At this stage, they are able to ask each other for more clarification and criticise ideas (or defend ideas against criticism). We then conducted a visualisation task to explore their chosen idea in more depth, as a way to think more about the specific way in which the idea would be realised. This involved sketching out a more detailed realisation of their chosen concept and then describing it to others.

(5) Wrap up [10 mins]

There will be a summary of results, and a revisiting of the challenge space (asking *Do our solution concepts address the challenge head on?*") to see if we can add to the results or refine them further.

4.3 Workshop Results

Participants unanimously voted to focus on Theme 3: Customising Period Trackers (as outlined in Section 3.3.2. This was perceived as the most tangible challenge that invited most innovation, compared to the other themes, and naturally incorporated elements of the other themes also.

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[12] http://crowdresearch.stanford.edu/w/img_auth.php/f/ff/How_might_we.pdf

The original "How might we… " statements were used as a basis, and participants generated further statements which were then grouped together (see Figure 11). Eventually, the following statements were chosen as a basis for ideating solutions for period trackers:

How might we…
…see what is normal?
…allow many inputs to be easily viewed and analysed?
…decide which info we want to see and when?

Figure 11 (top): Participants suggest "How might we..." statements pertaining to Theme 3. Verbal consent was obtained from participants for photography.
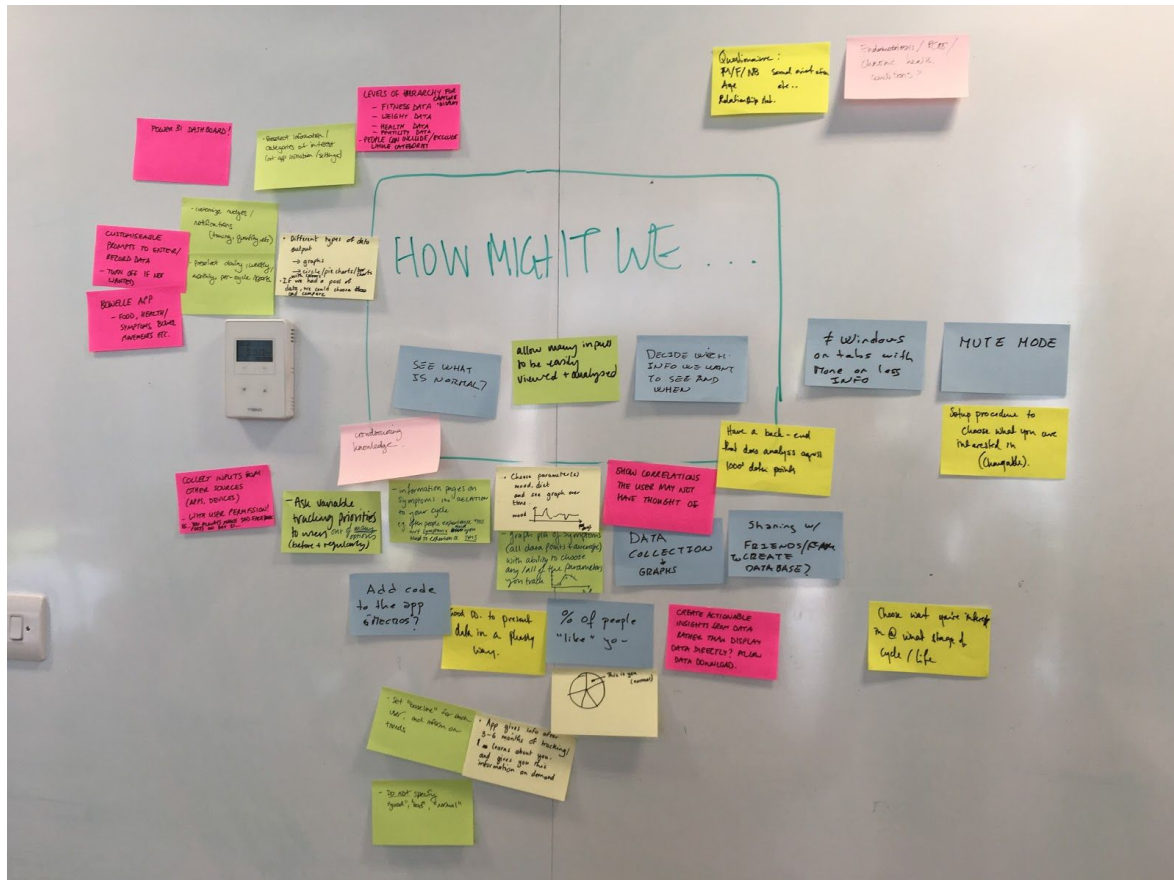

Figure 11: An illustration of the solution concepts as they were first generated by participants

4.3.1 Solution Concepts

The solution concepts could be naturally categorised into task- based groups: initiation; data presentation; external information synching; and customisation of data presentation. The comprehensive list can be found in Appendix 5, while the summarised highlights are outlined as follows.

Several ideas focused on the **initiation and onboarding** phases of a period tracker, specifically with a key consideration on allowing all possible use cases to be communicated (allowing users to give a clear picture of their situation and motivations to the tracker). For instance, features included "*indicate endometriosis/ PCOS/ chronic health conditions*" and "*preselect information/ categories of interest (at app initiation/ settings)*". Another category or solution concepts revolved around **customising data notifications** and information presentation frequency; for instance "*preselect daily, weekly, monthly, yearly, per-cycle reports*" and including a "*mute mode*".

Many of the concepts also build on the concept of **data visualisation and exploration**. Some of them assumed a "power user"-type level of engagement from users, in terms of enabling them to make relatively elaborate explorations of their own historical data and that of others (such as data from friends, family, and similar anonymised users *"to create a shared database"*). Other platforms such as Power BI and diet tracking mobile apps were noted as benchmarks for how data could be manipulated by users. For instance, one concept describes how the tracker could *"graph a plot of symptoms (all data points + average) with the ability to choose any/all of the parameters you track"* However, other concepts were targeted to users who would prefer a simpler interface, with the tracker designed to *"create actionable insights from data rather than display data directly"*.

Finally, other solution concepts considered the potential for self-tracking data to be synced and used with **information from other sources**, such as sentiment insights from social media to determine mood, digital calendars, or physical activity from fitness tracker wearables or phone apps.

It is important to note that the highlights mentioned here are a distillation of the solution concepts generated in the workshop. Conversely, the solution categories gave further differentiation into different areas of user journeys and validated the challenges within each, which helped to synthesise the insights from the user activities as a whole.

During the co-creation workshop, the participants took part in an exercise involving the sketching and presentation of a particular solution concept of their own choice. This was done to get participants thinking about how the concepts might be realised in a period tracking interface, and prompted discussion on which specific devices might be best suited for different features also. For instance, smart watches might be best suited for data logging but not so much for comparing different parameters from historical data.

4.3.2 User Journey Mapping

To further clarify and communicate the insights from the user group analysis and co-creation activities, a user journey map was created, with reference to an updated version of Persona 1 (from Chapter 3.3.4), with an additional section on technological capability.

This user journey was broadly separated into five distinct stages: (1) onboarding; (2) data logging; (3) exploring; (4) predicting and (5) exporting. Within each stage, the main actions carried out by the user and their negative or positive impacts on user emotions are highlighted, and cross-referenced to related quotes from the user interviews.The researcher also chose specific solution features which were mapped to identifiable pain points along user journey. The results are illustrated in Figures 12.1 & 12.2.
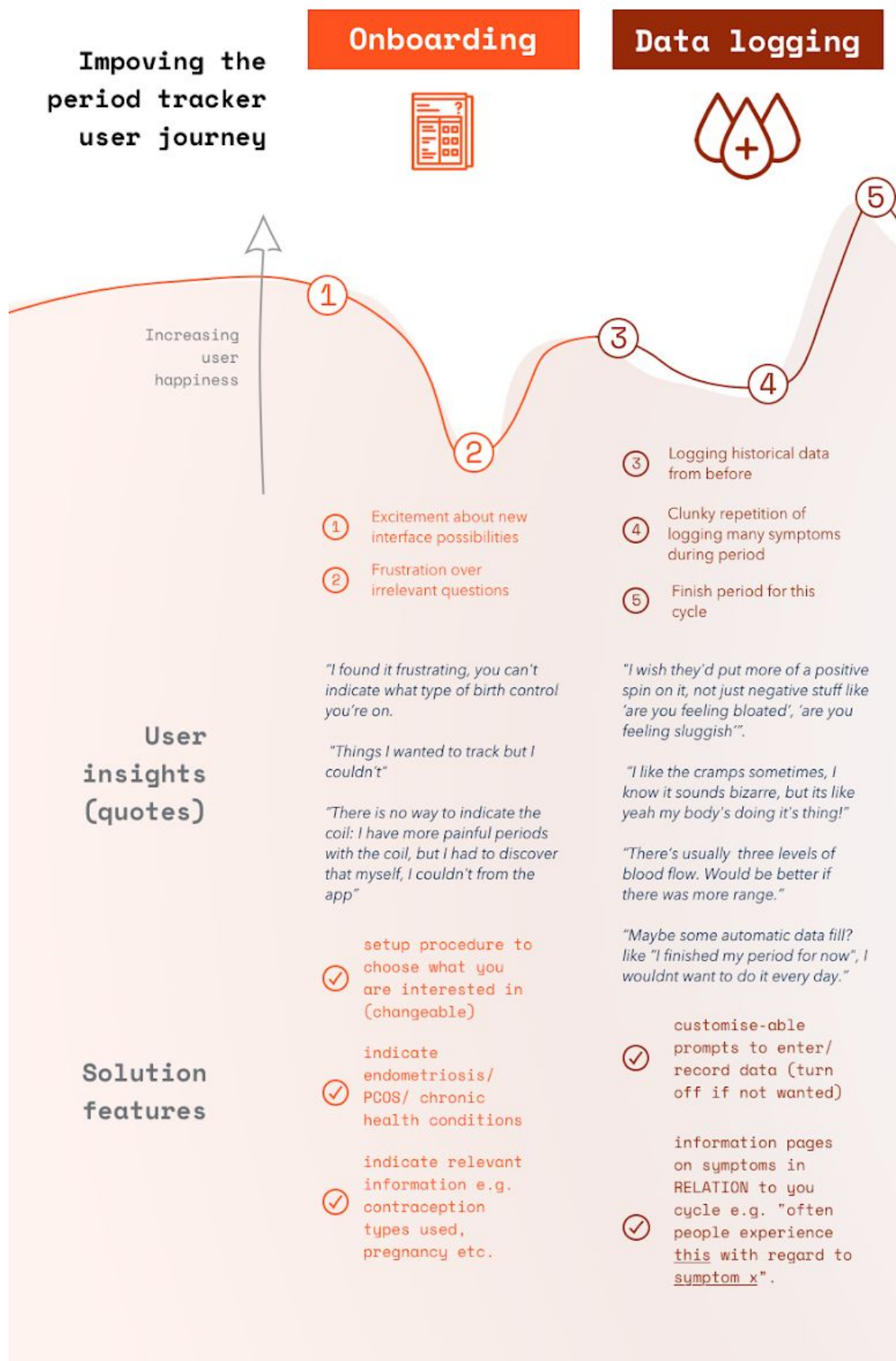
Impoving the period tracker user journey

Onboarding

Data logging

Increasing user happiness

1 — Excitement about new interface possibilities

2 — Frustration over irrelevant questions

3 — Logging historical data from before

4 — Clunky repetition of logging many symptoms during period

5 — Finish period for this cycle

User insights (quotes)

"I found it frustrating, you can't indicate what type of birth control you're on.

"Things I wanted to track but I couldn't"

"There is no way to indicate the coil: I have more painful periods with the coil, but I had to discover that myself, I couldn't from the app"

"I wish they'd put more of a positive spin on it, not just negative stuff like 'are you feeling bloated', 'are you feeling sluggish'".

"I like the cramps sometimes, I know it sounds bizarre, but its like yeah my body's doing it's thing!"

"There's usually three levels of blood flow. Would be better if there was more range."

"Maybe some automatic data fill? like "I finished my period for now", I wouldnt want to do it every day."

Solution features

✓ setup procedure to choose what you are interested in (changeable)

✓ indicate endometriosis/ PCOS/ chronic health conditions

✓ indicate relevant information e.g. contraception types used, pregnancy etc.

✓ customise-able prompts to enter/ record data (turn off if not wanted)

✓ information pages on symptoms in RELATION to you cycle e.g. "often people experience this with regard to symptom x".

Fig. 12.1

38

Exploring

Predicting

Exporting

⑥ Learning how to use the interface

⑦ Finding interesting correlations

"One shortcoming of the app is that it's really ugly. But I can deal with it when there's a lot behind it."

"periods starting and stopping is always open to your current context and how you're feeling and what's going on in your life"

"It would be good to assign a different colour for different things... It's not very easy to see a trend for what is happening"

"I give it all this information on how heavy flow, how much pain etc.; I would love to know if it could predict better how bad the headache is for instance."

"I think would be wonderful to be able to share your information.. Especially to normalise it."

✓ graph plot of symptoms (all data points + average) with ability to choose any/all of the parameters you track

✓ sharing with friends/family to create database of insights

⑧ Seeing new patterns in the data

⑨ Fertility reminder (inappropriate)

⑩ Predicting and planning life around periods

"last app kept telling me my fertile window, that's not what I'm interested in"

"Actually knowing when ill have my period...has made my life so much easier and less stressful or worried. I like to be prepared and since it was unpredictable i had to have anything with me all the time"

"the app can at least predict the rough week, and I'm happy with that, even that can be really helpful ... Useful to know when it's going to "trash my life" for a few days"

"I can know, 'ok that's going to be a bad week, can I frontload some work... ooh that's going to be a heavy week, I might postpone party'"

✓ create actionable insights from data rather than display data directly

✓ do not specify "good", "bad", "normal" - tailor insights to user's own motivations

⑪ Easily showing doctor a spreadsheet of data

⑫ Move to new phone - need to transport data across

"For me It became very important to track all the symptoms, so I can say to the doctor, look this month I had 2 periods, or I'm more stable now [and so on]..."

"I've lost trackers before just because I changed my phone and couldn't get my data back... it helps to keep the data, if you're trying to find a pattern."

"I'm not ready for kids but I want them one day... it would be good to build up information for that."

✓ different versions of data export (comprehensive for porting to new trackers or devices; summarised for sharing with others)

Fig.12.2

5 Solution Realisation

The goal of this stage is to design a hypothetical interface incorporating the selected solution concepts generated from the Co-creation Workshop (summarised in the User Journey Map, Section 4.3.2). This would (a) give further clarity on how to realise these solution features in a real period tracking interface and (b) create a tangible artefact with which to further consolidate insights with users. After reviewing the concepts, the researcher decided to create a **desktop-based dashboard** that incorporates the functionalities within each stage of period tracking outlined in the user journey.

There were several reasons for choosing a desktop to test the concepts. Firstly, many of the current mainstream solutions are mobile applications. Moving away from that mitigates the temptation to directly compare the interface to the applications that are commonly used. It also helped to start from a fresh perspective, with less preconceptions about the visual layout or functionality.

The specific questions which will be investigated during this solution realisation phase relate to sub-questions 2 and 3 as outlined in Section 1.1. In designing this interface, the insights and **5 key questions** (Section 6.2.1) will be a reference point. In testing the interface, these key questions are also being tested for their utility as a general guide for designing period trackers.

5.1 Dashboard creation process

5.1.1 Concept sketching

Some of the common elements that were found in the workshop interface sketches (see Figure 13.1 & 13.2) were used as a basis for designing the initial dashboard concept. For instance, there was a task-based layout idea, separating different hierarchies of user action, and this was used as a basis for how the user could interact with and change data parameters. In addition, using elements from current leading applications as reviewed in Chapter 2.1.1, such a circular cycle visualisation as in Figure 5, and related self-tracking apps such Noom[13] (for diet monitoring) or Bowelle[14] (for IBS patients) as a benchmark was also useful.

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[13] https://www.noom.com/
[14] https://bowelle.com/

Figure 13.1 & 13.2: sketching & wireframing some of the solution concepts

The dashboard flow was determined by the user journey generated in Section 4.3.2, with the five stages incorporated into the dashboard experience in a flow that roughly matches the same user journey.

In addition, the "Insights Sharing" functionality was based on a wider information architecture (see Figure 14). This was created to illustrate how different aspects of user data would be

accessible by different users depending on the user's own preferences, which in turn depend on the receiver's relationship with the user[15].

Figure 14: Information architecture sketch

5.1.2 Digital Prototyping

The hand sketches were digitised using Sketch[16], creating a low-fidelity, clickable prototype for user testing. The whole prototype flow chart can be found in Appendix 6. The solution concepts in more detail are outlined as follows.

Onboarding

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[15] This also considered the medium by which others might receive period tracking data and insights. A partner might not mind needing to download a companion app, and other users of the same tracker have their own motivations to track and share that information already. However, there would potentially be a need to explore other (potentially non-digital) ways of communicating information to people who interact with user on a semi-regular basis (without perpetuating stereotypes or objectifying user).
[16] https://www.sketch.com/

Figure 15: First onboarding page ("About You")

The natural first step for the user is to be able to customise the tracker to their own needs. Following one of the solution concepts suggested during the Co-creation workshop (Appendix 5), I divided the input for this across three sections: "About You"; "Your Health" and "Your Cycle" whereby users could indicate, and also *change across time*, their key information and the way in which they would like to interact with the period tracker. This is largely determined by certain key questions:

"*Reasons for Period Tracking?*" (see Fig.15) is highlighted as an early question as it would then inform the content presented in some of the other dashboard functionalities.

"*Are you experiencing any of the following?*", referring to certain health situations which may significantly affect periods (such as endometriosis, pregnancy, or menopause).

"*Which metrics would you like to track?*" can be answered by the user indicating whether certain metrics (divided by category) should be shown or hidden from them in the data input and predictions made by the period tracker, as well as whether the user would prefer binary day-to-day predictions or the predicted percentage confidence.

In addition, this dashboard allows the user to personally communicate their own understanding of their cycle and when certain symptoms tend to present themselves, which could provide valuable information which may not be communicated by historical data alone. This is

illustrated in figure 16., whereby users can set their own typical cycle and period lengths, as well as drag chips representing their symptoms onto a visual representation of their typical cycle.

Figure 16: Manual cycle customisation

Data Logging
Users can log data via the homepage (for ease of access) or calendar view. The particular innovation in this stage, regarding this hypothetical dashboard, was the use of "Find Out More" links for certain questions, answers, symptoms and others which could allow easy access to more information from an external source. These links would present as either symbols (as in Figure 17) or blue, underlined hyperlinks.

Figure 17: Find out more.

The choice to include these links stems from the previously mentioned strengths of period trackers, as highlighted by the user interviews: giving users a "safe space" to learn about their own health.

Exploring
The dashboard also incorporates sections focused on exploring the user's data and drawing insights from it. A customizable graph functionality allows the user to *"choose any/ all the parameters [they] track"* (directly relating to one of the solution concepts from the co-creation workshop), as illustrated in Figure 18. Being able to directly compare certain parameters whilst excluding others also relates to a specific need highlighted during the user interviews, in which one participant expressed an interest in comparing headache patterns directly with other non-period symptoms.
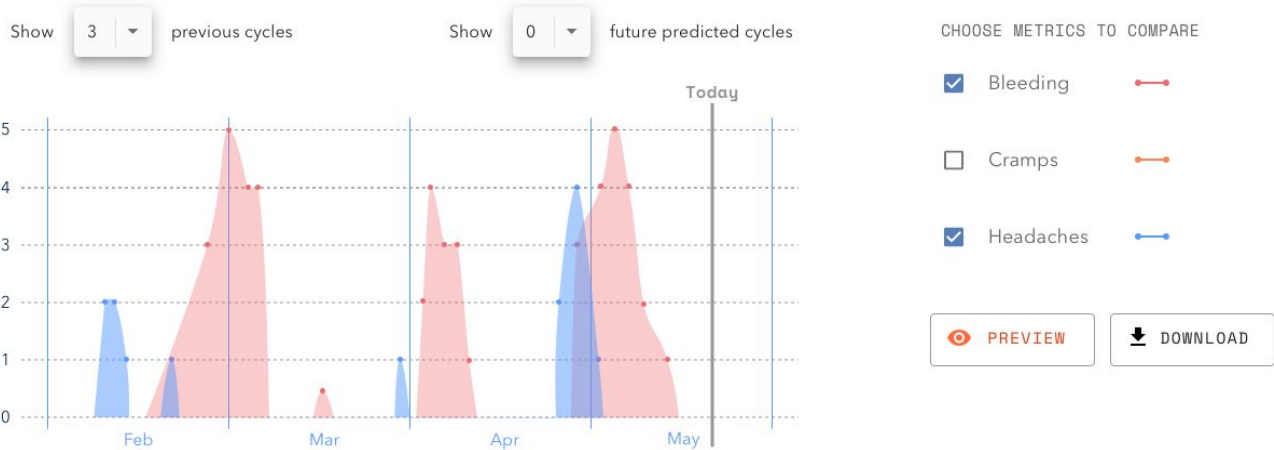
Figure 18: Customisable graph function

In addition, one of the solution concepts which provide a more speculative aspect to the dashboard was the "shared insight database". This would allow the user to customise how they shared data with friends, family, partners and other anonymous users, and see insights generated from correlation analyses conducted across datasets. Two different visualisations for the dashboard customisation were created, as shown in Figures 19 & 20.

Figure 19: Change sharing preferences Version 1
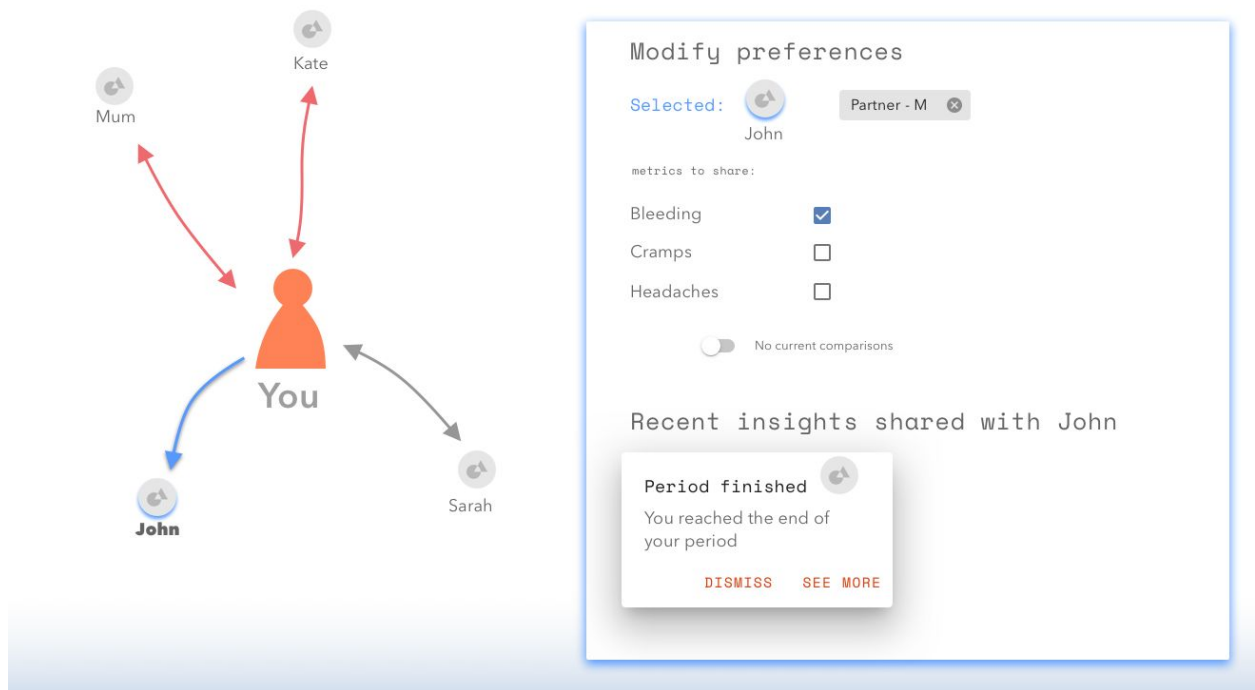
Figure 20: Change sharing preferences Version 2

Predicting

In terms of predicting periods and other relevant metrics for the user, the dashboard presents this information in different ways. One way in which the user can quickly see the current day's prediction is through the initial homepage, providing a "quick-glance" visualisation of where they are in their cycle as well as the % probability of experiencing their chosen symptoms, with a neutral presentation rather than any particular sentiment.

welcome to your tracker, laura

ABOUT YOU   EXPLORE

HEALTH   SHARE

8%
chance of bleeding

Today | Wednesday 22nd May 2019

＋   LOG SYMPTOMS

YOUR CYCLES   YOUR DATA

Day **17**

This week, both you are your sister Kate are likely to be particularly energetic - why not channel it by **booking a gym class together**?
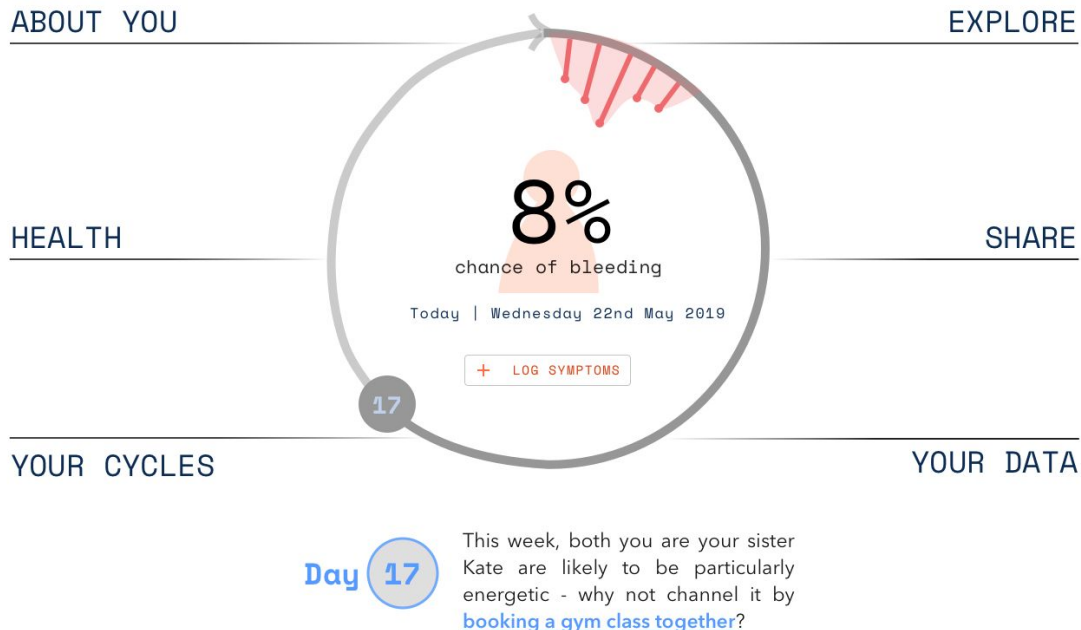
Figure 21: Homepage

In addition, a more traditional calendar view can be viewed to obtain future predicted probabilities. This can also be visualised in the aforementioned customisable graph.

Exporting

Finally, as suggested by the the solution concepting phase, the dashboard would allow "different version of data export (comprehensive for porting to new devices, if stored on-device ; or summarised for sharing with others". There is also an emphasis on transparency of data storage and sharing with third parties.

5.3 Solution Evaluation

5.3.1 User test methods

The goal of the user experience (UX) testing was to test the contexts of use and user requirements as hypothesised from the user group analysis, by directly presenting the

visualised solutions to these requirements in the form of the period tracking dashboard. In this way, the participants can give insights based on a tangible example.

Four participants who track, or have tracked, their periods were recruited from Cambridge Consultants to complete user tests of the dashboard. Two of the participants had initially taken part in user interviews, and none had taken part in the co-creation workshop. The following UX Review Guidelines were created to guide the tests:

<u>Artefacts:</u> User Journey (Figure 12), Conceptual Dashboard UI

<u>Task 1 (10 mins)</u>: Review user journeys and insights, as well as solution concepts.

Questions: Are these features that particularly resonate as useful? Would you use them? Are any useless or damaging?

<u>Task 2 (20 mins)</u>: Review conceptual design prototype: dashboard UI.

Questions: Pay attention to the language used, the tone conveyed and the overall architecture. Are the questions worded well? Are the answers clear and cover everything? Is the information conveyed sensitive/ strange/ intrusive?

Is the overall tone one you'd expect or like to see from a period tracker? E.g. think of the way in which it presents the concept of menstruation. Too clinical? Too patronising? Too happy/ sad?

Are the predictions trustworthy?

These Guidelines are based on Subquestions 2 & 3 as outlined in <u>Chapter 1.3: Research Questions</u>. A particular emphasis was placed on investigating their attitudes to the infrastructure & layout, language & tone, functionality and answer options of the dashboard. Many participants also suggested further example solutions as alternatives or additions to the current dashboard functionality, to illustrate their insights. This is summarised in the next section: Solution Evaluation.

5.3.2 Evaluation results

In general, the feedback on the information flow and architecture of the dashboard itself was positive, with participants describing it as "clear" overall. There was also positive reaction to some elements of the dashboard which had incorporated the sentiments and solution features from the co-creation workshop, suggesting that these solutions were welcome among users. However, there were criticisms about other elements within the dashboard which were very insightful in terms of evaluating how information should be presented and also excluded. The main insights are summarised in this evaluation review, and again, they have been divided by user journey stage for clarity.

In terms of the device interface, participants indicated that while the use of a desktop-based app was novel, it did not suit their preferences for logging data about periods. Most would still prefer a mobile phone application.

Onboarding
There were a few comments about the "*strangeness*" and "*necessity*" about some of the questions, such as "What is your gender?" and "Are you sexually active?", although these questions were only presented if the tracker was being used as a fertility tool. This prompted discussion on the *need for more explanation* being available to the user, on why that information was useful in certain cases. In addition, one participant flagged the need to include sensitive options for indicating infertility, such as a "Not applicable to me" option for the question "Are you using any methods of contraception?". However, participants liked the considerate range of options available to customise the period tracker.

Data Logging
Most users expressed appreciation at being able to choose which metrics were relevant to them, and to be able to "*declutter*" those that were not.
In terms of customising the metrics tracked by the user, there were a few suggestions from participants on how this could be improved: [1] to save time, pre-filling metrics according to personal situation and tracking reasons, which can then be comprehensively altered; and [2] to include "*honest, non-judgemental*" options for the user to indicate, for instance, if they had consumed a contraceptive pill late, or been sick, or had a condom failure.

Since some of the participants experienced chronic health conditions, they were also keen to see educational prompts on how their periods might be affected by their health conditions.

Exploring
Participants liked the ease of use of the customisable graphing function, but requested more clarity on what the vertical axes represented (severity of symptoms). This prompts the need to consider, *how do the different metric scales correspond to each other?*

Regarding the Insights Sharing dashboard, participants found the concept novel but not completely absurd. However, one participant rejected the idea of sharing any individual data with even anonymous users, and another felt that there were some situations which require extra precaution; for instance, reassurance that any recorded sexual activity would not be shared with family members. Most participants personally preferred Version 1 of the dashboard prototype (as shown in Fig. 19).

Predicting
In terms of presenting predicted user symptoms as percentages, rather than the binary "yes/no" predictions as is standard, there were mixed feelings. Participants suggested that this feature would be most useful to quantify likelihood of fertility, but one indicated that they would require

further "*explanation… otherwise you would could misinterpret and lose faith in the tracker's effectiveness if the percentage was low*". In addition, another participant suggested that the % would only be relevant to them if the percentage was high enough to be deemed "*certain, like 90%*". This generates a further question to explore, how different users might themselves interpret the significance of the percentage. This links to section 2.2.2 and the questions surrounding the perceived trustworthiness of information.

Regarding the insights from user data (such as: "*This week, both you and your sister Kate are likely to be particularly energetic - why not channel it by <u>booking a gym class togethe</u>r?*") there were also mixed reactions, with some participants feeling finding it "*off-putting*" and others appreciative, even suggesting further similar insights (such as common remedies for different symptoms, like herbal teas, or flagging up high-risk correlations such as aura migraines as a symptom of oestregen pills). This highlights how data presentation preferences differ greatly among users, and indicates that customisation is important, with options to hide irrelevant or unwanted information.

Exporting
Participants felt the option to do a comprehensive export of all data was useful, and also suggested a clear option to backup data to the cloud.

6 Discussion

6.1 Research Questions & Answers

> <u>Subquestion 1</u>: **What are the different user groups of period trackers?** How do they differ in goals and motivations?

The research identified five user groups with different motivations for period tracking as their basis: *[1] Period as personal fertility-related indicators; [2] Comorbidity with other symptoms for chronic health issues; [3] Life-planning/ general health issues; [4] Communicating to others* and *[5] Pattern spotting especially for those with irregular periods*. However, users are fluid and might change motivations throughout their lives, in accordance to changing health, life situations, and other external factors.

> <u>Subquestion 2:</u> Especially considering the increasing use of period trackers to predict user states, **how do we present the information in a way that the user can interpret, in order to ensure that they are perceived as sensitive, trustworthy (and in terms of data management:**

secure), and yet reasonably manage the expectations of the product? Are there other case studies of trackers from which we can learn design lessons?

Regarding data presentation, there are insights to consider from other period trackers currently on the market (both from press and scholarly sources, as outlined in Section 2), which closely match the user group analysis and solution evaluations conducted. While there are few one-size-fits-all recommendations, the key questions outlined in Section 6.2.1 help to inform designers in what data is important to collect from and communicate to the user, and how to communicate it sensitvely.

In terms of maintaining the user's trust and manage their expectations of the period tracker's capabilities, the research suggests that *transparency* is key: giving users the option to understand the predicted information about upcoming periods, fertility and other symptoms. This is especially relevant in a climate whereby increasing technical understanding of menstrual cycle modelling will help to increase predictive accuracy, and potentially more trackers will gain certification as a medical fertility tool.

> **Subquestion 3**: Ultimately, the use cases that we are tackling in period tracking can often be sensitive for the users. ***Can the development of their interfaces be used to open up the conversation and remove the stigma, for instance, in the language and tone conveyed in the interface?*** Could the additional features that technology allows (such as sharing cycles with peers) actually aid in the removal of stigma?

From general insights gathered during the research, there is hope that digitising period tracking could help in normalising periods; however, this might be more indirect. For instance, it could first help users feel more comfortable with menstruation on an individual level, as it has been shown to provide a *space and means to learn about their own menstrual health*. The sharing of menstrual data (which would be further enabled by its digitisation) could also have a knock-on effect as more people are exposed to information and subsequently normalised to it, as well as opening up more conversations which traditionally have been shied away from. Finally, on a wider societal level, the increased access to menstrual data in research, as well as growing popularity of digital period tracking which generates more market interest in women's health as a whole, will hopefully foster more acceptance of menstruation as a natural process.

The investigation of these sub-questions were used to inform the answer to the overall research question:

"What criteria can we follow to best design for users of digital period trackers?"

The insights from the whole research project have been distilled to form a *general guideline for designing digital period trackers* with reference to Hertzum's images of universal, situational and cultural usability. The guideline is outlined in the next section (Chapter 6.2 Research Results).

6.2 Research results

6.2.1 Key questions

Since there cannot be a one-size-fits-all design for period trackers, given the range of users who might use the technology, designers must first determine their target users' needs before designing. To determine these needs, the following **key questions** may be asked (through user research, such as interviews or questionnaires), to guide the collection of information. This will help to streamline enquiry and form the basis of the essential information that the tracker should design around. It also helps designers to meet the three-part guideline (outlined in Section 6.2.2).

1. **What are the key things the app should know about [the user]?**
Some example categories of information would include: life stage; medical "situation"; external factors e.g. contraception; purpose of tracking and tracking interests

2. **What are the most important pieces of information (s)he wants to know?**
Such as: when will there be bleeding & other affective symptoms, e.g. cramps, fatigue, bloating, headache/ more physical or mental energy/ medical explanations or simply insights.

3. **Who else will the information affect?**
Especially concerning: mental productivity/ affective symptoms/ mood perhaps (for work colleagues) and fertile window/ periods (for partners or doctors when trying for or avoiding pregnancy)

4. **How to communicate relevant information in a way that is appropriate to the receiver?**
Not only to the user but also others, and considering the specific situation in which the receiver would be interested in such information.

5. **What actions will (s)he take as a result of the information?**
For instance: personal life planning; work projecting; setting goals/ deadlines; exercise scheduling (setting goals, knowing what's likely to be possible some weeks)

6.2.2 Three-part guideline

As a distillation of the information gathered from this research project, a general guideline for designing period trackers was created. This was written with designers as a broad target audience, and is divided into three actionable principles. They are created to be used in conjunction with the Key Questions in Section 6.2.1: answering the Key Questions will help inform the user needs, these guidelines will help inform on how to meet those needs.

(1) Customise
Design the period tracker so that users can easily customise (and change across time) their own user profile. Either (i) ensure the broadest range of possible options for the user to be able

to indicate their situation, or (ii) clearly communicate which target users the period tracker is focused on, and ensure that their full range of possible use situations are catered for.

As far as possible, use this valuable user information to inform the period tracker interface design: prioritising the correct data input & output variables, using the right tone, and so on. If the user has not indicated or customised, avoid making assumptions about their sentiments when presenting information; for instance, do not specify what is good, bad, or normal but instead adopt a neutral tone.

It may also be beneficial to design a for an integrated tracker as part of a health-tracking system, rather an app singularly focused on period tracking. This related particularly to Key Questions 3 & 4. According to Repa (2019), this "*systemic thinking*" will be valuable in a future market whereby users are gravitating towards "*go-to systems for managing whole parts of your daily life*" including health management. There is also significant capacity for increasing accuracy and usefulness of period tracking and predictions by correlating with other, previously unrelated health metrics.

(2) Educate
Use the opportunity of this digital touchpoint to give users easy access to relevant, reliable health information. For instance, include optional links to information explaining *why* certain information might be useful for users to input to the period tracker (for instance, why indicating age may give potentially better predictions on future periods).

(3) Be Transparent
Give the user more access, should they wish to have it, to how the predictions have been calculated. This may consist of a simple breakdown of the statistics or algorithms (level of simplification may depend on user preferences and willingness to disclose the technical details). In addition, let users view and choose which data and parameters have been included in the calculations. This would benefit from a close reference to explainable AI principles when designing algorithmic systems for predicting menstruation (for instance, those outlined by Holzinger et al., 2017).

In addition, it some users might prefer to move away from binary predictions, in favour of percentages or confidence intervals. Finally, be transparent in how the data is stored, used and shared.

7 Conclusion

7.1 Relevance of findings

In summary, the research insights outlined in this thesis were gathered with the aim to inform the best-practise design of digital period trackers. No particular user group has been exclusively prioritised; the aim is to create guidelines applicable to all users of period trackers. However, as usual the generalisability of these guidelines is limited in several ways by research methods used: these are outlined in more detail in Section 7.2.

This research built upon, and largely corroborated findings from Epstein et al. (2017) and Gambier-Ross et al. (2018). However, rather than focusing mainly on user feedback of existing current applications as these two studies do, the aim of this research was to employ a ground-up, user-centred design approach, focusing on user needs regardless of what already exists in current period trackers.

This resulted in a set of insights which (a) emphasise the aspects of period tracking which users already value; (b) encourage trackers to be designed for increased accessibility and (c) suggest some aspects which are somewhat speculative in nature (such as more comprehensive sharing of data among different users). However, rather than using a speculative design experiment to illustrate these concepts[17], they were summarised into immediately- usable guidelines for period trackers in the social climate as it currently stands, which will hopefully nudge towards more open attitudes. The insights were also tested using interface design and evaluation.

7.2. Limitations

One of the limitations of this project was that it took place in the UK alone (although some of the participants are from non-UK backgrounds), which restricted the contextual environment in which research was conducted. While the participant age range varied across 4 decades, socioeconomic backgrounds and other potential affective factors were not deliberately varied. This suggests that the findings can only be applied to this market, and may change to different degrees in other cultures.

Due to this limited participant group, there was a potential for missed or under-emphasised use cases. For instance, there were no interviews conducted with any teen or pre-teen users, which is an important set of users to consider, especially as these users (i) may have completely different considerations to older generations and (ii) are likely to be using digital technology in different ways. In addition, on the increasing uses of period tracking is in the field of high-level

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[17] For examples of such speculative design concepts, see Fox et al. (2019) and Homewood (2018)

sports, where there is increasing understanding of how hormonal changes can affect female sports performance (Saner, 2019).

While the Guidelines and Key Questions ([Section 6.2](#)) from this research project may apply effectively to these use cases, as well as others which were not directly investigated during this project, robust testing with relevant users is also extremely important.

7.3 Suggestion for future work

In order to cover the gaps in the research methods, as outlined in [Section 7.2](#), users who had not been involved in this project (such as high-level athletes, transgender women and teens and pre-teens) may benefit from their own fresh analyses. This would involve using some of the same research methods used in this project (user interviews, co-creation and user testing), to investigate if there are any additions or amendments to the guidelines. This will help to ensure the robustness of these guidelines, and their applicable to a more general period-tracking population.

Regarding the presentation of predicted information, it would be insightful to conduct further experiments on how different users interpret statistical information. For instance: *what percentage or degree of confidence is required to trigger certain actions in users?* As an example: *If users are presented with the information that they are 48% likely to ovulate on a given day, will they interpret this as "likely" or "unlikely"? And will this be enough for some users to feel that they can modify behaviour, like using contraception?* These insights would be useful for further guidance on how to specifically present figures to users in a way that is not misleading.

In addition, it could be useful to explore the more speculative design aspects, such as data-sharing with family and friends, and integration with other health monitoring aspects. This would add more clarity on how period trackers could fit into a whole system of health monitoring and sharing, rather than with the user alone. For instance, an expansion on Homewood's (2018) system for sharing menstrual cycle stage through altering the colour of home lighting, could involve sharing the information through a more portable lighting device (for instance a small lamp that could sit on an office desk). Another speculative project could involve designing the interfaces for other members of the user's life, such as their partner, to investigate how information about the user should be presented to them.

References

Al-Razouki, M. (2018). *The Psycho is King*. [online] Medium. Available at:
https://medium.com/@Mussaad/the-psycho-is-king-39a38c739d45 [Accessed 29 Jul. 2019].

Boynton, P.M. and Greenhalgh, T. (2004) Selecting, designing, and developing your
questionnaire. *BMJ*, 328, pp.1312-1315.

Bradley, S. (2019). *The Most Popular Apps for Tracking Your Period and Fertility*. [online]
Women's Health. Available at:
https://www.womenshealthmag.com/health/g26787041/best-period-tracking-apps/ [Accessed
9 May 2019].

Caddy, B. (2019). *Garmin's new women's health tracking features explored*. Available at:
https://www.wareable.com/garmin/garmin-womens-health-tracking-guide-7417 [Accessed 29
July 2019].

Chen, W., Kitazawa, M. and Togawa, T. (2009). Estimation of the Biphasic Property in a Female's
Menstrual Cycle from Cutaneous Temperature Measured During Sleep. *Annals of Biomedical
Engineering*, 37(9), pp.1827-1838.

Dolan, B. (2019). *Digital health fertility services ramping up*. [online] MobiHealthNews. Available
at: https://www.mobihealthnews.com/19907/digital-health-fertility-services-ramping-up/
[Accessed 9 May 2019].

Das, R. (2019). *Women's Healthcare Comes Out Of The Shadows: Femtech Shows The Way To
Billion-Dollar Opportunities*. [online] Forbes.com. Available at:
https://www.forbes.com/sites/reenitadas/2018/04/12/womens-healthcare-comes-out-of-the-s
hadows-femtech-shows-the-way-to-billion-dollar-opportunities/#41d5113d6159 [Accessed 9
May 2019].

Delano, M. (2019). *I tried tracking my period and it was even worse than I could have imagined*.
[online] Medium. Available at:
https://medium.com/@maggied/i-tried-tracking-my-period-and-it-was-even-worse-than-i-could-h
ave-imagined-bb46f869f45 [Accessed 9 May 2019].

DiCicco-Bloom, B. and Crabtree, B.F. (2006) The qualitative research interview. *Medical
Education,* 40(4), pp.314-321.

Dubow, S. (2019). *The Five Ways FemTech is Changing the Language of Women's Health*. [online]
Medium. Available at:

https://medium.com/femtech-collective/the-five-ways-femtech-is-changing-the-language-of-womens-health-8adb2dee4a64 [Accessed 9 May 2019].

Epstein, D. A., Lee, N. B., Kang, J. H., Agapie, E., Schroeder, J., Pina, L. R., ... & Munson, S. (2017). Examining menstrual tracking to inform the design of personal informatics tools. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 6876-6888). ACM.

Felizi, N. and Varon, J. (2019). *MENSTRUAPPS - How to turn your period into money (for others)*. [online] Chupadados. Available at: https://chupadados.codingrights.org/en/menstruapps-como-transformar-sua-menstruacao-em-dinheiro-para-os-outros/ [Accessed 9 May 2019].

Fox, S., Howell, N., Wong, R., & Spektor, F. (2019). Vivewell: Speculating Near-Future Menstrual Tracking through Current Data Practices. In *Proceedings of the 2019 on Designing Interactive Systems Conference* (pp. 541-552). ACM.

Future Market Insights (2019). *Fertility Tracking Apps Market: Global Industry Analysis 2012 – 2016 and Opportunity Assessment; 2017 – 2027*. [online] Available at: https://www.futuremarketinsights.com/reports/fertility-tracking-apps-market [Accessed 9 May 2019].

Frost & Sullivan (2019). *Femtech—Time for a Digital Revolution in the Women's Health Market | Frost & Sullivan*. [online] Frost & Sullivan. Available at: https://ww2.frost.com/frost-perspectives/femtech-time-for-a-digital-revolution-in-the-womens-health-market/ [Accessed 9 May 2019].

Gambier-Ross, K., McLernon, D. and Morgan, H. (2018). A mixed methods exploratory study of women's relationships with and uses of fertility tracking apps. *DIGITAL HEALTH*, 4.

Gimpel, H., Nißen, M., & Görlitz, R. (2013). Quantifying the quantified self: A study on the motivations of patients to track their own health. *Thirty Fourth International Conference on Information Systems*.

Glaser, B. G., & Strauss, A. L. (1967). The Discovery of Grounded Theory (London, Weidenfeld & Nicolson). *The Discovery of Grounded Theory*.

Gordon, J. (2019). *#Femtech: Empowering women with health and wellness tech*. [online] Tektonika. Available at: https://www.tektonikamag.com/index.php/2017/03/08/femtech-empowering-women-with-health-and-wellness-tech/ [Accessed 9 May 2019].

Hertzum, M. (2010). Images of usability. *International Journal of Human-Computer Interaction*, 26(6), pp. 567-600. ISSN: 1044-7318, doi:10.1080/10447311003781300.

Holzinger, A., Biemann, C., Pattichis, C. S., & Kell, D. B. (2017). What do we need to build explainable AI systems for the medical domain? *arXiv preprint arXiv:1712.09923*.

Homewood, S. (2018). Designing for the Changing Body: A Feminist Exploration of Self-Tracking Technologies. In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems* (p. DC11). ACM.

ISO 9241-210 (2010) Ergonomics of human-system interaction – Part 210: Human-centred design for interactive systems.

Lupton, D. (2015). Mastering Your Fertility: The Digitised Reproductive Citizen. Chapter for *Negotiating Digital Citizenship: Control, Contest and Culture*, edited by Anthony McCosker, Sonja Vivienne and Amelia Johns. To be published by Rowman and Littlefield, London.

McHugh, M. (2019). *Does Femtech Give Users Control of Their Health or Take It Away?*. [online] The Ringer. Available at: https://www.theringer.com/tech/2019/3/18/18267094/femtech-female-health-apps-menstruation-fertility-trackers-clue-glow-ava [Accessed 9 May 2019].

Moglia, M., Nguyen, H., Chyjek, K., Chen, K. and Castaño, P. (2016). Evaluation of Smartphone Menstrual Cycle Tracking Applications Using an Adapted APPLICATIONS Scoring System. *Obstetrics & Gynecology*, 127(6), pp.1153-1160.

Monella, L. (2019). [online] Euronews.com. Available at: https://www.euronews.com/2018/04/11/beware-of-fertility-apps-your-data-may-be-sold-to-companies-warns-think-tank [Accessed 9 May 2019].

Nordfeldt, M. and Widen, O. (2019). *Me, my cycle and I - a study of women's use of a digital contraceptive*. Bachelor's. University of Gothenburg. Available at: https://gupea.ub.gu.se/bitstream/2077/53216/1/gupea_2077_53216_1.pdf

Pai, A. (2019). *Five digital health tools for tracking fertility*. [online] MobiHealthNews. Available at: https://www.mobihealthnews.com/30449/five-digital-health-tools-for-tracking-fertility [Accessed 9 May 2019].

Pruitt, J. and Grudin, J. (2003) Personas: practice and theory. In Proceedings of the 2003 conference on Designing for user experiences (CHI '03). ACM, New York, USA, pp. 1-15. doi:10.1145/997078.997089

Quintin, C. (2019). *The Pregnancy Panopticon*. [online] Electronic Frontier Foundation. Available at: https://www.eff.org/wp/pregnancy-panopticon [Accessed 9 May 2019].

Repa, V. (2019). *Stop Building Apps -- Create Systems Instead*. [online] Forbes.com. Available at: https://www.forbes.com/sites/forbestechcouncil/2019/06/25/stop-building-apps-create-systems-instead/#51b9dcb6cdda [Accessed 29 Jul. 2019].

Sanders, E. B. N. (2003). From user-centered to participatory design approaches. In *Design and the social sciences* (pp. 18-25). CRC Press.

Saner, E. (2019). *How period tracking can give all female athletes an edge*. [online] the Guardian. Available at: https://www.theguardian.com/lifeandstyle/shortcuts/2019/jul/10/how-period-tracking-can-give-all-female-athletes-an-edge [Accessed 30 Jul. 2019].

Schechner, S. and Secada, M. (2019). *You Give Apps Sensitive Personal Information. Then They Tell Facebook.*. [online] WSJ. Available at: https://www.wsj.com/articles/you-give-apps-sensitive-personal-information-then-they-tell-facebook-11550851636 [Accessed 9 May 2019].

Sudjic, O. (2019). *'I felt colossally naive': the backlash against the birth control app*. [online] the Guardian. Available at: https://www.theguardian.com/society/2018/jul/21/colossally-naive-backlash-birth-control-app [Accessed 9 May 2019].

Starling, M., Kandel, Z., Haile, L. and Simmons, R. (2018). User profile and preferences in fertility apps for preventing pregnancy: an exploratory pilot study. *mHealth*, 4, pp.21-21.

Strauss, A., & Corbin, J. (1990). Basics of Qualitative Research: Grounded Theory Procedures and Techniques, *Sage Publications*, Inc.

Statt, N. (2019). *App makers are sharing sensitive personal information with Facebook but not telling users*. [online] The Verge. Available at: https://www.theverge.com/2019/2/22/18236398/facebook-mobile-apps-data-sharing-ads-health-fitness-privacy-violation [Accessed 9 May 2019].

Symul, L., Wac, K., Hillard, P., & Salathe, M. (2019). Assessment of menstrual health status and evolution through mobile apps for fertility awareness. *NPJ digital medicine*, *2*(1), p.64.

Tiffany, K. (2019). *Who are period-tracking apps really built for?*. [online] Vox. Available at: https://www.vox.com/the-goods/2018/11/13/18079458/menstrual-tracking-surveillance-glow-clue-apple-health [Accessed 9 May 2019].

Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science, 185*(4157), 1124-1131. Retrieved from http://www.jstor.org/stable/1738360

Urteaga, I., Albers, D. J., Wheeler, M. V., Druet, A., Raffauf, H., & Elhadad, N. (2017). Towards Personalized Modeling of the Female Hormonal Cycle: Experiments with Mechanistic Models and Gaussian Processes. *31st Conference on Neural Information Processing Systems* (NIPS 2017), Long Beach, CA, USA

Weaver, J. (2019). *The hidden bias in iterative product development*. [online] Medium. Available at: https://uxdesign.cc/the-hidden-bias-in-iterative-product-development-21e307a2c327 [Accessed 29 Jul. 2019].

Willis, O. (2019). *Breaking the menstrual taboo that still holds women back*. [online] ABC News. Available at: https://www.abc.net.au/news/health/2017-09-30/menstrual-cycle-taboo-holds-women-back/8996526 [Accessed 9 May 2019].

Wilson, C.E. (2006) Triangulation: the explicit use of multiple methods, measures, and approaches for determining core issues in product development. *interactions*, 13(6), pp. 46-47, 63. ISSN: 1072-5520, doi:10.1145/1167948.1167980

Weigel, M. (2019). *'Fitbit for your period': the rise of fertility tracking | Moira Weigel*. [online] the Guardian. Available at: https://www.theguardian.com/technology/2016/mar/23/fitbit-for-your-period-the-rise-of-fertility-tracking [Accessed 9 May 2019].

Appendices

Appendix 1: Interview Guide

Interview Guide: User Insights on Period Tracking

Please take a quick look at these questions and consider how you might answer them, prior to the interview. Remember, you don't need to answer all of them if you do not want to.

General demographics

- Gender? Age? Lifestyle?

Period tracking habits

- Do you track your period? Why/ why not?

If you track your period:

- What method do you use? If digital, what particular technology/ app?
- Are you tracking very carefully or less carefully? Do you also track period-related symptoms?
- Why/ why not do you use digital period trackers? For instance:
  - Using your period as personal **fertility-related indicators?**
  - Comorbidity of period with other symptoms for **chronic health conditions?**
  - **Life-planning**/ general health issues?
  - **Communicating** to others?
  - **Pattern spotting?**

If you track your period using a digital period tracker:

- Are there any particular issues or problems you have already experienced with digital trackers? Related to, for instance:-
  - Limited options for indicating symptoms, contraception, etc,
  - Misunderstanding your motivations
  - Language, tone, or visuals used
  - Issue with data input

- Concerns over your own data
- Intrusiveness
- Would you prefer active or passive checking of the period tracker?
  - E.g. how do you feel about reminders in the period tracker? If positive, what is the preferred format?

Social attitude regarding periods

- How happy are you to talk about periods with:-
  - Friends/ partners
  - Colleagues
  - Family
- How do you feel in general about your own period? Is it, for instance, a nuisance, interesting, shameful, awful, a source of joy, an inconvenience, a mixture of these, or something else?
- Has tracking your period changed your attitude towards periods at all? Or have any other life events changed your attitude?
- How do you think that by using more technology in tracking periods, we can begin to overcome social stigma and traditional "shame" over periods? For example: some apps allow you to share your cycle information with others

Appendix 2: Informed Consent Form

Informed Consent Form

User Research on Period Tracking Applications

1 Purpose of the Interview

The Researcher and interviewer, Mary Chan, will undertake an interview with you gather insights on the motivations and challenges underlying period tracking (the "Project"). These insights will be used to form the basis of research for Mary's Master thesis as well as potentially other reports such as whitepapers, articles.

2 Approach

INTRODUCTION The interview is one-on-one with the Interviewer in a room. It is conducted in a semi-structured informal format.

PROCESS The interview session should last approximately **30 minutes**. During the interview, you will be asked questions related largely to your current experiences of tracking periods, and your underlying motivations in doing so. You will be provided with a separate Interview Guide prior to the interview, with questions to think about before the interview takes place.

DATA COLLECTION AND RECORDING The interview will be recorded by audio for checking accuracy of notes and kept for maximum one month after the interview. After this period, the audio will be destroyed. The Interviewer will also take notes.

CONFIDENTIALITY What we are going to discuss in the interview is confidential in nature. Similarly, all the information you provide to us in the interview will be held confidentially in accordance with our Data Handling Procedure.

3 Consent

You have the right to revoke your consent for the study to use the information collected from you at any time up to the completion of the interview.

Participation in this study is voluntary, you may withdraw from the study at any time and request deletion of your contributions up to the completion of the interview.

4 Data Protection

We will only collect data necessary for the Project, including where necessary your details which may include your personal information, simulated use assessment data, your views and opinions. The data will be used for the purposes of the Project only.

All data (e.g. notes and audio recordings) will be stored securely, accessible to the Researcher only and any regulatory authorities.

Our procedures for this are defined in the Data Handling Procedure Sheet, which you have been provided with a copy. By signing this Informed Consent Form, you acknowledge receipt and having read and understood the Data Handling Procedure Sheet.

Upon completion of the interview, the data will be retained on the basis of the contract between us.

5 Risk and Safety

We do not anticipate any significant health and safety risk or discomfort to you in this study. However, the personal nature of this interview means that there may be a risk of emotional distress of discomfort during the interview; for instance, if sensitive personal topics are discussed.

6 General

If you are in agreement with the terms of this letter, your consent is implied by the participation in the interview.

If you have any questions about the research, your data or any related issues please contact the Researcher, Mary Chan, by email: mary.chan@cambridgeconsultants.com.

Appendix 3: Data Handling Procedure Sheet

Data Handling Procedure Sheet

User Research on Period Tracking Applications

1 Introduction

This document describes the way the Researcher (Mary Chan) will handle the data collected during the user research. The Researcher is gathering data for their master's thesis, conducted with Cambridge Consultants (CC) and the University of Twente, which will also potentially be written as an informal report or whitepaper. Adherence to this procedure is necessary in order to meet the requirements of applicable data protection law and/or data protection law around the world.

The user research will take place in the form of interviews. The interviews will be undertaken with the participants who are experiencing periods. During the interview, participants will be asked questions relating to their attitudes towards tracking periods. They will also take part in an open discussion with the interviewer regarding period tracking. The outcome of the simulated use assessment and the participants' views and comments will be recorded (both in note form and audio recordings) and transcribed if necessary. This information will be collated with that from other interviews and used as a basis for the research questions of the aforementioned master's thesis. This thesis, as well as any other linked reports, will not contain any information about specific participants that would reveal their name or contact details.

In order to do this the Researcher will seek permission from the participants, to record the data necessary for the project. This research will only collect data necessary for the project, e.g. details of the participants which may include their personal information, simulated use assessment data, and participants' views and opinions may be collected. We may receive participants contact details for initial recruitment purposes (e.g. to arrange an interview time and date) but will undertake not to pass this information on to any third parties (including members of CC and the client who are not involved with the project). All data will be stored securely, accessible only to the Researcher.

Following completion of the interview and under the law, the participant has the right to request a copy of all personal information retained by the company.

2 Procedure

2.1 Informed Consent Form

Prior to conducting any interview, the interviewee must have access to the **Informed Consent Form** (ThesisMC-CF-001). The Informed Consent Forms will be available only to the Project Team and any regulatory authorities.

This document contains clauses covering the following:

- Consent for their personal information (e.g. age, gender, medical history, views and opinions) which is of direct relevance to the research topic to be used for the project purposes.
- Consent for the Researcher to retain the data on a contractual basis, in accordance with the provisions of data protection law.
- Consent for CC and our client to exploit any IP arising from the research
- Confirmation that Researcher will not pass on participants' contact details and any personal information to any other parties except for the regulatory authorities (if required).

2.2 Interview Procedure

All interviews will be conducted in accordance with the approach described in the Informed Consent Form.

3 Data Handling

3.1 Participant details

Minimal information necessary about the participant will be collected. This may include:

- Participant name and contact details (if necessary). This will only be used initially to organise the interview time and date, after which it will be unlinked to the interviews.
- Relevant personal information, e.g. age, gender, medical history, etc.
- The date, time, and location of the interview.

3.2 Raw interview data

During the interviews, data may be captured in the following forms:

- Notes taken in physical formats, e.g. in a project logbook
- Notes taken in electronic format, e.g. on a spreadsheet (MS Excel)
- Audio recordings which may be partially transcribed later if necessary.

During the collection of the interview data or transcription of audio recordings, no information will be recorded that is not directly relevant to the research topic.

3.3 Secure data storage and transfer

All interview data will be held securely and will be accessible to the Researcher only and any regulatory authorities. The data will only be used for the project purposes.

If any personal information relating to study participants needs to be transferred electronically, then data transfer will be limited to one of the following four methods: Virtual Private Network (VPN); SSL encrypted website with password-controlled access; Encrypted personal information sent via FTP or sent via e-mail; or a physical point-to-point connection.
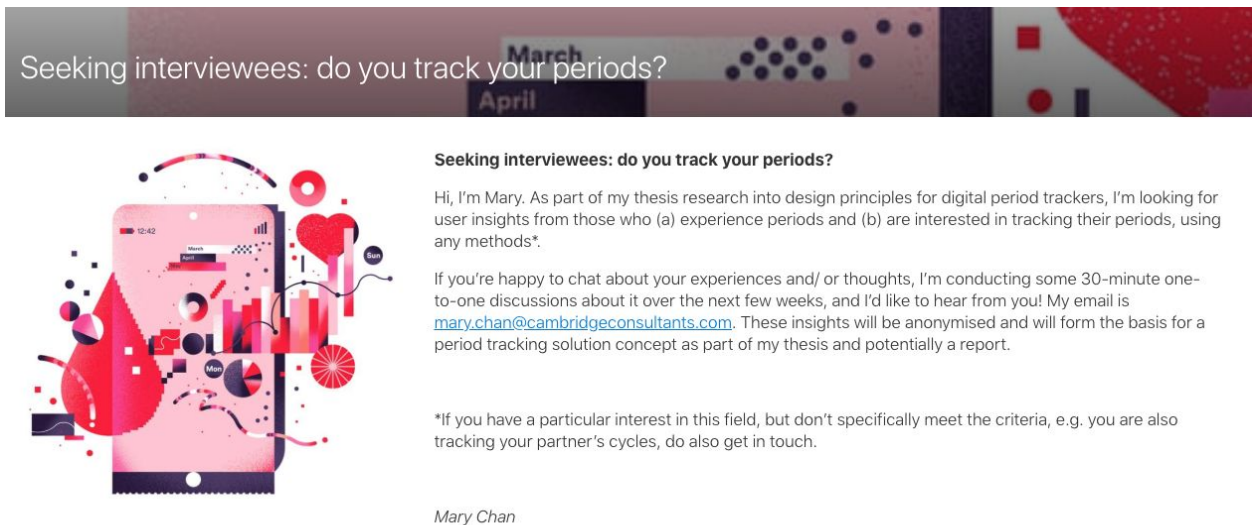
3.4 Research reporting

The final thesis and/or report(s) which will be made available publicly will contain summaries of the interview data and may contain direct quotations or observations. Personal information may be discussed if it is of direct relevance to the study. These reports will not contain any information about specific participants that would reveal their name or contact details.

4 Opt-out process

If a participant revokes consent to use their personal information or data at any time during the interview process, the data (including any physical/electronic notes and audio files) will be immediately destroyed and not included in the raw data set.

Appendix 4: Recruitment Advertisement

Appendix 5: Solution Concepts

App initiation:

- Questionnaire: gender, age, relationship status, sexual orientation etc... (with options to not answer)
- indicate endometriosis/ PCOS/ chronic health conditions
- choose what you're interested in at what stage of cycle/ life
- setup procedure to choose what you are interested in (changeable)
- preselect information/ categories of interest (at app initiation/ settings)

Customise data notifications/ information presentation frequency:
(what kind of notifications)

- customise-able prompts to enter/ record data (turn off if not wanted)
- customise nudges. notifications (timing, quantity etc)
- preselect daily, weekly, monthly, yearly, per-cycle reports
- mute mode

Data presentation:

- number of windows or tabs with more or less detailed information

- levels of hierarchy for capture display - fitness data/ weight data/ health data/ fertility data (people can include/ exclude whole categories)
- different types of data output - graphs; circle/ pie charts/ bar charts with colours
- if we had a pool of data, we could choose and compare
- ask variable tracking priorities to users out of many options (before and regularly)
- choose parameter(s) mood, diet and see graph over time
- show correlations that the user may not have thought of
- have a backend that does analysis across 1000s of data points
- graph plot of symptoms (all data points + average) with ability to choose any/all of the parameters you track
- good interaction design to present data in a pleasing way
- add code to the app - "macros"
- set "baseline" for each user, and inform on trends
- app gives info after 3-6 months of tracking/ learns about you and gives you this info on demand
- do not specify "good", "bad", "normal"
- create actionable insights from data rather than display data directly + allow data download

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Sync with other info

- e.g. phone accelerometer, calendar etc.
- crowdsourcing knowledge
- collect inputs from other sources (apps, devices) - with user permissions! (e.g. "You always make :(sad face posts on Day 21...")
- information pages on symptoms in RELATION to you cycle e.g. "often people experiences this with regard to symptom x and you tend to experience this"
- % of people "like" you
- pie chart: this is you (normal)
- sharing with friends/fam to create database

Appendix 6: Mockup dashboard flow chart