



This Watchface Fits with my Tattoos: Investigating Customisation Needs and Preferences in Personal Tracking

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ABSTRACT

People engage in self-tracking with diverse data collection and visualisation needs and preferences. Customisable self-tracking tools offer the potential to support individualized preferences by letting people make changes to the aesthetics and functionality of tracker displays. In this paper, we use the customisation options offered by the displays of commercial fitness smartwatches as a lens to investigate when, why and how 386 self-trackers engage in customisations in their daily lives. We find that people largely customise their trackers' display frequently, multiple times a day, or not at all, with frequent customisations reflecting situational data, aesthetic and personal meaning needs. We discuss implications for the design of tracking tools aiming to support customisation and discuss the utility of customisations towards goal scaffolding and maintaining interest in tracking.

CCS CONCEPTS

• **Human-centered computing** → *Mobile devices; User studies.*

KEYWORDS

smartwatch, personal informatics, customisation, physical activity

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1 INTRODUCTION

Personal informatics, or collecting and reflecting on personal data [68], can be helpful towards a variety of health and wellbeing goals including self-understanding, self-improvement, and connecting with others [39]. In spite of the benefits, a common challenge people experience with personal informatics systems is that the design of the systems often assumes what sort of data a person might be interested in collecting (e.g., step activity, calorie metrics) and how they might want to represent that data (e.g., through charts summarising particular metrics) [68]. People's tracking goals and needs further evolve through tracking experience, requiring revisiting

the utility of tracking tools [43, 79]. People often cite mismatches between their needs and the collection and reflection capabilities of tracking tools as reasons for abandoning particular apps or devices, or the act of tracking altogether [29, 40, 58, 64]. Although switching tracking tools can mitigate some concerns, people are often reluctant to do so as they may lose their personal data histories and need to purchase and learn a new tool [43, 68, 92].

To address mismatches between technology's tracking capabilities and people's needs, research has suggested that technology support people in *customising* tracking tools. Research has suggested that customising what data is tracked and how it is presented for assisting in reflection can better support people's individual and diverse goals, such as goal monitoring or answering specific questions [34, 41, 70, 72, 88, 89]. Customisation can also allow people to express themselves through their tracking, such as through public-facing color and form preferences [18, 23, 42, 50, 61]. Feedback from deployments of research tools which support creating customised tracking tools, such as OmniTrack [63] and Trackly [21], further illustrate that people find personalised and customised representations meaningful and useful.

Although significant work has argued for the benefit of customisation in personal informatics, we have limited understanding of how, when, and why people customise the display of their tracking tools in practice. Customisation capabilities are widespread in certain tracking technologies; commercial tracking apps and devices often provide a range of customisation options, such as the ability to select from different data types to track [67, 70, 72], and adjust the color scheme [23, 50]. In studying how people customise the display of their tracking tools, we contribute to understanding how personal tracking differs in customisation needs from more conventional software and technology [73].

We use the customisation of data representation in fitness smartwatches as a lens to understanding tracking people's tracking customisation needs and practices. Fitness smartwatches such as Apple Watches, Garmin Vivosmart, and Fitbits are widely used, with over 40% of U.S. and 25% of European adults having used one as of 2020 [1, 2]. Fitness smartwatches are a useful space for understanding how and why people customise watchfaces because the data collected can support a range of goals, and have extensive and widely-used tools for creating watchfaces. Conventional smartwatches support multiple forms of automatic data collection [26], including steps walked, heart rate, floors climbed, and calories burned. Watchface customisation APIs allow people to design their own watchface, and many commercial watch manufacturers provide resources (e.g., Fitbit's Gallery, Apple's Face Gallery) to let people select from watchfaces that others have made. Understanding how people select among watchfaces available and further customise



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them to their needs deepens our understanding of what sorts of tracking customisations people find important, as advocated by prior work [20, 25]. Further, this understanding can provide design criteria for APIs and lower-threshold systems which allow people to create custom watchfaces and other custom tracking tools. Finally, understanding and improving customisation is particularly crucial for wearable tracking technology and other closed tracking ecosystems, as there are greater financial and logistical costs of switching devices to support collection and reflection needs compared to app-based tracking [67].

We conducted two related studies with Fitbit smartwatch owners to understand smartwatch customisation needs: a survey study with 368 participants and an interview study with 18 participants. We find that participants largely customised the display of their smartwatches in three ways: *data customisations*, changing the form and kind of activity data displayed on their smartwatch; *aesthetic customisations*, changing the colors, fonts, and layouts; and *personal meaning customisations*, aligning watchfaces with pictures, interests, and values that mattered to them. Participants largely sought to blend data needs with aesthetic and personal meaning preferences, using their smartwatches to simultaneously help achieve health and wellbeing goals, self-presentation goals around their watches being public personal displays, and personal meaning goals around deriving joy and keeping entertained. Participants were largely split between keeping one watchface and adjusting watchfaces weekly, daily, or more often, motivated by fashion desires and occupational needs.

Beyond confirming prior work suggesting the utility of customisable self-tracking tools, our work points out that data customisation can help people maintain long term interest in tracking by supporting people in deriving enjoyment from reviewing their data. We further identify the utility of customisation towards scaffolding tracking goals and mitigating goal creep, and surface a need for approaches to tracking customisation to better support longitudinal goal evolution.

We contribute with:

- An understanding of how people customise the watchfaces of their smartwatches, and how personal data is represented in those watchfaces. We find that people customise the data, aesthetics, and personal meaning of their smartwatches, balancing these needs as possible.
- An understanding of when, why, and how often people customise their smartwatch watchfaces. People largely either customise frequently or not at all, with frequent customisers changing in response to social settings, situational goals, or exploration early in the tracking process.
- Implications for future tracking tools and tools aiming to support tracking customisation. We discuss the utility of customisation towards goal scaffolding and maintaining interest in tracking and strategies for aligning personal, aesthetic, and data needs. We also highlight the importance of creating lower-burden tools for creating custom watchfaces.

2 RELATED WORK

Our examination of how and why people customise their smartwatch watchfaces is driven and informed by prior literature on

selection and customisation in personal informatics, people's use of smartwatches in everyday life, and visualisation of data and information on smartwatches.

2.1 Goal-Setting, Selection, and Customisation in Personal Informatics

Personal informatics describes the class of technology which supports people in collecting data about themselves and reflecting on it towards better understanding themselves and their habits [39]. Past models describing how people use personal informatics tools, including Li et al.'s stage-based model [68] and Epstein et al.'s Lived Informatics Model [43] separate the act of selecting and configuring a tracking tool (e.g., finding a tracking app or device) from its everyday use collecting and reflecting on data towards self-understanding. More recently, in studying selection of mobile apps for tracking, Lee et al. [67] suggest that people's act of selecting a tracking tool is often intertwined with their use of it. In practice, people trial and tweak tracking tools while they use them, constantly refining and switching between them to better support their needs. People have distinct patterns for when and how often they wear their smartwatches, but many wear them consistently throughout the day [53, 74]. Lee et al. further note that people may not switch as frequently when tracking with physical devices [67]. Following this finding, we view "customisation" in this work as temporally-independent. Customisation can occur both soon after selecting a tracking tool (e.g., configuration) and after sustained use (e.g., adjustment, refinement). We therefore use these words interchangeably throughout this paper to refer to the act of customising a tracking tool.

People use tracking technology for a range of different reasons, including goal-setting and self-improvement, monitoring health and wellbeing, and satisfying curiosities [27, 43, 86]. To support people's varied tracking goals and needs, research has frequently suggested that tracking tools move beyond being "one-size-fits-all" towards being more customisable and configurable. Customisation provides people greater sense of control over the experience of tracking, which can help people come to terms with difficult health conditions [22, 33, 62], avoid rumination [78], and have aspects of their personal identities like gender, sexual orientation, or interests reflected in the tool [42, 64]. Customisation also enables greater creativity, allowing people to find meaning in the representations they create or configure [18, 23]. Customising can also mitigate boredom with the act of tracking [31].

Empirical studies of how people use tracking technology have offered a range from general to more specific guidelines about *how* tracking technology should support customisation. More generally, research has advocated for offering people different views or visualisations of their data [41, 84], helping people see themselves reflected in their data [83], or supporting tracking holistically across life events and stages [35, 44]. More specifically, research has suggested that tracking tools should allow people to customise aspects of collection, including what type(s) of data they collect [36, 82, 88], how frequently it is collected [59, 70], at what level of detail [72]. In addition to customising visualisation of data, customising the type of goal (e.g., qualitative, quantitative, monitoring, learning) [37, 79, 89, 90], amount for more quantitative

goals [36, 48, 60], or whether there is a goal at all [80] can better support people's reflection needs around their data.

Research has also pointed out how people can benefit from customisation of colors and iconography, such as people wishing to replace pink and flowery imagery in menstrual tracking tools [42]. Particularly for passive tracking on smartwatches and other wearable devices, customisation of physical form such as choosing wristbands [50] or on-body location [30, 93] can make people more physically comfortable and meet self-presentation needs. Most closely relevant to our work, Kang et al. find that when wearable trackers support cosmetic changes such as iconography and color, people feel they better reflect their personal identity [56].

Building upon these suggestions, recent studies have designed, developed and evaluated novel customisable self-tracking prototypes. Driven by a theoretical concern, the goal of these studies was to understand how the customisation of trackers supports people's tracking needs and practices. For instance, Kim et al. developed *OmniTrack*, a mobile application that allows people to create customised trackers by choosing what data they want to track, how their data should be tracked (i.e. manually and/or automatically) and the timing and frequency of tracking [63]. A field study of *OmniTrack* found that people often created multiple trackers with different setups, supporting diverse and evolving tracking needs. Similar studies have found customisation to foster experiences of agency [21, 54] and empowerment [82] as people make decisions on when and how to track, and fit trackers to their individual needs and practices [21, 54]. However, a challenge with these customisable tracking tools is that they often result in "goal creep", or designing tools with more potential goals to monitor and interesting data to collect than is feasible to review [89].

Other studies have looked at the role that cosmetic changes play in how people use trackers, such as how data is visualised and the form of trackers. Kim et al. developed *DataSelfie* [61], a web-based interactive system that allows people to create visual mappings of their personal data. Similarly, Ayobi et al. drew inspiration from bullet journaling to create *Trackly*, a mobile application that created customised trackers by allowing people to select and colour pictorial shapes that would represent their data [21]. In both studies, people experienced a strong sense of identity with their trackers through creating meaningful pictorial trackers that documented and represented essential aspects of their lives.

2.2 Data and Information Visualisation on Smartwatches

The advent of smartwatches has changed how people engage in tracking. Due to their increased availability, smartwatches can support people in reflecting, learning and making changes to their behaviors while they collect data [43]. Gouveia et al. found that people frequently check their health visualisations on smartwatches, about 100 times per day [47]. Piazza et al. further suggest that glancing at one's watchface makes up approximately 50% of all interactions with smartwatches [81]. While brief (5 seconds), these interactions support the frequent re-visitation of tracking goals and highlight opportunities to pursue tracking them. People frequently revisit their data to learn about their daily activities, and see how these activities are contributing to their daily goals [46].

Aligning with the advent of mobile visualisation [65, 66], work in information visualisation has proposed and studied opportunities for personal data visualisation on smartwatches. People tend to visualize 2-3 different health and fitness metrics on their smartwatches, together with other metrics related to weather and device status (e.g., battery life) [52]. People prefer to see the personal health data their smartwatches collects on the device, rather than on a larger, paired device like a phone [51]. However, the size of the watch limits what kinds of visualisations are interpretable, particularly during the quick glances typically associated with smartwatches, typically under 5 seconds [24, 45]. For example, horizontal compression of time-series health data, such as heart rate data, may still allow for detecting trends and changes at a glance [77]. While significant kinds of health and wellbeing data can be visualised on a smartwatch, the short glances make interactions subject to information overload [38].

To identify opportunities for health and wellbeing visualisation on smartwatches, Amini et al. worked with graphic designers to envision different visualisations of physical activity for the smartwatch, finding that designers preferred representations which maximized use of the space and had minimal text [20]. Their design exercises further elicited different styles of visualisation which could be incorporated into smartwatches, including goal-based and motivational representations. In a similar line of work, Gouveia et al. derived six design qualities typically used to display physical activity data on smartwatches, including abstracting and mapping data to shapes and images. One well known example of data abstraction within HCI literature is Consolvo's *UbiFit Garden*, which uses the metaphor of a blossoming garden to represent progress towards a daily step count goal [31]. Data abstraction can support privacy, enabling the display of data without revealing that a user is tracking health behaviors, and make a tracker's display more attractive, increasing people's chances to use it over time [32]. As described by Consolvo et al., a display that is "attractive, understandable, and provides timely feedback has a much better chance of swaying users to give up their photos of babies, kittens, or their beach vacation in order to use the display" [32, p. 245]. Other interfaces on mobile and ambient displays have similarly abstracted tracker activities to promote engagement, such as into displays with fish [69] or narrative interfaces [76, 87].

In summary, dedicated research on customisation in personal informatics for smartwatches is still in its beginning. Few studies have been carried out to understand how people engage in tracker customisation in their everyday lives, and how these practices support people in their tracking goals. Given the limited real estate of a smartwatch's screen, people will need to make choices about what information is valuable enough for them to want to always see [32]. Our work investigates the choices that people make when deciding what they want to see on their screen, and why. Concretely, our work addresses the following research questions:

- RQ1: How do people customise their watchfaces, and how does personal informatics data factor into those customisations?
- RQ2: What motivates people to customise their watchfaces, and when and how often do they do so?

3 METHODS

We conducted two complementary studies, a survey study and an interview study, to understand how and why people customise their fitness smartwatches. In particular, the multiple studies help compensate for the relative weaknesses of each. The survey helped provide information about the range of customisations people created and patterns around when they customised. However, after initial analysis of participants' survey responses, we still had open questions about why participants chose to customise their watchfaces and their process for identifying and selecting watchfaces. Interviews offered us opportunity to answer these questions in greater depth. Both studies were approved by our university's IRBs.

3.1 Survey Study

We conducted a survey study primarily to understand the breadth of watchfaces people select and the regularity with which they customise. We recruited 368 participants between August and December, 2021 from social media, via a mix of Facebook groups and Reddit subreddits related to Fitbit (e.g., "Fitbit Friends", /r/fitbit).

A post, with a link to a survey, was created asking people to "share a picture and tell us about your current watchface!". The survey, which took approximately 5 minutes to complete, included a mix of close-formed and open-ended questions and was distributed through Qualtrics. We asked participants to describe what they liked about their current watchface, how long they had used it, and upload a picture of it. We also asked participants to describe what motivates them to change their watchface, if at all. We required participants be at least 18 years old and own a Fitbit smartwatch. Participants were not directly compensated for their involvement.

Survey respondents ranged from 18 to 81 years old (average 42.3), 230 were female and 138 were male. Respondents had used their current Fitbit device for an average 9.4 months, with 120 having used it for less than 6 months (minimum less than a month) and 127 for over a year (maximum 36 months). 328 were using either the Fitbit Versa 1 (n=47), Versa 2 (n=89) or Versa 3 (n=192), 19 a Fitbit Ionic, and 21 a Fitbit Sense at the time of the study.

3.2 Interview Study

Building on the breadth of watchfaces surfaced in the survey study, we sought to more deeply understand people's motivations and preferences behind customising their watchfaces in particular ways. We therefore recruited 18 participants between May and June 2022 from similar social media sources to the survey study. A post was created asking for people that had "tried out different Fitbit watchfaces. I'd like to hear about your experiences with choosing and using Fitbit watchfaces". In a screening survey, participants provided their demographics and past experiences with Fitbit. We required participants be at least 18 years old, and have used a Fitbit regularly for at least 6 months to ensure sufficient consideration of what information or content they might want on their watchface.

Ahead of the interview, participants were asked to send the research team pictures of the watchface(s) they were currently using, and watchface(s) they had used previously. Each participant was interviewed by two members of the research team, with one leading the interview and the other asking probing and follow-up questions.

Table 1: Interview participants came from 9 countries, with most having used their Fitbit smartwatches for a year or more.

P#	Demographics	Fitbit version	Months with device
P1	M, 33, U.S.A.	Sense	13
P2	F, 31, U.S.A.	Versa Lite	18
P3	M, 57, U.S.A.	Versa 2	6
P4	M, 36, Croatia	Sense	18
P5	F, 38, Netherlands	Sense	10
P6	M, 28, U.S.A.	Versa 3	12
P7	F, 34, U.S.A.	Versa 2	36
P8	M, 36, Germany	Versa 3	30
P9	M, 51, Belgium	Versa 2	36
P10	M, 28, U.K.	Inspire HR	14
P11	M, 42, U.S.A.	Versa 2	8
P12	F, 29, South Africa	Versa 2	28
P13	F, 31, Canada	Charge 3	12
P14	F, 53, U.S.A.	Versa 3	12
P15	F, 51, U.S.A.	Versa 3	18
P16	F, 68, U.S.A.	Versa 3	24
P17	F, 49, U.S.A.	Versa 2	24
P18	F, 45, Australia	Sense	10

The interview was split into two parts. The first part sought to understand participants' experiences and processes for searching for a watchface, as well as understanding how their interests surrounding watchfaces have evolved over their duration of use. The second part sought to more deeply understand what participants valued around their current watchface(s), what goal or goals the watchface supports, and if or when they swap between watchfaces. Interviews were semi-structured, lasting 45 minutes on average. Given the geographic spread of participants, the interviews took place online and were recorded for further analysis. Participants were compensated for their time with a \$40 USD Gift Card to Amazon.

Table 1 describes participant's demographics. 10 participants were female, 8 male, and ranged from 28 years old to 68 (median 37). Participants were from 9 countries, with half living in the U.S.A. Participants had experience using 6 different Fitbit devices, with a minimum of 6 months of prior use (median 16 months). Four participants had made their own watchfaces, with P3 using FitFace [9] and P6, P7, and P8 using Fitbit's API.

3.3 Customising the Fitbit Display

Our rationale for focusing on Fitbit devices is twofold. Firstly, we wanted to focus on an ecosystem that had a more diverse set of use cases and customisation practices as compared to dedicated sports tracking devices (e.g. Garmin), which typically support performance, self-improvement and metric-driven uses (as suggested in [57]). While some Fitbit models do support sports tracking, their ecosystem focuses on a broader tracking of everyday physical activity and health metrics and audience, with more casual relations with well-being.

Secondly, Fitbit offered a range of customisation options to users. The first and most prominent was by downloading new watchfaces

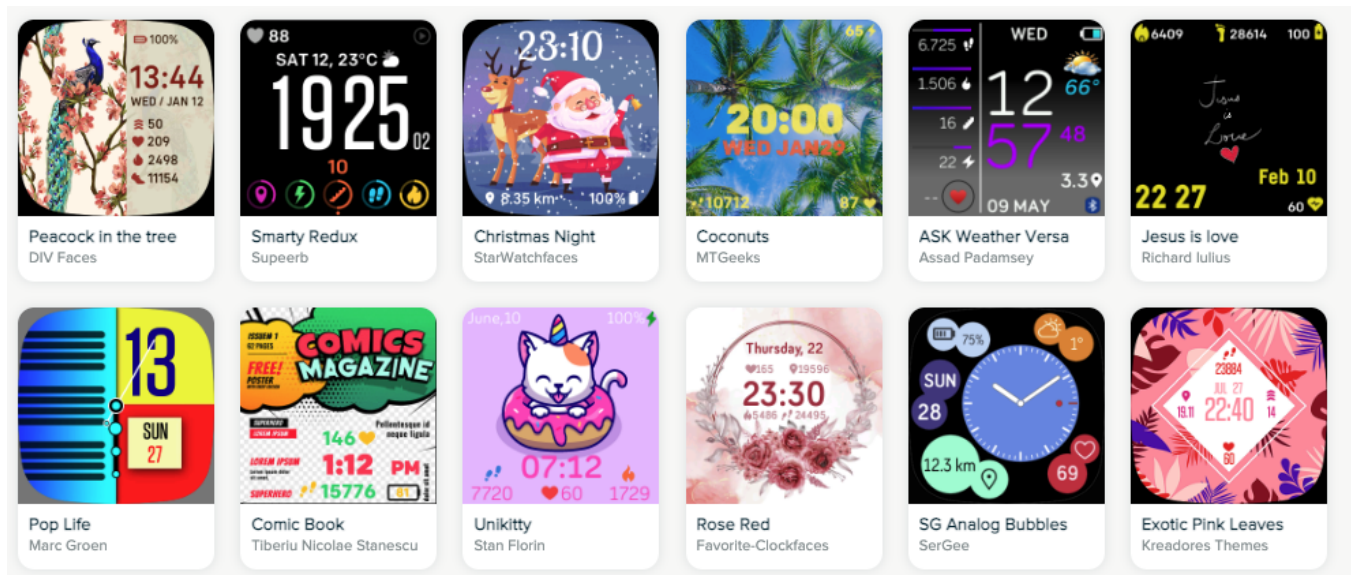


Figure 1: The Fitbit Gallery contains over 7000 watchfaces which users can browse and download. Watchfaces have a range of different styles, collected data and displayed feedback.

through the Fitbit gallery (Figure 1), a collection of publicly available watchfaces created by Fitbit and individual developers [5], or third-party websites, such as FitFace [9]. As of the September 2022, the Fitbit gallery and FitFace featured more than seven thousand and ninety thousand watchfaces respectively, organized in different categories by tracked metrics (e.g. active zone minutes), popularity (e.g. staff picks) and amount of displayed metrics (e.g. stats heavy). The page for each watchface contains its average star rating, developer name, a preview picture, and tags for different attributes - such as what it tracks (e.g., active zone minutes) and style tags (e.g., spring, flowers). The gallery also included a search bar, where users could look for watchfaces directly using keywords and tags. Users could save up to 5 watchfaces on their Fitbit and switch between them directly on their watch. Some watchfaces were customisable, allowing users, for instance, to change the colours or displayed metrics. Further, users were also able to create their own watchfaces through, for instance, Fitbit’s SDK studio [8] or FitFace [9], a web based editor to create watchfaces. While other smartwatches offer similar public galleries, such as Apple’s Face Gallery [6] and Garmin’s Connect IQ Store [4], we found the number of available watchfaces and customisation options to be limited. Further, many of the existing Apple watchfaces do not allow users to customise the metrics portrayed on a watchface. Focusing on a tool with a wider range of customisation options was likely to reveal a richer set of customisation practices.

Most of the different Fitbits owned by participants (i.e., Fitbit’s Versa 1, 2, 3, Lite, Sense and Ionic) had similar screen size (min: 34mm, max: 41 mm) and resolution (min: 300x300, max: 336x336) [7]. They also either used a OLED or LCD display, resembling the displays used by current smartwatches models on the market, such as the Apple Watch (e.g. series 7 and 8) and Android Wear Watches (e.g. Samsung Galaxy Watch 5). These displays have full colour

graphics, wide viewing angles, always on and bright displays. This offers increased visibility to users, but also others who might be nearby [38, 49, 71]. Two interview participants did however use Fitbits with relatively smaller screen sizes (18 and 25mm), resolutions (128x72 and 100x160) and no always-on display [7], the Fitbit Inspire HR and Charge 3, respectively. We purposefully included these participants in our interviews to understand the motivations and customisation practices within devices with lower visibility and real estate for customisation. We take these differences into account when discussing our results.

All Fitbits contained an accelerometer and optical heart-rate tracker, automatically tracked basic physical activity metrics (i.e. steps taken, floors climbed, active minutes and calories burned), as well as current heart rate and sleep [3, 10–12, 15, 16]. Two Fitbit versions (Fitbit Versa 3, Sense) included a temperature and light sensor, allowing users to additionally track skin temperature variation, oxygen saturation and breathing rate [14, 17].

3.4 Analysis

We largely analysed participant’s responses qualitatively, beyond reporting descriptive statistics summarizing when and how often participant customised their watchface and the data contents of the watchfaces. We followed a reflexive thematic analysis process, with a constructionist and experiential orientation [28]. Towards a constructionist approach, we often filtered themes we conceptualised through what we considered to be meaningful towards our research questions, such as ignoring trends in the specific colors or layouts participants selected for their watchfaces in favor of understanding what might have motivated them to customise in these ways. Following experientialism, we largely aimed to describe and report on participant’s preferences around customisation, and did

not examine what social or societal factors might have influenced those preferences.

We first analysed the survey responses, which informed both the interview questions and analytic approach of the interview study. After familiarising ourselves with the watchfaces participants uploaded, three researchers open-coded the responses in the survey around why participants changed their watchfaces and what they liked about their current watchfaces. Discussion converged around a story of the styles of customisation and motivations for customisation. We then consolidated the list of open codes produced by the three researchers to 14 codes around watchface customisation goals. Through enacting these codes and considering the underlying data, we organised our findings into three categories: data, aesthetic, and personal meaning customisation. Example sub-codes for each category included useful metrics, medical need, a desire to hide metrics (data); match outfit (aesthetics); pop culture, public message (personal meaning). We then coded the watchfaces participants uploaded according to this scheme.

Interviews were first transcribed with Otter.ai and then manually corrected by two members of the research team. After familiarising ourselves with the interviews, we applied the same coding scheme regarding interview participant's customisation goals and motivations for customisation. Interview participant's goals, customisation styles and motivations were largely the same as survey participant's, but offered richer description of how and why they customised their watches. For instance, while survey answers provided initial insights into how frequently people changed watchfaces, interviews provided detailed insights into what motivated these changes and if motivations varied over time. We did not observe any instances where interview participants clearly contradicted or disagreed with goals identified in the survey study. After reading the interviews, we introduced three additional codes around motivations for customisation: style expressions, shifting goals, and exploring possibilities.

3.5 Limitations

Our interview sample was largely Western, with 16 of 18 participants coming from North America or Europe. Though we did not collect the country of residence from survey participants, we expect a similar bias given commonality in recruitment technique. Further work would benefit from examining how customisation practices vary in other cultures. For example, Niess et al.'s study comparing fitness tracking needs across demographics suggests that Arab users emphasise physiological measurement over goal setting [80], which has the potential to influence what watchfaces this demographic group may find valuable.

Because we recruited from social media related to Fitbits, we suspect our survey and interview participants were more likely to have thought about or customised their watches. Our quantitative data therefore likely overestimates the extent to which people customise their smartwatches, and should therefore not be treated as an observation of the rate of customisation.

We interpret Fitbit's reputation as that of a fitness-based smartwatch, serving a more casual audience than dedicated sports watches (e.g., Garmin) but with more of a wellbeing focus than general-purpose smartwatches (e.g., Apple Watch). Our participants may therefore overemphasize interest in health and wellbeing metrics

compared to users of other kinds of smartwatches. Further, there was substantial variation in what Fitbits participants had used, with devices having slightly different tracking capabilities (e.g., Sense including stress sensing and skin temperature). Aspects of participant's customisation preferences may therefore vary somewhat based on smartwatch capabilities, and be influenced by the target functionality the smartwatch aims to support.

4 RESULTS

Towards our research questions, we report on the styles of smartwatch customisations that participants selected and when and how they went about customising their smartwatches. When reporting our results, quotes from survey participants are denoted by the letter "S", followed by a participant number (e.g. S5) and interview participants by the letter "P", also followed by a participant number (e.g. P11).

4.1 RQ1: Styles of Smartwatch Customisations

Addressing RQ1, or how people customise their watchfaces, participants' customisations followed three general forms: customisation of *data* presented to align with goals and interests, *aesthetic* customisations to align with style and social circumstances, and customisations intended to give their watch greater *personal meaning*. Participants regularly blended these interests, such as seeking out watchfaces which matched their data needs and aesthetic preferences.

4.1.1 Data customisations. Customisations were often driven by data needs, largely following tracking motivations discussed in prior personal informatics work [43, 86]. For example, participants regularly sought out metrics which were important to monitoring their health and wellbeing goals, such as P5 "[it's] recommended is to have at least 150 active minutes a week. So I set that as my goal, and then I can check every evening how many minutes I gained" and S85 "I'm preparing for a marathon, so it's important to control how my [heart] rate is doing through the day." Others used data to satisfy personal curiosities, such as P7 monitoring his heart rate: "the heart rate just simply because it's cool, there's nothing health related to it... Or sometimes if I'm stressed in a meeting, just out of curiosity, I'd like to see if my heart rate is going up. That's just access to something that the watch gives you that I want to see". Motivations would often be further inspired by medical conditions or job circumstances. For example, 6 participants described using their watchface (Figure 2a) as part of a Continuous Glucose Monitor for their diabetes: "this face gets my glucose through my miaomiao transmitter, and turns it into a CGM :).". Participants often mixed data in support of their health and wellbeing goals with data they were curious about on a single watchface, such as S50: "I'm on a strict diet, so I need to see how much many calories I've burnt and the steps that I've taken at different points of my day. The heart rate is just for curiosity."

Participants typically had a list of metrics in mind that they hoped a watchface would contain. For example, S42 described their data priorities as: "time and date are my biggest need. Steps are second, calories and heart rate are third/fourth depends on what I am doing. Exercising heart rate is needed." S332 (Figure 2b) had similar priorities, and speculated on most users' needs "Any clock face that displays Time + Heart Rate + Calories + Steps in one simple screen is

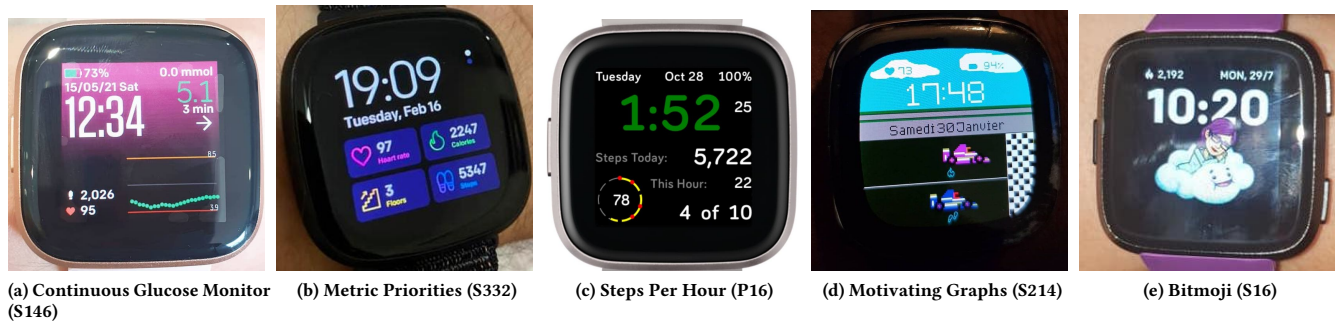


Figure 2: Example data and aesthetic customisations participants selected for their watchfaces. Participants frequently customised their watchfaces to show the metrics most important to monitoring their health and wellbeing, picking or altering watchfaces with colors and styles they found visually appealing.

more than worth it. I would think it's the most basic set of stats that most users want to look at. The Fitbit is both a watch and a tracker, so you expect to see all this information simultaneously." P18 described how she would judge whether a watchface was useful to her based on the metrics it provided, "the scientific part of my brain always kicks in and goes, 'Oh, it doesn't have this metric', or 'Oh, it doesn't have that metric'. So then I go back to looking at my watchfaces with metrics on them."

Participants generally aimed to balance the metrics they desired with the glanceability and interpretability of the watchface. For some participants, this need was functional, as they struggled to read watchfaces with more than a few metrics: *I love to have a clock face that just shows everything in the largest font possible. It's gotten to the point where I need to put my readers on just to check my steps during the day* (S336, 3 others expressed a similar sentiment). Others instead aimed to simplify the display, such as for P15: *"in the beginning I tried several ones, but many of them were too cluttered and showed too many metrics... often the ones that show a lot of information that have all these bars and graphs and it becomes too cluttered, I don't really like that."* Participants generally identified metrics which were most important to display on the watchface, and left other metrics of interest to review elsewhere. For example, P11 described that other metrics he was interested in would be available in Fitbit's mobile app: *"what am I tracking [on my watchface is] physical activity, calories burned, heart rate, time, date. And anything else that I want to see that the watch tracks is much easier to look at the app instead of the actual watch. Because it's small."* P6 similarly preferred leaving metrics out of the watchface, and just in the companion app *"I just don't need to always see it. Someday maybe I'll think of some questions for which will be interesting to look at, like, my heart rate, and then I will open the app. But I don't want to look at it for no reason"*. Similarly, participants frequently aimed to center or highlight one or a few particular metrics, although the watchface included others. S179 described that their watchface was *"simple, easy to read. the most important stat is in the middle (steps). helps me see if i'm on track with my 30k daily step goal."* S151 further described, *"I like how clean it is. It's important for me that it first looks like a clock, so I keep away from the funky stuff. The heart rate is also neatly hidden in the corner, away from curious eyes."*

Aligning with past work highlighting that people can find monitoring data uncomfortable when it is not aligned with their goals [33, 40, 64], participants also frequently sought out and selected watchfaces which did not include metrics they would find stressful to review regularly. For example, S148 said her watchface *"only has steps, not sure what to do with the heart rate. I feel stressed seeing it."* S150 similarly said he *"just have steps and calories, heart rate just fuels the anxiety."* P7 similarly found it demotivating seeing the progress towards a step goal displayed on their watch, and found one which instead displayed their step as just the count. She said, *"Fitbit's API tells you the percentage of the goals you're reaching. And for me, I thought they don't help me motivate like, they do not motivate me, they stress me out... it was more like an impending message of, 'hey, you're failing today, because you haven't reached your circle.' I didn't want that, seeing that I haven't reached whatever goals I have... I prefer a specific counter on the steps."*

Participants often had particular forms that they wanted data of a particular type presented in. For example, P16 sought out a watchface which let her view the number of steps she had walked that hour, rather than step progress towards her daily goal (Figure 2c) *"I got a little bit disappointed in that I was looking for something that would help me more with the number of steps per hour, because I thought that that would be an important feature for me with the Fitbit, I have the tendency to exercise and kind of that takes an hour or two hours, and then to be more sedentary during the day, which isn't as good for me... So I started looking for that. And I actually I think I kind of Googled around to see if there was a Fitbit face that would provide that."* Similarly P2 found it more motivating to monitor progress, and sought out a watchface which displayed her steps in that form: *"the more you achieve something the bar goes to the right. So that is kind of motivating to like, if you see you are all the way to the right, then it makes you push more to do more whatever you are doing like, cover more steps. [It's] more captivating than the other [watchfaces] that just like, show data and whatever. [My watchface] is goal oriented and pushes you more to do something."*

4.1.2 Aesthetic customisations. Beyond customising data, participants frequently sought to customise visual aspects of their watchface including colors, pictures, and icons. For many, these aesthetic customisations were based on what they enjoyed looking at. They

would often select colors they liked, such as S186: *"I liked the combination of gold and navy"* (12 others expressed a similar sentiment). Others identified watchfaces which aligned with their personal style, such as S261 *"my favourite colour is purple so that is why it is my favourite watchface"* and S173 *"love this watchface, it fits with my tattoos. Might update it if I get some new ones"*. Others similarly selected background images they enjoyed looking at *"the flower is relaxing and restful"* (S232, 5 others), or styles they found nostalgic *"I started using this watchface based on an old Casio watch. I like how it has the proper old numbers and look"* (S327, 13 others).

Aligning with prior work on smartwatch cosmetics [55, 56], others viewed their watchfaces as a mechanism for presenting their identity, and customised them to match their clothing or social settings. P5 described switching between a more casual and dressy watchface depending on her setting, saying *"[I] try to find something that, you know, matches with everything, also with my outfit. So, if I have an event where I need to dress up a bit, then I switch because it looks a little bit better if you're dressed up. This [watchface] is a more everyday, sporty look. So I can switch to the other if you know, if I need to look a little bit more professional."* S206 and 6 other participants described regularly changing their watchface to match their attire: *"as [my watchface's] background I have a picture of a striking detail of my shirt, since all of them have a small motif, button or another detail which is noticed right away. That way the detail and color comes back in the watchface, so my watchface is changed almost every day. It's a bit of work to have all the pictures taken and edited, but once you've collected/synced them it's absolutely worth it."* Prior work has surfaced that people sometimes customise their watch wristbands to match their attire [50, 56], but 3 participants further described changing the color of their watchface to match these: *"I can change the colors to match bands and outfits"* (S38).

Participants typically aimed to find watchfaces which included both desirable metrics and aesthetics they liked or could personalize. P12 described that she was looking for *"a pretty watch, but shows you the things that you want to see. Like, steps, burning... burning fat and my heartrate. I would be happy with that"*. S120 similarly described that she liked her watchface because *"it's so pretty and floral-y and I get all my stats on one screen"* (8 others expressed a similar sentiment). 5 participants, such as S140, further appreciated watchfaces which allowed them to choose how their data was reflected: *"not only does it have the stats on the watchface it can be customised, I picked what I wanted to be each color"*. When looking for a watchface in the gallery, P7 struggled to balance her data needs with layouts she liked. She described, *"this is based on the priority I gave, which was first data than aesthetics, I couldn't find one that match those two in a way that suited me the best... it had to be either one or the other. Either you have the good data, and that's it, or you have nice background watch with just the time... and I didn't want that. I wanted something that I feel good looking at my watch as well as all the data."* The inability to find a watchface she found both attractive and included the data she desired ultimately led her to create her own (see Figure 3b): *"I'm wasting so much time looking through the gallery that I one day out of curiosity, I opened up their like their documentation... And I thought, well, you know, let's play around with it."*

Some participants further described how these aesthetic customisations helped motivate them towards their health and wellbeing

goals, similar to past work on stylized data representations [32]. For example, S214 described how their watchface (Figure 2d) made improving their physical activity more fun, with a more appealing narrative of a small challenge: *"it has two cars that race towards a finish line as I reach my goals. I really like how fun it makes physical activity, it's like a game that I can have fun with, instead of this serious, 'I need to do this or that...' I guess it kind of motivates me to move, especially if I'm close to the finish line xD."* S258 similarly described *"growing a flower with my steps, love these interactive watchfaces. It's a fun way of getting a reward for your steps."* 8 participants described using Bitmoji watchfaces, appreciating *"seeing it change throughout the day. it's really fun to see how it changes depending on how much i walk or sleep or how my heart rate is. it's like looking in a mirror"* (S16, Figure 2e).

4.1.3 Personal meaning customisations. Beyond picking or customising watchfaces with colors or pictures that they liked, participants frequently customised their watchfaces in ways which were more personally meaningful to them. For example, 26 participants including added photos of family members *"my husband and me :)"* (S82) or their pets *"I had to set my cat as my background. I just love her!!!!"* (S117, Figure 3a). 20 participants similarly had watchfaces with graphics related to personal interests, such as S45's Nirvana watchface *"nirvana is my favourite band"* or S237's Dungeons and Dragons watchface *"of course the first thing I got was a D&D watchface for my fitbit lol."* 43 participants described shifting their watchfaces to get into the spirit of holidays they cared about, including Valentine's day (11 participants), Christmas (7), and Halloween (10). For example, P7 (Figure 3b) described *"I love Halloween. I love Christmas. So I like doing countdowns. So the Christmas watch tells you, for example, 20, like 20 days into Christmas, 19 days, 18 days, 17 days, that gives me like a little happiness boost whenever I see that number. And that's mainly more than what others have. It's mainly a very selfish thing in regards to what I want, basically."* These customisations made the watches feel more personal, and participants derived greater joy from looking at these watchfaces.

Many participants made personally meaningful customisations to show off their interests to others. For example, two Star Trek fans described wanting to share their interest in the franchise: *"Growing up as a Trekkie, I like to show people how proud I am of it"* (S152) and to hopefully identify others *"I like being an easy to spot Star Trek fan! Now that my Fitbit Sense has a Star Trek style it feels like having my own tricorder!"* Participants further used their watchfaces to highlight causes they supported, such as LGBTQIA+ rights *"I changed my watchface to one with a pride flag because my children are part of the LGBT community and it is important for me to show them my support"* (P15, 7 others), Cancer research *"I am a thyroid cancer survivor. won the battle with cancer 6 months ago, I have been using this watchface since then"* (S260, 6 others) or political movements *"I live in the UK. goes without saying that I wasn't pleased with Brexit. Have this one [watchface] ever since"* (S235, Figure 3c; 4 others). Participants used these watchfaces as mechanisms for self-expression, much like attire or phone lock screens.

When displayed in conjunction with their data, some participants felt their personally meaningful watchfaces offered them further motivation towards their health and wellbeing goals. For example,



Figure 3: Example personal meaning customisations participants selected for their watchfaces. Participants selected and created watchfaces which matched their personal interests, conveyed opinions, or highlighted aspects of their identity. Some participants who created their own watchfaces aimed to integrate their tracked data into the design.

S176 described that “seeing my grandchildren [on my watchface] helps me get up and move. I’m struggling with my knee so bad :(seeing them makes me try to move a bit and make myself stronger to spend more time with time. It’s like a persistent reminder to try and get up.” S83 similarly expressed that “my baby boy is there to help me create a hot mom bod 😂 I started a fitness journey to be in tip top shape to chase this baby around when he gets bigger and have the energy to play with her whenever she wants.” Participant further found watchfaces which matched with pop culture interests similarly motivating, such as S122 “it goes without saying that I am a huge Simpsons fan. Homer goes into ‘fun mode’ as I get to my step goal, which is funny to see. It’s like a little reward that I’m getting, seeing Homer at all of his splendor when I hit 100%” and S142 “big spiderman fan here. It helps me enjoy my fitbit a bit, sometimes even feel a bit heroic when I get really active.”

Two participants who made their own watchfaces further described how important it was to have their data metrics integrate into the design of their watchfaces. P3 made a watchface to look like the Pip-Boy 3000 wearable device from the Fallout video game series (Figure 3d). He integrated multiple metrics into the watchface as bar graphs, commenting that it “was just important to match the aesthetic of the Pip-Boy. So the numbers are all that really matters, but the bar graph fits in with the display design of Pip-Boy.” P8 similarly designed a Mortal Kombat watchface (Figure 3e), encoding his activity levels as the fighter’s health bars “then it just clicked: why not? Why not just use them as actual stats, because health, it’s just so close, like healthbars, they work differently at the start Alright, when it’s zero on both sides, and they usually start all green and then you get punched and then... But yeah, that’s just my percentage goal in those healthbars of calories and steps.” However, P3 struggled to integrate metrics with a meaningful picture when he made a watchface for his wife. He said, “I had a picture of the grandkids on the first time I made it. And she’s like, ‘I don’t want the numbers all over their faces.’”

4.2 RQ2: Use and Frequency of Customisation

Addressing RQ2, or when and why people customise their smartwatch watchfaces, participants followed two largely distinct patterns of customisation, as illustrated in Figure 4. Many survey

participants changed watchfaces frequently, with 43 (12%) changing weekly and 97 (26%) changing daily. Participants would often rotate between a small set of saved watchfaces (max. 5), rather than looking for new watchfaces. These customisations were largely driven by circumstantial needs arising or changing environments. Conversely, other survey participants’ watchface customisation practices more closely followed typical processes of selecting tracking tools [67], including a trial period before settling on a watchface to use for the foreseeable future. 117 participants (30%) reported having not changed their watchface in the past year, with another 76 (20%) reporting having changed their watchface once. Further, 53 (14%) of the watchface photos that survey participants sent us were the default watchface provided by Fitbit, indicating that they either had not changed their watchface or had reverted back to the default after exploring options. As discussed in our limitations, these customisation rates are potentially overestimated due to our recruitment focus from social medias related to Fitbit, which might have attracted people particularly motivated towards customisation. We suspect the frequency in which Fitbit users change their watchfaces to be slightly lower than what we show here.

The data and representation types that participants included on their smartwatches largely followed Islam et al.’s findings [52]. Survey participants’ watchfaces included an average 2.7 health and wellbeing metrics, most commonly step counts (302 participants, or 82%) and heart rate (283 participants, or 73%). Counts and other text feedback were common, on 338 participants’ watchfaces (88%). A minority of survey participants’ watchfaces included data in the form of graphs (96 participants, 25%) or more stylized feedback (35 participants, 9%). In subsequent sections, we further describe participant’s motivations for customising their smartwatches.

We found three underlying motivations for frequent watchface changes: (1) appropriations to one’s style and social setting, (2) shifting goals and information needs, and, (3) exploring a tracker’s possibilities. Contrastingly, those that had settled on a watchface described developing specific data and visualisation preferences which their current watchface addressed. In the following section we describe these different motivations:

4.2.1 Customisations driven by style expressions and social settings. Juhlin et al. [55] describe reasons why people frequently customise wearable devices, including matching wearables to different outfits

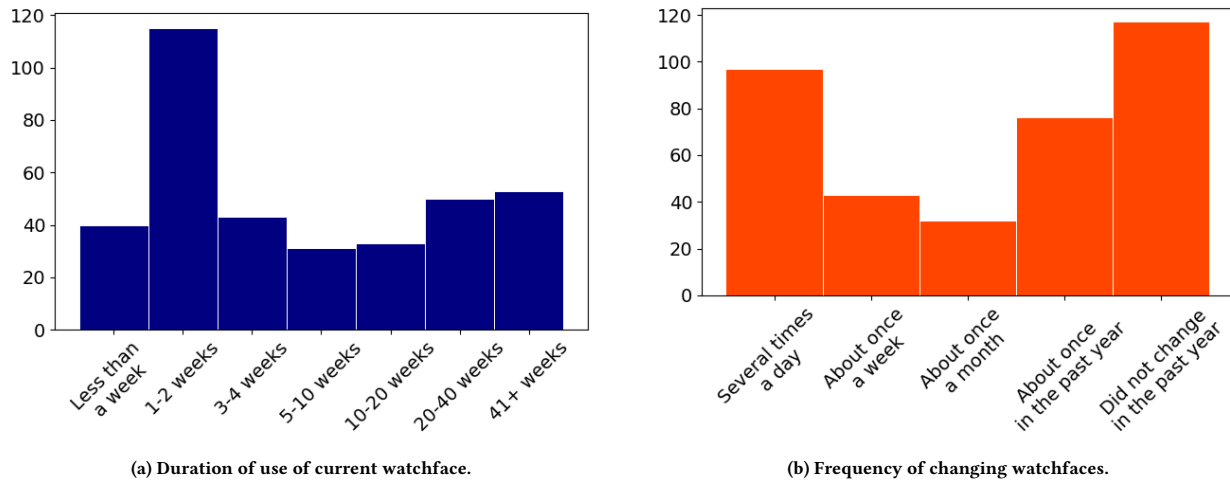


Figure 4: Participants were largely bimodal in their frequency of changing their watchfaces, with many changing weekly or daily while others kept the same watchface for months or longer.

and appropriating wearables to different social settings. We noted similar practices, with some participants viewing their trackers as part of their outfits. This was visible in concrete decisions that were made on what to wear and how a tracker should look like. 46 survey participants described changing the appearance of their tracker - namely, their watchface's color (33 participants), background picture (16 participants) and watch bands (28 participants), to match the patterns and styles of the different outfits they wore or planned to wear. Very much like matching accessories to outfits when getting dressed, trackers had become part of people's daily dressing rituals and were carefully crafted to "match" (S10,S64,S106,S229), "complement" (S8) and "fit" (S377) their different outfit choices. S156 changed the colors of his tracker to match those of his daily outfits: "green and blue faces are only good for lighter shirts but not so good with darker ones". S206 embedded details of his outfits in his watchfaces: "As my background I have a picture of a striking detail of my shirt, since all of them have a small motif, button or another detail which is noticed right away. The detail and color comes back in the watchface, so my watchface is changed almost every day."

For 8 participants, these style expressions were attempts to avoid unwanted attention or judgment from what was being displayed on a watchface, and even from using a tracker. P4 would swap out his Mortal Kombat watchface "when I'm going out to like some fancy place and then accidentally my clock face goes on and it looks like, I don't know, I'm a 15 year old kid or so. So I actually try to match my watchfaces to the situation where I am in or the place where I am at." S294 feared people judging her as a "person that is a fitness freak" for all the stats on her watchface. P18 similarly described how she was afraid that people considered her "frail", and was concerned that a fitness-focused watchface might catch unwanted attention. Instead, P18 would match her tracker's color to the colors of her daily outfits because she felt her tracker would "stand out less, be less recognizable" and "attract limited attention."

For other participants, the ability to customise a watchface presented another clothing accessory to style, much like a necklace

or a pair of earrings. P4 and P13 were both conscious about their styles, and described how important it was for their watchface to "look cool", "stylish" and "fashionable" or "it wouldn't be worn." For both, the data displayed on one's watchface was often of secondary importance to how well it gave continuation to their overall style and clothing. As described by P4, the important thing was to have a watchface which was in line with one's style, even if this meant looking at less data: "It provides minimal information, but looks better with a nice shirt and pants".

4.2.2 Customisations driven by shifting tracking goals and information needs. Epstein et al. [43] describe reasons why people transition between different tracking tools, including switching to tools that better meet their information needs. We noted similar practices. 24 participants described modifying or swapping their current watchfaces to ones that gave them feedback that was more "useful" and "informative" than what was provided by their current watchface. In most of these cases, people's tracking goals changed as they engaged in different daily activities. In turn, this led them to change their watchfaces to satisfy different information needs associated with their goals. For instance, S353 had "a preferred clock face for most of my day, but different needs from it at other times. E.g. at work, I need mostly to just know how many steps I've done that hour, as frankly I'm supposed to be working and sit at my desk most of the time. But if I'm on my commute (cycling and walking) or exercising in general (like walking the dog), I prefer to see total steps for the day and my heart rate". Similarly, S253 mentioned: "I'm a teacher so usually I switch from utility with a minute hand during school to a data intensive one when not teaching which is what I prefer. I can't really do much with the data while I'm teaching, but after I'm done it's nice to look back and see what I got and if I should get some steps in." People's information needs were often context-specific, as described by S151, who had a watchface that he would use when going to sleep to see the "morning sunrise times, my sleep levels, and a link to a voice recorded in case I need to remember a dream"

and another watchface that he used when exercising to see his workout goals. This was further described by P7: *If I'm doing an activity, I want something that is completely customised to give me information about that activity. I don't care about my clock face at the moment. I don't care about the battery life, I don't care about that stuff. I care specifically what I need about data on regards to that exercise or activity. In that scenario, I don't care about a nice pretty image behind the data, because it's actually going to bother my eyes.*

4.2.3 Exploring possibilities. Most interview participants mentioning changed watchfaces frequently during the early days (11 participants) or weeks (11 participants) of use. Participants were motivated to try out new watchfaces to understand what data could be collected (6 participants), how data could be delivered (5 participants) and the different possible looks for a watchface (11 participants). Past literature has shown that people often have preconceived ideas of what data should be collected, how data should be displayed and what a tracker should look like when selecting self-tracking tools [67]. We often found that the initial selection of watchfaces was less planned or guided towards specific tracking needs, with 12 participants describing “never know(ing) exactly what I'm looking for” (P12), “just looking around” (P1) and “simply looking for inspiration” (P8). This was reflected in how participants selected watchfaces, with many “simply browsing the gallery” (P12), as opposed to searching for specific keywords or tags for watchface attributes: *“I don't think I've ever put a keyword in for watchfaces. I've just opened whatever the search is for watchfaces and then scroll through. Opened ones that I thought were interesting and ended up downloading the two that I have”* (P11). These experiences were pervaded by feelings of “excitement” (P2,P12,P18), “curiosity” (P2,P3,P6,P10,P15,P18) and “fun” (P6) as participants discovered novel features and possibilities that were out there for them to learn from as initial experiences with trackers took place, as described by P18: *“I didn't really know anything about Fitbit... So exploring the watchfaces. I mean, I knew you could have watchfaces, but I didn't really know, the scope. So exploring the watchface store was really quite exciting. It was exciting and like mind opening, because I didn't understand or know what was possible.”*

Interestingly, these early, frequent customisations would often act as a proxy for tracking goals and for forming specific preferences for watchfaces. When participants used watchfaces, they would often pick up an interest in the metrics or visualizations that were used by them, as described by P16: *“the one that I use now, if I want I could make it (set a reminder for walking) 300 steps, I could make it 200 steps... when I was looking for faces and I found this one, all of a sudden, I saw I could do a lot more with it. so it sort of created the need for it once I saw the feature rather than go out and looking.”* 5 interview participants described how using stats heavy watchfaces helped develop an interests in specific metrics: *“at first I didn't really know what I wanted so I went for one with more than a dozen different metrics. And I honestly can't recall the timeline, but there was preference that I developed after using the very, you know, busy watch faces and started settling on a smaller number of metrics that I was interested in.”* (P11).

4.2.4 Motivations for less frequent customisation. Many survey (50%, 193 participants) and interview participants (67%, 12 participants) had settled on a watchface, keeping it as their main watchface

over the past year. When inquiring into the reasons for less frequent changes, participants often described having developed and maintained specific data and visualization preferences, which their current watchface addressed, as described by P2: *“I would say like the beginning, it was just the excitement thing that drove me to keep changing the faces, but now I know more about what I want... and this one (watchface) has what I want.”* Still, many interview participants (8 participants) described visiting the Fitbit gallery occasionally or swapping watchface for a short period of time before coming back to their main watchface. Participants described getting “bored” (4 participants) and looking for something “new and interesting” for the looks of their watchface (2 participants), as described by P7: *“it's not the data that bothers me, it's the same image, you know, every time you look at it. So when you change that image, it sort of feels like a fresh watch... it feels like something new”*. P9 further described the process of looking for new, interesting watchfaces: *“It's not unlike turning on Netflix, for instance. you're not looking for anything, but you just want to see, is there anything I haven't met I've missed.”* However, changes out of boredom or lack of interest were often short lived, with people going back to their main watchfaces hours or days after changing: *“It just felt like I went a step backwards, because the other one gave me so much information.”* (P7).

5 DISCUSSION

Our findings provide empirical evidence supporting arguments made in prior work around the utility of customisation of tracking tools [23, 34, 50]. We surface that, in practice, people appreciate the ability to customise wearable trackers towards their goals, needs, and preferences. Customisations varied in frequency, with many people settling into one watchface after some experimentation while others frequently customised to their surroundings. People typically follow three different styles of customisations (1) data, or what statistics are highlighted; (2) aesthetic, or color, layout, and iconography; and (3) personal meaning, or relating to personal interests or values. These styles and motivations for both frequent and infrequent customisations point to ways of rethinking how we support goal scaffolding and evolution around personal informatics, and important opportunities for the design of tools looking to do so.

5.1 Maintaining Interest in Tracking through Other Forms of Meaning

Past work has often sought to make ambient displays “interesting” through data abstraction and story-driven approaches [32, 69, 76, 87], and more meaningful by allowing people to select personally relevant data types [21], glyphs, and color schemes [61, 85]. We highlight that when presented with a range of customisation options, people customise their watchfaces with images, colors, and icons which are much more personally meaningful to them: people and pets they care about, causes they support, pop culture they like, holidays they long for, and more. Rather than sticking to one or even a few of the most “popular” watchfaces as promoted in the Fitbit gallery, participants put significant thought into what they wanted displayed, and time and effort into finding or making a watchface which supported that.

Importantly, our work surfaces that highlighting these personal interests on watchfaces are not solely about making a public display nor a personal connection to the device [55]. Instead, people aim to blend their personal interests with their tracking needs, as illustrated by customising watchfaces to tightly connect data to health bars of video game characters or see progress reflected in changes to movie or TV characters. We speculate that this personal meaning helps maintain more sustained interest in using the watchface towards tracking health and wellbeing. While a person's interest in growing a flower or following a story might fade over time, the external motivator of seeing data connected with a personal interest may persist longer. This evidence from people's lived experience with custom watchfaces helps confirm Kang et al.'s suggestion that people are more likely to engage with watchfaces which they feel closely align with their personal identity [56], and findings in other domains like microblogging where customisation has been empirically shown to improve engagement [90]. However, it remains an open question how specific the desire to blend personal interests and tracking needs are to the parameters of tracking via a wearable device. We suspect this interest largely draws from use of a passive ambient display for viewing data, as people more regularly make the association between the two. This would suggest that similar desires for blending might emerge when tracked data is represented on other devices like lock screens of phones or public displays, but might be less valuable if tracking exists only in a dedicated app that is opened with a tracking or reflection task more clearly in mind.

Our work points to the value of creating authoring tools to help people integrate their data needs into their own personally meaningful watchfaces. In particular, we believe there is room in the design landscape for lower-threshold creation tools, beyond direct engagement with the native APIs of smartwatches only accessible by people with expert knowledge [27] or highly expressive tools like FitFace [9]. A main challenge is designing tools which allow blending data with aesthetic and personal meaning needs, where improving the experience of searching and browsing for watchfaces that others created is unlikely to support people's individual preferences and ways of creating meaning. For example, allowing people to create watchfaces which annotate pictures they find meaningful with the data fields they value could enable people to better connect personal meaning with data needs. Such tools could further support people's aesthetic preferences through enabling customising the locations and colors of different data fields on the watchface, mirroring the flexibility of paper [18, 23]. Finally, authoring tools could leverage triggers [63] to support watchfaces in changing based on events, such as achieving a daily step goal or changing from month to month. Improving tagging and filtering of watchfaces in public galleries by data, aesthetic, and personal meaning needs could also make it easier for people to find watchfaces they appreciate, similar to tracking apps [67]. But we suspect that improving selection alone is insufficient for supporting people's highly individual needs around customisation.

It is worth reiterating that our study parameters likely overemphasised perspectives of people who customised their watchfaces, while many people do not. In the future, it is therefore worth examining whether people who have not customised would benefit from doing so, such as identifying new goals, avoiding discomfort from measures they do not wish to see, or finding greater personal

meaning. And if so, it is worth considering how we can design tracking technologies to further encourage their customisation. We also expect that some of our findings around meaning-making may not fully apply to people who are deeply motivated to monitor performance towards health and wellbeing goals, such as use of sports watches [91]. For some people, monitoring the tracked metrics may be sufficient for maintaining interest, paralleling differences between the Quantified Self movement and Lived Informatics [27, 86].

5.2 Customisation as Goal Scaffolding

Similar to Lee et al., [67] participants' experiences searching for watchfaces highlight the utility of customisation towards helping people identify health and wellbeing goals they are interested in pursuing that tracking is well-suited to assist with. We observed that people follow similar practices to selecting tracking apps, searching watchface galleries for inspiration and trialing different watchfaces to see what data they find valuable and what data they might find stressful to monitor. This practice also contrasts with some conceptualisations of customisation, which have assumed that self-trackers know how they want to customise their tracking regimen [70]. Through customisation, people may identify and address kinds of data that they find uncomfortable or unpleasant to review, helping to manage negative mental wellbeing outcomes which can from engaging with tracking [22, 33, 42, 78]. Our work further provides evidence that customisation in tracking can help scaffold the process of evolving from hedonic and eudaimonic needs, such as wanting to feel better, towards quantitative tracking goals which are well-represented on a watchface [79]. These benefits suggest that integration of customisation into tracking processes has the potential to help people achieve physical and emotional wellbeing goals, by identifying tracking directions which seem beneficial and avoiding those which might be emotionally harmful.

Our findings suggest that the form factor of the watch and the desire for a single watchface was helpful for people to instinctively mitigate aspects of goal creep, or introducing too many goals to set and data to monitor [89], when customising watchfaces. Participants frequently mentioned prioritizing readability and glanceability over including "more" information on their watchface. Even participants who preferred data-heavy watchfaces typically customised their watchfaces to emphasise the metrics they found most important by placing them in the center or making them larger than other, less-important metrics. Further, participants were happy to move metrics or visualisations they found less crucial, but still valuable to a "second screen", whether accessible on their phone or via a swipe on their watch. This suggests that involving consideration of the display in the process of scaffolding tracking experiences may help people prioritise and filter their goals. Future work could consider how to encourage promoting the physical constraints of other devices towards mitigating goal creep, such as aiming to keep a list of manually-tracked parameters to a single screen of a phone.

Although explicit scaffolding practices may still prove helpful towards quickly arriving at an ideal customisation (e.g., suggesting data to collect based on goals [89]), our work suggests that supporting customisation in tracking technology inherently provides assistance towards refining tracking goals by allowing people to try them and re-evaluate. The shared data backend in watchfaces

avoided common challenges around data portability [92], enabling seamless transition as people refined their tracking needs. This suggests potential value of other platforms with similar shared data to similarly support representation customisation, such as mobile personal health data ecosystems like Apple Health and Google Fit.

5.3 Challenges in Supporting Goal Evolution

In spite of the value of customisation in helping to support maintained interest in tracking and scaffolding of relevant and tractable tracking goals, participants tended to settle relatively quickly on a watchface or watchfaces that served their needs. Some participants would occasionally switch watchfaces seasonally or “randomly”, but we found relatively few examples of participants who reconsidered whether there was other information which their watchface could display which could better address a new or evolving need. One interpretation is that people abandon tracking on their smartwatches (or using their smartwatches altogether) once they learn enough about their habits [40]. Another interpretation, which we think is more likely, is that customisation is currently a relatively short procedure, and once people settle on a watchface they tend not to reconsider.

Because we know people’s wellbeing goals [19] and tracking needs [43, 79] evolve substantially over time [75], there is value in designing watchface customisation tools which encourage revisiting tracking needs. Straightforward, highly-infrequent notifications reminding people that watchfaces can be customised could provide a useful nudge toward encouraging people to reconsider the utility of their current watchface. Or in a more extreme example, watch developers or a custom watchface could A/B test different design layouts, such as varying what metrics are shown and using common metrics used to evaluate interest like dwell time or number of usage sessions [47]. Beyond tracking goal evolution, encouraging revisiting watchfaces could allow people to try different aesthetics to mitigate boredom or keep up with their evolving everyday interests. The phone lockscreen photo shuffle introduced in iOS 16 could be one inspiration for identifying and adjusting watchfaces to reflect personally meaningful interests [13].

6 CONCLUSION

In this paper, we investigated how self-trackers engage in the everyday customisation of their smartwatch displays, and how these practices support tracking goals. We found that the customisation of self-trackers often involved balancing health and wellbeing, self-presentation and personal meaning goals and that customisation often helped people in scaffolding tracking goals and maintained their interest in tracking over time. Our work also highlights some opportunities for future work in this area, such as developing low-burden tools that allow people to balance their different self-presentation and tracking needs, and exploring how customisation can best support goal evolution.

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REFERENCES

- [1] 2017. *Percentage of Mobile Medical Application Categories Used by U.S. Adults at Least Once as of 2017*. <https://www-statista.com/statistics/378850/top-mobile-health-application-categories-used-by-us-consumers/>
- [2] 2020. *Changing Views on Healthcare and Digital Health Tools - GlobalWebIndex*. <https://www.gwi.com/reports/digital-healthcare>
- [3] 2022. *Charge3*. https://statics.fitbit.com/content/assets/help/manuals/manual_charge_3_en_US.pdf
- [4] 2022. *Connect IQ Store*. <https://apps.garmin.com/en-US/>
- [5] 2022. *Discover Smartwatch Clock Faces*. <https://gallery.fitbit.com/clocks>
- [6] 2022. *Explore the Face Gallery on Apple Watch*. <https://support.apple.com/guide/watch/explore-the-face-gallery-apdd90945f0/watchos>
- [7] 2022. *Fitbit Features*. <https://smartwatchchart.com/smartwatches-category/list-of-fitbit-smartwatches-and-trackers/>
- [8] 2022. *Fitbit SDK*. <https://dev.fitbit.com/>
- [9] 2022. *FitFace*. <https://fitface.xyz/>
- [10] 2022. *InspireHR*. https://statics.fitbit.com/content/assets/help/manuals/manual_inspire_hr_en_US.pdf
- [11] 2022. *Ionic*. https://statics.fitbit.com/content/assets/help/manuals/manual_ionic_en_US.pdf
- [12] 2022. *Lite*. https://help.fitbit.com/manuals/manual_sense_en_US.pdf
- [13] 2022. *Personalize your iPhone Lock Screen*. <https://support.apple.com/guide/iphone/personalize-your-iphone-lock-screen-iph4d06c351/ios>
- [14] 2022. *Sense*. https://help.fitbit.com/manuals/manual_sense_en_US.pdf
- [15] 2022. *Versa*. https://statics.fitbit.com/content/assets/help/manuals/manual_versa_en_US.pdf
- [16] 2022. *Versa2*. https://statics.fitbit.com/content/assets/help/manuals/manual_versa_2_en_US.pdf
- [17] 2022. *Versa3*. https://help.fitbit.com/manuals/manual_versa_3_en_US.pdf
- [18] Parastoo Abtahi, Victoria Ding, Anna C Yang, Tommy Bruzzese, Alyssa B Romanos, Elizabeth L Murnane, Sean Follmer, and James A Landay. 2020. Understanding physical practices and the role of technology in manual self-tracking. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 4, 4 (2020), 1–24.
- [19] Elena Agapie, Patricia A. Areán, Gary Hsieh, and Sean A. Munson. 2022. A Longitudinal Goal Setting Model for Addressing Complex Personal Problems in Mental Health. (2022).
- [20] Fereshteh Amini, Khalad Hasan, Andrea Bunt, and Pourang Irani. 2017. Data representations for in-situ exploration of health and fitness data. In *Proceedings of the 11th EAI international conference on pervasive computing technologies for healthcare*. 163–172.
- [21] Amid Ayobi, Paul Marshall, and Anna L Cox. 2020. Trackly: A customisable and pictorial self-tracking app to support agency in multiple sclerosis self-care. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–15.
- [22] Amid Ayobi, Paul Marshall, Anna L Cox, and Yunan Chen. 2017. Quantifying the body and caring for the mind: self-tracking in multiple sclerosis. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. 6889–6901.
- [23] Amid Ayobi, Tobias Sonne, Paul Marshall, and Anna L Cox. 2018. Flexible and mindful self-tracking: Design implications from paper bullet journals. In *Proceedings of the 2018 CHI conference on human factors in computing systems*. 1–14.
- [24] Tanja Blascheck, Frank Bentley, Eun Kyoung Choe, Tom Horak, and Petra Isenberger. 2021. Characterizing Glanceable Visualizations: From Perception to Behavior Change. In *Mobile Data Visualization*. Chapman and Hall/CRC, 151–176.
- [25] Marta E Cecchinato, Anna L Cox, and Jon Bird. 2017. Always on (line)? User experience of smartwatches and their role within multi-device ecologies. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. 3557–3568.
- [26] Eun Kyoung Choe, Saeed Abdullah, Mashfiqui Rabbi, Edison Thomaz, Daniel A Epstein, Felicia Cordeiro, Matthew Kay, Gregory D Abowd, Tanzeem Choudhury, James Fogarty, et al. 2017. Semi-automated tracking: a balanced approach for self-monitoring applications. *IEEE Pervasive Computing* 16, 1 (2017), 74–84.
- [27] Eun Kyoung Choe, Nicole B Lee, Bongshin Lee, Wanda Pratt, and Julie A Kientz. 2014. Understanding quantified-selfers’ practices in collecting and exploring personal data. In *Proceedings of the SIGCHI conference on human factors in computing systems*. 1143–1152.
- [28] Victoria Clarke and Virginia Braun. 2013. Successful qualitative research: A practical guide for beginners. *Successful Qualitative Research* (2013), 1–400.
- [29] James Clawson, Jessica A Pater, Andrew D Miller, Elizabeth D Mynatt, and Lena Mamykina. 2015. No longer wearing: investigating the abandonment of personal health-tracking technologies on craigslist. In *Proceedings of the 2015*

- ACM international joint conference on pervasive and ubiquitous computing. 647–658.
- [30] Sunny Consolvo, Katherine Everitt, Ian Smith, and James A Landay. 2006. Design requirements for technologies that encourage physical activity. In *Proceedings of the SIGCHI conference on Human Factors in computing systems*. 457–466.
 - [31] Sunny Consolvo, Predrag Klasnja, David W McDonald, Daniel Avrahami, Jon Froehlich, Louis LeGrand, Ryan Libby, Keith Mosher, and James A Landay. 2008. Flowers or a robot army? Encouraging awareness & activity with personal, mobile displays. In *Proceedings of the 10th international conference on Ubiquitous computing*. 54–63.
 - [32] Sunny Consolvo, Predrag Klasnja, David W McDonald, James A Landay, et al. 2014. Designing for healthy lifestyles: Design considerations for mobile technologies to encourage consumer health and wellness. *Foundations and Trends® in Human-Computer Interaction* 6, 3–4 (2014), 167–315.
 - [33] Mayara Costa Figueiredo, Clara Caldeira, Elizabeth Victoria Eikey, Melissa Mazmanian, and Yunan Chen. 2018. Engaging with health data: The interplay between self-tracking activities and emotions in fertility struggles. *Proceedings of the ACM on Human-Computer Interaction* 2, CSCW (2018), 1–20.
 - [34] Mayara Costa Figueiredo, Clara Caldeira, Tera L Reynolds, Sean Victory, Kai Zheng, and Yunan Chen. 2017. Self-tracking for fertility care: collaborative support for a highly personalized problem. *Proceedings of the ACM on Human-Computer Interaction* 1, CSCW (2017), 1–21.
 - [35] Mayara Costa Figueiredo, Thu Huynh, Anna Takei, Daniel A Epstein, and Yunan Chen. 2021. Goals, life events, and transitions: examining fertility apps for holistic health tracking. *JAMIA open* 4, 1 (2021), oaab013.
 - [36] Nediya Daskalova, Eindra Kyi, Kevin Ouyang, Arthur Borem, Sally Chen, Sung Hyun Park, Nicole Nugent, and Jeff Huang. 2021. Self-e: Smartphone-supported guidance for customizable self-experimentation. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–13.
 - [37] Tina Ekhtiar, Rúben Gouveia, Armağan Karahanoglu, and Geke Ludden. 2022. Reflection during goal setting: An analysis of popular personal informatics apps. *DRS2022: Bilbao* 25 (2022).
 - [38] Daniel A Epstein, Tanja Blascheck, Sheelagh Carpendale, Raimund Dachsel, and Jo Vermeulen. 2021. Challenges in Everyday Use of Mobile Visualizations. In *Mobile Data Visualization*. Chapman and Hall/CRC, 209–240.
 - [39] Daniel A Epstein, Clara Caldeira, Mayara Costa Figueiredo, Xi Lu, Lucas M Silva, Lucretia Williams, Jong Ho Lee, Qingyang Li, Simran Ahuja, Qiuer Chen, et al. 2020. Mapping and taking stock of the personal informatics literature. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 4, 4 (2020), 1–38.
 - [40] Daniel A Epstein, Monica Caraway, Chuck Johnston, An Ping, James Fogarty, and Sean A Munson. 2016. Beyond abandonment to next steps: understanding and designing for life after personal informatics tool use. In *Proceedings of the 2016 CHI conference on human factors in computing systems*. 1109–1113.
 - [41] Daniel A. Epstein, Felicia Cordeiro, Elizabeth Bales, James Fogarty, and Sean A. Munson. 2014. Taming data complexity in lifelogs: exploring visual cuts of personal informatics data. In *Proceedings of the 2014 conference on Designing interactive systems*. 667–676.
 - [42] Daniel A Epstein, Nicole B Lee, Jennifer H Kang, Elena Agapie, Jessica Schroeder, Laura R Pina, James Fogarty, Julie A Kientz, and Sean Munson. 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*. 6876–6888.
 - [43] Daniel A Epstein, An Ping, James Fogarty, and Sean A Munson. 2015. A lived informatics model of personal informatics. In *Proceedings of the 2015 ACM international joint conference on pervasive and ubiquitous computing*. 731–742.
 - [44] Catrin Feron, Tina Ekhtiar, and Ruben Gouveia. 2022. Transitions in Personal Informatics: Investigating Self-Tracking During Moments of Change. In *Adjunct Proceedings of the 2022 Nordic Human-Computer Interaction Conference*. 1–5.
 - [45] Rúben Gouveia, Evangelos Karapanos, and Marc Hassenzahl. 2015. How do we engage with activity trackers? A longitudinal study of Habito. In *Proceedings of the 2015 ACM international joint conference on pervasive and ubiquitous computing*. 1305–1316.
 - [46] Rúben Gouveia, Evangelos Karapanos, and Marc Hassenzahl. 2018. Activity Tracking in Vivo. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (Montreal QC, Canada) (CHI '18). Association for Computing Machinery, New York, NY, USA, 1–13. <https://doi.org/10.1145/3173574.3173936>
 - [47] Rúben Gouveia, Fábio Pereira, Evangelos Karapanos, Sean A. Munson, and Marc Hassenzahl. 2016. Exploring the Design Space of Glanceable Feedback for Physical Activity Trackers. In *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (Heidelberg, Germany) (UbiComp '16). Association for Computing Machinery, New York, NY, USA, 144–155. <https://doi.org/10.1145/2971648.2971754>
 - [48] Rebecca Gulotta, Jodi Forlizzi, Rayoung Yang, and Mark Wah Newman. 2016. Fostering engagement with personal informatics systems. In *Proceedings of the 2016 ACM Conference on Designing Interactive Systems*. 286–300.
 - [49] Jungmin Han and Hyeon-Jeong Suk. 2019. Do users perceive the same image differently? Comparison of OLED and LCD in mobile HMDs and smartphones. *Journal of Information Display* 20, 1 (2019), 31–38.
 - [50] Daniel Harrison, Paul Marshall, Nadia Bianchi-Berthouze, and Jon Bird. 2015. Activity tracking: barriers, workarounds and customisation. In *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. 617–621.
 - [51] Alaul Islam, Ranjini Aravind, Tanja Blascheck, Anastasia Bezerianos, and Petra Isenberg. 2022. Preferences and Effectiveness of Sleep Data Visualizations for Smartwatches and Fitness Bands. In *CHI Conference on Human Factors in Computing Systems*. 1–17.
 - [52] Alaul Islam, Anastasia Bezerianos, Bongshin Lee, Tanja Blascheck, and Petra Isenberg. 2020. Visualizing information on watch faces: A survey with smartwatch users. In *2020 IEEE Visualization Conference (VIS)*. IEEE, 156–160.
 - [53] Hayeon Jeong, HeePyung Kim, Rihun Kim, Uichin Lee, and Yong Jeong. 2017. Smartwatch wearing behavior analysis: a longitudinal study. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 1, 3 (2017), 1–31.
 - [54] EunKyung Jo, Austin L Toombs, Colin M Gray, and Hwajung Hong. 2020. Understanding Parenting Stress through Co-designed Self-Trackers. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–13.
 - [55] Oskar Juhlin, Yanqing Zhang, Jinyi Wang, and Anders Andersson. 2016. Fashionable services for wearables: Inventing and investigating a new design path for smart watches. In *Proceedings of the 9th Nordic Conference on Human-Computer Interaction*. 1–10.
 - [56] Jin Kang, Jomara Binda, Pratik Agarwal, Bruno Saconi, and Eun Kyoung Choe. 2017. Fostering user engagement: Improving sense of identity through cosmetic customization in wearable trackers. In *Proceedings of the 11th EAI international conference on pervasive computing technologies for healthcare*. 11–20.
 - [57] Armağan Karahanoglu, Rúben Gouveia, Jasper Reenalda, and Geke Ludden. 2021. How are sports-trackers used by runners? Running-related data, personal goals, and self-tracking in running. *Sensors* 21, 11 (2021), 3687.
 - [58] Evangelos Karapanos, Rúben Gouveia, Marc Hassenzahl, and Jodi Forlizzi. 2016. Wellbeing in the making: peoples' experiences with wearable activity trackers. *Psychology of well-being* 6, 1 (2016), 1–17.
 - [59] Ravi Karkar, Jessica Schroeder, Daniel A Epstein, Laura R Pina, Jeffrey Scofield, James Fogarty, Julie A Kientz, Sean A Munson, Roger Vilardaga, and Jasmine Zia. 2017. Tummytrials: a feasibility study of using self-experimentation to detect individualized food triggers. In *Proceedings of the 2017 CHI conference on human factors in computing systems*. 6850–6863.
 - [60] Dmitri S Katz, Blaine A Price, Simon Holland, and Nicholas Sheep Dalton. 2018. Data, data everywhere, and still too hard to link: Insights from user interactions with diabetes apps. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 1–12.
 - [61] Nam Wook Kim, Hyejin Im, Nathalie Henry Riche, Alicia Wang, Krzysztof Gajos, and Hanspeter Pfister. 2019. Dataselfie: Empowering people to design personalized visuals to represent their data. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. 1–12.
 - [62] Sung-In Kim, EunKyung Jo, Myeonghan Ryu, Inha Cha, Young-Ho Kim, HeeJung Yoo, and Hwajung Hong. 2019. Toward becoming a better self: Understanding self-tracking experiences of adolescents with autism spectrum disorder using custom trackers. In *Proceedings of the 13th EAI International Conference on Pervasive Computing Technologies for Healthcare*. 169–178.
 - [63] Young-Ho Kim, Jae Ho Jeon, Bongshin Lee, Eun Kyoung Choe, and Jinwook Seo. 2017. OmniTrack: A flexible self-tracking approach leveraging semi-automated tracking. *Proceedings of the ACM on interactive, mobile, wearable and ubiquitous technologies* 1, 3 (2017), 1–28.
 - [64] Amanda Lazar, Christian Koehler, Theresa Jean Tanenbaum, and David H Nguyen. 2015. Why we use and abandon smart devices. In *Proceedings of the 2015 ACM international joint conference on pervasive and ubiquitous computing*. 635–646.
 - [65] Bongshin Lee, Eun Kyoung Choe, Petra Isenberg, Kim Marriott, and John Skasko. 2020. Reaching broader audiences with data visualization. *IEEE Computer Graphics and Applications* 40, 2 (2020), 82–90.
 - [66] Bongshin Lee, Raimund Dachsel, Petra Isenberg, and Eun Kyoung Choe. 2021. *Mobile Data Visualization*. CRC Press.
 - [67] Jong Ho Lee, Jessica Schroeder, and Daniel A. Epstein. 2022. Understanding and Supporting Self-Tracking App Selection. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 5, 4, Article 166 (dec 2022), 25 pages. <https://doi.org/10.1145/3494980>
 - [68] Ian Li, Anind Dey, and Jodi Forlizzi. 2010. A stage-based model of personal informatics systems. In *Proceedings of the SIGCHI conference on human factors in computing systems*. 557–566.
 - [69] James J Lin, Lena Mamykina, Silvia Lindtner, Gregory Delajoux, and Henry B Strub. 2006. Fish'n'Steps: Encouraging physical activity with an interactive computer game. In *International conference on ubiquitous computing*. Springer, 261–278.
 - [70] Yuhuan Luo, Peiyi Liu, and Eun Kyoung Choe. 2019. Co-Designing food trackers with dietitians: Identifying design opportunities for food tracker customization. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. 1–13.

- [71] Zhenyue Luo and Shin-Tson Wu. 2015. OLED versus LCD: Who wins. *Opt. Photonics News* 2015 (2015), 19–21.
- [72] Lucas M. Silva and Daniel A. Epstein. 2021. Investigating preferred food description practices in digital food journaling. In *Designing Interactive Systems Conference 2021*. 589–605.
- [73] Wendy E Mackay. 1991. Triggers and barriers to customizing software. In *Proceedings of the SIGCHI conference on Human factors in computing systems*. 153–160.
- [74] Donald McMillan, Barry Brown, Airi Lampinen, Moira McGregor, Eve Hoggan, and Stefania Pizza. 2017. Situating wearables: Smartwatch use in context. In *Proceedings of the 2017 chi conference on human factors in computing systems*. 3582–3594.
- [75] Jochen Meyer, Judy Kay, Daniel A Epstein, Parisa Eslambolchilar, and Lie Ming Tang. 2020. A life of data: characteristics and challenges of very long term self-tracking for health and wellness. *ACM Transactions on Computing for Healthcare* 1, 2 (2020), 1–4.
- [76] Elizabeth L Murnane, Xin Jiang, Anna Kong, Michelle Park, Weili Shi, Connor Soohoo, Luke Vink, Iris Xia, Xin Yu, John Yang-Sammataro, et al. 2020. Designing ambient narrative-based interfaces to reflect and motivate physical activity. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–14.
- [77] Ali Neshati, Launa Leboe-McGowan, Jason Leboe-McGowan, Marcos Serrano, Pourang Irani, et al. 2019. G-sparks: Glanceable sparklines on smartwatches. In *45th Conference on Graphics Interface (GI 2019)*. 1–9.
- [78] Jasmin Niess, Kristina Knaving, Alina Kolb, and Pawel W Woźniak. 2020. Exploring fitness tracker visualisations to avoid rumination. In *22nd International Conference on Human-Computer Interaction with Mobile Devices and Services*. 1–11.
- [79] Jasmin Niess and Pawel W Woźniak. 2018. Supporting meaningful personal fitness: The tracker goal evolution model. In *Proceedings of the 2018 CHI conference on human factors in computing systems*. 1–12.
- [80] Jasmin Niess, Pawel W Woźniak, Yomna Abdelrahman, Passant ElAgroudy, Yasmeen Abdrabou, Caroline Eckerth, Sarah Diefenbach, and Kristina Knaving. 2021. 'I Don't Need a Goal': Attitudes and Practices in Fitness Tracking beyond WEIRD User Groups. In *Proceedings of the 23rd International Conference on Mobile Human-Computer Interaction*. 1–14.
- [81] Stefania Pizza, Barry Brown, Donald McMillan, and Airi Lampinen. 2016. Smartwatch in vivo. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. 5456–5469.
- [82] Kyrrill Potapov and Paul Marshall. 2020. LifeMosaic: Co-design of a personal informatics tool for youth. In *Proceedings of the interaction design and children conference*. 519–531.
- [83] Amon Rapp and Federica Cena. 2016. Personal informatics for everyday life: How users without prior self-tracking experience engage with personal data. *International Journal of Human-Computer Studies* 94 (2016), 1–17.
- [84] Amon Rapp, Alessandro Marcengo, Luca Buriano, Giancarlo Ruffo, Mirko Lai, and Federica Cena. 2018. Designing a personal informatics system for users without experience in self-tracking: a case study. *Behaviour & Information Technology* 37, 4 (2018), 335–366.
- [85] Hugo Romat, Nathalie Henry Riche, Christophe Hurter, Steven Drucker, Fereshteh Amini, and Ken Hinckley. 2020. Dear pictograph: Investigating the role of personalization and immersion for consuming and enjoying visualizations. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–13.
- [86] John Rooksby, Mattias Rost, Alistair Morrison, and Matthew Chalmers. 2014. Personal tracking as lived informatics. In *Proceedings of the SIGCHI conference on human factors in computing systems*. 1163–1172.
- [87] Herman Saksono, Carmen Castaneda-Sceppa, Jessica Hoffman, Vivien Morris, Magy Seif El-Nasr, and Andrea G Parker. 2020. Storywell: designing for family fitness app motivation by using social rewards and reflection. In *Proceedings of the 2020 CHI conference on human factors in computing systems*. 1–13.
- [88] Jessica Schroeder, Chia-Fang Chung, Daniel A Epstein, Ravi Karkar, Adele Parsons, Natalia Murinova, James Fogarty, and Sean A Munson. 2018. Examining self-tracking by people with migraine: goals, needs, and opportunities in a chronic health condition. In *Proceedings of the 2018 designing interactive systems conference*. 135–148.
- [89] Jessica Schroeder, Ravi Karkar, Natalia Murinova, James Fogarty, and Sean A. Munson. 2019. Examining Opportunities for Goal-Directed Self-Tracking to Support Chronic Condition Management. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 3, 4, Article 151 (dec 2019), 26 pages. <https://doi.org/10.1145/3369809>
- [90] S Shyam Sundar, Jeeyun Oh, Saraswathi Bellur, Haiyan Jia, and Hyang-Sook Kim. 2012. Interactivity as self-expression: A field experiment with customization and blogging. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 395–404.
- [91] Jakob Tholander and Stina Nylander. 2015. Snot, sweat, pain, mud, and snow: Performance and experience in the use of sports watches. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. 2913–2922.
- [92] Jason Wiese, Sauvik Das, Jason I Hong, and John Zimmerman. 2017. Evolving the ecosystem of personal behavioral data. *Human-Computer Interaction* 32, 5-6 (2017), 447–510.
- [93] Clint Zeagler. 2017. Where to wear it: functional, technical, and social considerations in on-body location for wearable technology 20 years of designing for wearability. In *Proceedings of the 2017 ACM International Symposium on Wearable Computers*. 150–157.