



Exploring the Lived Experience of Behavior Change Technologies: Towards an Existential Model of Behavior Change for HCI

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The majority of behavior change and persuasive technologies are exclusively addressed to modify a specific behavior. However, the focus on behavior may cloud the “existential aspects” of the process of change. To explore the lived and meaning-laden experience of behavior change, we interviewed 23 individuals who have used behavior change technology in their everyday life. The study findings highlight that behavior change is tied to meanings that point to existential matters, relates to a nexus of life circumstances, and unfolds over long periods of time. By contrast, the technology used by the participants appears mostly to focus on the present target behavior, ignoring its links to the participants’ life “context” and “time,” also providing scarce help for sense-making. Based on these findings, we surface a preliminary “existential model of behavior change,” identify several barriers that may prevent the modification of behavior and propose some design suggestions to overcome them.

CCS Concepts: • **Human-centered computing** → **HCI theory, concepts and models**; *Empirical studies in HCI*;

Additional Key Words and Phrases: Behavior change, persuasive technologies, self-tracking, personal informatics, existence, theoretical model

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1 INTRODUCTION

Over recent years, an increasing number of systems aimed at changing behavior have been designed by **Human-Computer Interaction (HCI)** researchers, as well as made available commercially, offering opportunities for behavior tracking and interventions that were hitherto unavailable. The field of “persuasive” [Fogg 2009] and behavior change [Hekler et al. 2013] technologies precisely focuses on the opportunities for yielding behavioral changes in domains as diverse as health [Luo et al. 2018], safety [Chin et al. 2017], sustainability [Gentile and Mylonopoulou 2017],

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and work [Whittaker et al. 2016]. The growing popularity of self-tracking devices has further promoted technology-based interventions on behavior: in the so-called “quantified self” rhetoric, people lack knowledge about themselves, and the personal information collected by wearables and tracking apps can support them in reviewing and reflecting upon their own behavior, possibly leading to its modification [Rapp and Tirassa 2017].

As the very name of this research area points out,¹ the majority of behavior change technologies are addressed to modify a specific, target, behavior. This may appear obvious, as they are designed to solve a supposed well-defined behavioral problem, like losing weight or stopping smoking. However, on a closer look, we may see that the focus on the target behavior often clouds the wider context in which it is embedded, that is the “life” of the individual, meant as a nexus of practices, meanings, experiences, and concerns, which characterize her everydayness. This happens as most behavior change designs rely on the idea that the central, not to say exclusive, focus of the technological intervention should be the behavior, conceived as a sort of “quantum” that can be isolated and studied from an external point of view [Rapp et al. 2019]. From this perspective, behavior is an objective phenomenon, which has more or less the same meaning for every individual and can be effectively manipulated without considering the subjective experience of the person.

Designers have found this way to see behavior pragmatically useful because it enables the identification of well-defined variables that can be easily tackled and turned into design solutions, also allowing for the precise measurement of the successfulness of the intervention (e.g., whether the number of smoked cigarettes has been decreased or not). It is worth noticing that such an approach to behavior change has brought successes [e.g., Hamari et al. 2014; Hermesen et al. 2016; Orji and Moffatt 2018]. However, over the years, an increasing number of studies have also started questioning the capability of technologies grounded in this perspective to produce enduring changes in behavior and sustain the user engagement during the intervention [Caraban et al. 2019; Baumesteir et al. 1994; Agapie et al. 2016a; Kovacs et al. 2021; Egebark and Ekström 2016; Caraban et al. 2019].

It may be useful, therefore, to start exploring an alternative approach that, rather than paying attention exclusively to the behavior, may extend our perspective to the wider individual’s life, diving into the subjective and “existential” aspects of the behavior change process. With the term “existential” we refer to existentialism and existential psychology tradition pointing to certain fundamental concerns that are an inescapable part of the human being’s existence in the world, like our intrinsic finitude and frailty, the difficulty of knowing and being known by others, and the need of being authentic [Kaptelinen 2018].

To this aim, in this article, we investigate how people deal with behavior change using technology, embedding the “behavior change issue” into the person’s “life.” Building upon research framed within the so-called third HCI wave [Bødker 2006] or paradigm [Harrison et al. 2007] and responding to the recent call to tackle existential issues in HCI [Kaptelinen 2018], we interviewed 23 individuals that used a behavior change system to modify their own behavior, exploring their lived experience: through semi-structured interviews, we investigated how participants connected their experiences of change through technology to their existential concerns and the life-context in which they occurred. By framing our investigation in this perspective, we hypothesize that different aspects of behavior change would emerge, which, in turn, might enrich the design of systems for modifying behavior.

In sum, we will try to answer questions like: How do individuals experience and account for the changes that they want to produce in their own behavior? How do technologies used to address

¹Although it is common to talk about both persuasive and behavior change technologies within HCI, from now on we will use the latter, following Hekler et al. (2013), as the former risks exclusively evoking the Fogg behavioral model (Fogg, 2009).

behavioral matters connect to the wider aspects of people's life? What lesson can we draw from people's behavior change experiences to the design of novel behavior change technologies?

Our contribution to the HCI community aims to be threefold. First, starting from the findings of 23 interviews we surface some tentative themes that might be relevant to understanding how behavior change is lived and accounted for by people, as well as how technology use is embedded in their everyday life. Second, we preliminarily define a behavior change model that puts in the foreground the internal and existential aspects of change. Third, we identify barriers that may prevent the successful accomplishment of the process of behavior change and propose some design suggestions to overcome them.

2 BACKGROUND

2.1 The Dominant Perspective on Behavior Change

HCI behavior change research commonly draws on cognitive or behavioral theories to make decisions about design. In the last decade, a variety of systems have been developed informed by, for example, the Social Cognitive Theory, which posits that change is affected by expectations about the outcomes of behavior and efficacy expectations, or self-efficacy, that is the belief in one's own ability to achieve a given goal [Bandura 1986]; the goal-setting theory, which highlights a positive linear relation between degrees of goal difficulty and levels of performance [Strecher et al. 1995]; the **Health Belief Model (HBM)** [Rosal and Bodenlos 2009] or the Theory of Planned Behavior [TPB] [Ajzen 1991], which both emphasize the role of beliefs and intentions in guiding human behavior; behaviorism, which sees behavior as the byproduct of stimulus–response pairs formed outside conscious decision-making, whereby mental entities are considered unobservable and thus falling outside the terrain of science [Skinner 1938]; the **Transtheoretical Model (TTM)** of behavior change, which describes behavior change as a linear process made up of six different stages through which a person progresses [Prochaska and Velicer 1997]; or the Fogg behavioral model, a set of ad-hoc behavioral strategies that computers may use to change people's behavior [Fogg 2009].

By and large, current behavior change designs based on this kind of theories emphasize either the role of reflection and rational processing as the means to produce behavior change [e.g., Ploderer et al. 2012; Halttu and Oinas-Kukkonen 2017; Saksono et al. 2019], or the automatic, mindless effects that technology may elicit through behavioral cues and nudging mechanisms [e.g., Adams et al. 2015; Pinder 2017; Caraban et al. 2019].

The former approach is supported by the growing amount of behavioral data (like the number of steps taken) made available by self-tracking devices and is based on the assumptions that people lack self-awareness of their own behavior and that gaining more “self-knowledge” may entail a change in the individual [Rapp and Tirassa 2017]. The personal informatics model proposed by Li et al. [2010], for instance, mirrors the TTM and illustrates different stages through which people transition when using a self-tracking tool. The process culminates in the reflection stage, when the person consciously reflects on her own data, and the action stage, when she enacts a behavioral change on the basis of the newfound understanding of herself. Applications exploiting behavioral data may not only promote reflection on the past [Kersten-van Dijk et al. 2017], but also help users envision how such data will evolve in the future to encourage them to take action in the present [Rho et al. 2017; Lee et al. 2020]. Likewise, systems grounded on Social Cognitive Theory tend to rely on conscious, rational processing of behavior change intentions and outcome expectancies [Pinder et al. 2018; Rabbi et al. 2015].

The mindless approach, instead, mainly refers to behaviorism and behavioral economics, which either exploit “environmental cues” that may reinforce certain behavioral emissions [e.g., Villamarín-Salomón and Brustoloni 2010], or introduce subtle changes in the way that choices and

information are presented with the goal of guiding users toward desired behaviors [e.g., Caraban et al. 2019]. For instance, systems grounded on Applied Behavior Analysis, which represents the contemporary version of behaviorism [Cooper et al. 2007], conceive behavior as the product of operant conditioning, i.e., the pairing of a behavioral emission with a positive reinforcement for increasing the future emissions of a wanted response, or with a punishment for decreasing the future emission of an unwanted one, whereby a key determinant of the intervention is how and when the reinforcements and punishments are delivered [e.g., Nakajima et al. 2008; Rabbi et al. 2017]. Behavioral economics, instead, relies on the notion of nudging, that is any aspect of the choice architecture that alters people's behavior in a predictable way [Thaler and Sustein 2008]: technologies based on this approach leverage people's heuristics (i.e., mental shortcuts) and biases (i.e., systematic deviations from rational judgment) to yield change in their behavior [e.g., Lee et al. 2011; Gunaratne and Nov 2015].

The interesting thing is that most of the HCI work based on these theories [e.g., Peng 2009; Pathmanathan et al. 2011; Thieme et al. 2012; Yun and Arriaga 2013; Macvean and Robertson 2013; Meyer et al. 2016; Chaudhry et al. 2016; West et al. 2017; Kim et al. 2019; Oyebode et al. 2021] share a sort of "behavioral model of change," which sees behavior as an objective and punctual phenomenon that can be observed and acted upon from the outside, and its modification as a surgical intervention that can be almost exclusively addressed to the target behavior. Here, behavior change is conceived as a discrete and isolated event, which can be spatially and temporally circumscribed. Rapp et al. [2019] pinpointed that this model may cloud the subjective experience of change. In this sense, the wider aspects of the individual's life in which the behavior is embedded, such as personal experiences and existential concerns, are not considered in the technological intervention.

This conception is shared not only by behavior change designs embracing explicitly the idea that behavior is the only thing that matters in an intervention, like those based on behavioristic approaches, but also by technologies that give importance to cognition and (self-)reflection. Personal informatics systems, for instance, often only apparently give value to the interiority of the individual: rather, they mostly focus on a "self as a database," that is a conglomerate of quantifiable behavioral data collected by self-tracking devices [Schüll 2016]. Here, importance may be given to personal data meant as objective traces of the user's behavior, which can be used to produce behavioral changes through processes that are almost automatic [Rapp and Tirassa 2017]: by exploiting, for instance, the reactive effects of technology, that is the phenomenon whereby the very process of recording a behavior causes that behavior to change [Kanfer 1977]; or self-regulation [Bandura 1991] and feedback loop [Ruckenstein and Pantzar 2017] mechanisms, in which change is meant to happen when a behavior that is being monitored is compared to a standard or goal, as if it were a thermostat tending to homeostasis.

The behavioral model also grounds those designs based on a "pick-and-mix" approach, namely those systems that use different theories or constructs together [Hekler et al. 2013; Pinder et al. 2018]: we might say that it is precisely this common "ground" that makes it possible to combine diverse "pieces" coming from different theories. For instance, similarities across these kinds of theories allowed researchers to integrate the TTM, Li et al.'s model, and the theory of planned behavior into an HCI integrated model for multifaceted behavior change [Grevet and Mynatt 2011].

In fact, the behavioral model is revealed in how behavior change technologies are commonly evaluated: the ideal instruments to assess the effectiveness of a technology-based behavioral intervention allegedly are large quantitative studies, such as Randomized Controlled Trials [Klasnja et al. 2011], which are supposed to provide an exact measure of the quantity of change that has occurred in the target behavior (and only in that). How the person "lived" the change, instead, usually falls outside the scope of this kind of evaluation.

To summarize, it appears that most current behavior change systems use existing behavior change theories to focus on a target behavior, conceived as an externally observable and objective phenomenon. This perspective allows researchers to identify relevant variables that can be directly tackled by design and punctually evaluated through quantitative studies, excluding from the intervention any “disturbing factor” that can shift the attention from the external manifestations of the behavior: in this perspective, internal aspects of behavior change, such as the existential issues that are connected to the behavior to be changed, or the life context in which behavior change occurs, are not considered relevant.

We recognize that the behavioral model has its merits, as in many situations modifying the external manifestation of a specific behavior is what is really needed, in particular when that behavior must be rapidly changed because it can cause harm to the individual. This is also what people may seek in technology-based interventions, for example, because they do not want to undergo a deeper modification of their life. Nonetheless, in many cases, behavior change may reveal greater complexity, involving a variety of internal aspects that pertain to the individual’s “life.” An internal take on behavior change, therefore, may integrate and develop what has been done in HCI under the behavioral model.

2.2 Alternative Takes of Behavior Change

The behavioral model of change has been challenged by different perspectives outside HCI. The focus on singular behaviors, for instance, has been critiqued on the account that the psychological states underlying such behaviors are characterizable only in terms of their relations to each other [Putnam 1964; Searle 1983], so that even behaviors cannot be isolated. Likewise, the idea that behavior can be studied without considering the internal processes of the individual has been opposed by the idea that the same behavior can be the byproduct of different psychological states [Lewis 1994]. Consequently, other models of behavior change have been proposed, such as the social ecological model [Sallis et al. 2008], which identifies different factors affecting behavior change, from culture to biology.

Within HCI, the behavioral model has been questioned with reference to its effectiveness. It has been noticed that individuals using behavior change systems may quickly relapse to their old habits once the technological intervention is withdrawn [Caraban et al. 2019]. Moreover, they may become disengaged from the intervention and rapidly abandon the usage of these systems [Lazar et al. 2015; Rapp and Cena 2016; Rapp et al. 2018]. People may further feel a lack of agency in the implementation of the behavioral program or may feel as though the program is not relevant to their individual needs [Lee et al. 2017]. Ethical concerns have also been raised regarding the prescriptive approach of these technologies [Baumer et al. 2012].

Moreover, the theoretical assumptions behind the behavioral model have been criticized by a variety of HCI researchers. For instance, it has been noticed that the behavioral model adopts a static view of the individual and does not account for changes in her internal states [Clawson et al. 2015]; that it rests on the assumption that people are rational agents using the information to maximize the utility of their actions, bracketing the environment in which they live [Brynjarsdóttir et al. 2012]; that it narrows the vision of behavioral interventions by focusing on the final destination, instead of the journey [Rapp 2019]; that it frames the individual as an executor of pre-defined behavioral programs, enforcing sublimated social goals [Purpura et al. 2011].

However, even though several HCI researchers have argued against the behavioral approach, the behavioral model still appears to be hegemonic in the behavior change system domain. Recent systematic reviews pointed out that the HBM, the TTM, the SCT, the goal-setting theory and the Fogg behavioral model are the most used theoretical frameworks in the HCI behavior change field [DiSalvo et al. 2010; Stowell et al. 2018; Orji and Moffatt 2018; Pinder et al. 2018].

Despite its dominance, HCI researchers also explored alternate approaches to be applied to behavior change system design, such as the social practice theories [Schatzki 2001; Rapp et al. 2017], which widen the perspective to the social practice in which people’s behaviors are situated. Moreover, in the field of personal informatics, there are several examples of how the behavioral model has been challenged by theoretical approaches that go beyond quantification and rational analysis of behavior [Rapp and Tirassa 2017; Rapp 2023]. Epstein et al. [2015], for instance, proposed a lived informatics model of personal informatics, which accounts for the different motives for self-tracking, like social engagement and curiosity regarding data and habits. Likewise, Murnane et al. [2018] use the Ecological Systems Theory to propose a model that considers the person’s relationships and the broader sociocultural context in which self-tracking is enacted. In the same vein, the tracker goal evolution model [Niess and Woźniak 2018] emphasizes the longitudinal experience of tracking, whereby a tracking goal stems from hedonic and eudaimonic needs, which are first manifested in qualitative goals, and then turned into quantitative goals that can be used in a tracker. Rapp and Tirassa [2017] presented a theory of the self based on the phenomenological and constructivist traditions, which aimed to move the self-tracking discourse from behavior and its objective data to the self and its subjective meanings.

Empirically-driven research also highlighted different aspects of behavior change process and behavioral data analysis. Rooksby et al. [2014] pointed out that there exist different styles of tracking, like documentary tracking and fetishized tracking, tying the tracking activity to people’s lives, worries, hopes, and interests. In a similar way, Rutjes et al. [2019] investigated the health coaches’ perspective on behavior change, stating that technology puts too much emphasis on behavioral information: instead, coaches report that often there is a more profound problem underlying a stated behavior change goal and that it is needed to capture contextual information and the lived experience of the client for a successful intervention. Likewise, Bhattacharya et al. [2017] interviewed providers with diverse experiences in smoking cessation counseling, finding that they consider essential understanding the care and social context in which the intervention occurs. A focus on context is also present in Bhattacharya et al.’s [2018] work, where they notice that people’s pivotal experiences in making progress toward behavior change may be triggered by conjunctures, like negative health events and support coming from other individuals. The role of “others” is also investigated by Agapie et al. [2016b, 2018], who explored the usefulness for the person of behavior change plans generated with friends or crowds and discovered that people are more likely to follow plans that fit with their lives and lifestyle.

All these works have somehow pointed to the broader context beyond behavior and the data that represent it, as well as to a longitudinal perspective on behavior change. However, they did not explore specifically and in depth how life circumstances and the evolution of the course of life may impact on the process of behavior change. In the same vein, Rapp et al. [2019] argued for an alternative take on behavior change, by looking at how individuals experience “important changes” in their everyday life. They found that “change” has multiple meanings and implies the individual’s agency. Moreover, it is holistic and continuous, so that it connects with different life domains and usually lacks normative sequences. This work points out an alternative perspective on “change” suggesting that it is applied to the design of behavior change technologies. Nonetheless, the authors did not investigate how people use technology in the process of change. Moreover, the authors preferred to focus on how “general change” (common features in e.g., relationship, location, activity changes) unfolds rather than on behavior change: only a few participants reported changes in habits or behavior and none of them were studied in relation to technology support. The possibility of applying their findings to the behavior change technologies field thus remained an intriguing hypothesis in search of further confirmation.

We then decided to build upon this previous work by focusing on the lived experience of people trying to change their own behavior: we considered participants using at least one behavior change system and shifted the focus of the investigation from the target behavior to be changed to the wider life context in which the behavior change attempts were embedded. In so doing, we also responded to the recent call for adopting an existential perspective in HCI [Kaptelinin 2018], looking at behavior change as a matter that intertwines with relevant existential issues. With the term “existential issues” (or matters, or concerns) we mean *all those aspects of life that are connected with what fundamentally means to be a human, being an inescapable part of the human being’s existence in the world*. These issues are pointed out in the tradition of existential philosophy [Kierkegaard 2000; Heidegger 1927/1990; Sartre 1993] and psychology [Yalom 1980; Pyszczynski et al. 2010; Greenberg et al. 2014] and relate, for example, to our freedom of choice (and thus the responsibility of controlling the “direction” that our life takes); the urgency of giving sense to ourselves and the world (and thus to face meaninglessness and void); our intrinsic frailty and finitude (and thus the possibility of being “harmed” and the inevitability of death); the difficulty of knowing and being known by others (and thus the possibility of being alone); and the need to be authentic (and thus being true to myself) [Kaptelinin 2018].

Moreover, we align with a phenomenological perspective that puts in the foreground the subjective experience of the individual. Phenomenology is a philosophical and psychological paradigm that investigates phenomena as they are given in our everyday life world [Fallman 2003], embracing the first-person perspective that characterizes the natural way through which we experience ourselves and the world. In such a perspective, great attention is given to subjective meanings and how they are actively constructed by the individual [Husserl 1977; Heidegger 1982; Gallagher and Zahavi 2020]. The phenomenological take has been widely used in HCI [Dourish 2001; Svanæs 2013; Rapp and Tirassa 2017; Rapp 2018] because it represents an optimal frame for understanding how individuals make sense of their own existence [Frauenberger et al. 2010], allowing for the exploration of phenomena within the individual’s universe of sense. For this, it connects to the rise of the third wave/paradigm of HCI, which shifted attention from the cognitive and behavioral aspects of interaction to the lived experience [Bødker 2006], valuing the way in which we come to understand the world [Harrison, Tatar, and Sengers 2007].

3 METHOD

3.1 Participants

We recruited 23 participants (mean age = 35.5; females = 9) through e-mails and snowball sampling. The e-mail recruiting message contained a brief description of the study and the method used (qualitative interviews), inviting anyone who had used technology to change a behavior in the last year to participate (*if you would like to participate in this study and have tried to change a behavior of yours with the help of technology (e.g., an app, wearable device) in the past year, please respond to this e-mail*). All the participants were Italian. Inclusion criteria were that the participants had tried to change at least one specific behavior in the last year using at least one technological instrument (either an app or a physical device like a wearable) to support the behavior modification. To establish whether the participants were trying to change a behavior and used technology as a support to modify it we relied on their explicit accounts and conceptualizations reported in a preliminary phone interview. In other words, we considered fulfilled the inclusion criteria if the participants appraised their experience as a behavior change attempt and stated that they used technology to this aim. For instance, we excluded those participants that reported that they were monitoring a behavior to e.g., understand how much they walked during a day, without them considering this practice as a behavior change endeavor. However, we included participants who

initially started tracking for a non-behavior change goal, for example, out of curiosity, and then found in the tracker an opportunity to change their own behavior.

We mainly focused on health-related behavior change, as we wanted to have a sufficiently homogeneous phenomenon to investigate: this would have allowed us to identify patterns across the experiences, as well as diversities in accounting, living, and managing an apparently similar episode of change. In so doing, we privileged participants that attempted to address physical exercising and dieting, as these two target behaviors appear among the most tackled behaviors in health behavior change technology domain [Wang et al. 2019; Orji and Moffatt 2018]. However, we also included participants trying to modify different health-related behaviors, like quitting smoking, modifying sexual behavior for getting pregnant, starting meditating for increasing psychological wellness, and quitting alcohol consumption, in order to increase the heterogeneity of the sample and the generalizability of the findings [Gobo 2008]. Finally, we included one participant that attempted to change a non-health-related behavior, that is saving money, as an outlier, to investigate behavior change dynamics in a heterogeneous domain. Table 1 provides further details about the sample composition. All the participants had a smartphone, and some of them owned a wearable device (or more than one). Three participants had a chronic health condition (i.e., osteoporosis, fibromyalgia, endometriosis).

We aligned the sample size with the common practices in qualitative research (Marshall et al. 2013] and with other HCI studies with similar designs and purposes [e.g., Rooksby et al. 2014; Lazar et al. 2015]. However, our sample followed the theoretical saturation principle first recommended by Glaser and Strauss [2010]: in other words, the decision of settling for 23 participants came when we realized that additional data would not have produced substantial new results for the aims of our study, following a data saturation criterion [Bowen 2008].

3.2 Procedure

The interviews lasted between 90 and 120 minutes. Six interviews were conducted in person, while 17 were conducted through Skype, due to the restrictions imposed by the COVID-19 pandemic. The main goal of the study was to gain insights on how people experience and make sense of their attempts to change behavior through technology from their own point of view. Each interview started in a very open-ended way, by asking participants to describe the behavior change attempts that they considered important in their life, starting from the most recent one. This open-ended approach entailed long narratives as participants recounted relevant changes during the interview. This is similar to approaches by Elsdén et al. [2016], who asked people to recount “what their data is about” in the field of personal informatics. We deliberately did not propose a definition of “behavior change” to leave the participants free to choose what they considered relevant and recount it in the manner they considered appropriate, based on their own idea of “behavior” and “change.” If needed, the participants were invited to go more in depth into the changes they had reported. The asked questions were as follows: *Why did you mention these kinds of changes? Why are they important to you? Can you describe any aspects that you consider relevant in relation to these attempts of change? How is/was your life when you attempted to change behavior?*

In the second part of the interview, we asked participants to focus on the technologies they used to receive support in their endeavors. We asked them: *Why did you use a technological support? How did you use it? What was its role?*

The participants were free to add themes that were not included in the initial list of questions, and when necessary, they were prompted to further enrich or clarify their recounts with examples taken from their personal histories. Participants were not compensated for their participation. Each interview was audio recorded and then transcribed verbatim for subsequent analysis. The ethical board of our university approved the study.

Table 1. Sample

ID	Gender	Age	Profession	Education level	Target behavior(s)	Instrument(s) used	Period of use of technology
U1	F	32	Employee	Master's degree	Sexual activity	Flow	5 months
U2	M	29	Employee	Master's degree	Physical activity	Push Ups: 100 pushups trainer; Mi Fit	1 month (Push Ups: 100 pushups trainer); 3 months (Mi Fit)
U3	M	32	Sport reporter	Bachelor's degree	Physical activity, dieting	La mia dieta; Nike Training Club: workout	1 month (both the apps)
U4	M	28	Employee	Master's degree	Smoking	My Last Cigarette	4 months
U5	M	32	Employee	Master's degree	Physical activity	Strava	3-4 years
U6	F	60	Retiree	High School Diploma	Physical activity	Health (iPhone app)	3-4 years
U7	M	32	Air force pilot	Military Academy	Dieting	Macros	1 year
U8	M	33	Lawyer	Master's degree	Meditation	Serenity	2 months
U9	F	42	Free lance	Master's degree	Physical activity, dieting	Lifesum	1 month
U10	M	32	Restaurant owner	High School Diploma	Drinking alcohol, dieting	Samsung Health	2 years
U11	M	41	Employee	High School Diploma	Physical activity, dieting	Health (iPhone app); Apple Watch	2 years
U12	M	47	Employee	Master's degree	Physical activity	Mi Fit, Fitbit	Mi Fit (1 month and a half), Fitbit (6 months)
U13	F	25	Nurse	Bachelor's degree	Physical activity	Fitness (iPhone app); Apple Watch	4 months
U14	F	32	Employee	Master's degree	Physical activity, meditation	Samsung Health; Runtastic; Mrs. Sporty; FitHomeless; Serenity	At different times during a 5-year period
U15	M	33	Employee	High School Diploma	Physical activity	Mi Fit; Apple Watch; Nike Training Club: workout	6 months (Mi Fit); 3 years (Apple Watch); 3 weeks (Nike Training Club: workout)
U16	F	46	Manager	Master's degree	Physical activity	Fitbit	4 years
U17	F	32	Personal Trainer	High School Diploma	Physical activity, dieting	Fitbit, Lifesum	2 years (irregularly)
U18	M	28	Employee	Middle school	Physical activity	Fitbit	5 months
U19	F	35	University student	Hotel School Diploma	Physical activity, dieting	Fitbit	4 years
U20	M	34	Employee	Master's degree	Physical activity, dieting	Fastic; Lifesum; Nike Run Club; Nike Training Club: workout	1 week (Fastic); 1 week (Lifesum); 1 month (Nike Run Club; Nike Training Club: workout)
U21	F	34	Employee	Master's degree	Physical activity, dieting	Lifesum; Fat Secret; MyFitnessPal	2 months in the first phase; 1 month in the second phase (All the apps)
U22	M	26	Free lance	High School Diploma	Saving money	Wallet	1 year
U23	M	52	University Professor	PhD	Smoking, dieting	Kwit, MyFitnessPal	1 month (both the apps)

3.3 Data Analysis

The data were analyzed with an **Interpretative Phenomenological Analysis (IPA)** approach [Smith and Shinebourne 2012]. Differently, from other methods used for data analysis like Grounded Theory [Glaser and Strauss 2010], IPA values more individual idiosyncrasies, subjective meanings, and personal histories, and fits better the purpose of understanding people's sense-making, investigating each participant's perceptions of what is important in relation to the phenomenon under study. Although the analysis first focused on each participant's personal recount, it yielded a set of thematic codes, identifying patterns across the behavior changes reported by the participants. The analysis was conducted inductively. In line with the approach that we adopted, we paid particular attention to how the participants subjectively appraised the phenomenon under investigation.

In particular, the first and the second authors first familiarized themselves with the data, independently reading through the entire data set twice. Then, data were coded independently by them, who defined the initial codes, by identifying data features that they considered relevant, breaking the data down into separate parts, and labeling them. At this stage, we were seeking elements that could account for the nature of the behavior change from a subjective point of view: we attempted to treat each case on its own terms, to do justice to its own individuality, bracketing, as far as was possible, the ideas emerging from the analysis of the previous case while working on the subsequent one [Smith and Shinebourne 2012]. This procedure is different from methods like Grounded Theory, where the coder may seek similarities and differences across the interviews from the very beginning of the analysis. We paid particular attention to how the participants related their behavior change attempts to personal meanings, concerns, and experiences, focusing on how they conceptualized and lived the experience of change. We also looked at how technology was used in their everyday life, what meanings the participants ascribed to it, and the role that it had in both their everydayness and in relation to the behavior to be modified. Once all the cases were initially analyzed, we looked at patterns across cases which led to a reconfiguring and relabeling of codes.

Then, the two authors reviewed the generated codes and their application to assess consistency [MacQueen et al. 1998; McDonald et al. 2019]. This process entailed a constant comparison between the codes developed by the two researchers. Several inconsistencies were related to discrepancies in labeling the same concepts. In other cases, two codes were condensed into one or new codes were developed, when the discussion between the two researchers led to identify clearer similarities or differences among the meanings of the data points. This process went through the whole data set. As is common in qualitative research adopting an interpretative approach [e.g., Yardley 2000; Harry et al. 2005; Brown and Clark 2013] as well as within HCI [e.g., Jun et al. 2018; Yang and Neustaedter 2018], no numerical reliability rating is reported, because our goal was to reach an intersubjective consensus, where each point of difference was debated and clarified until the coders agreed on appropriate usage of the set of codes [Harry et al. 2005].

In total, 96 initial open codes were identified. Then, the two researchers developed axial codes independently by grouping the open codes into key categories reflecting the main features of the behavioral changes highlighted by the participants. Such codes were then compared again to solve inconsistencies. This yielded 17 axial codes. Axial coding categories from open coding were then amalgamated to create a more defined hierarchy forming key-related categories. The resultant four selective codes correspond to the central themes emerging from the answers to our interviews.

4 FINDINGS

We recount four tentative themes emerging from the analysis of the collected data, that is meaning, life circumstances, life course, and successfulness. We first highlight that the participants always

Table 2. Key Findings

Theme	Behavior change features	Technology use	Barriers/Risks	Design Implications
Meaning	<ul style="list-style-type: none"> - Behavior change points to meanings that refer to personal and existential matters - "Identical" behavior may be connected to very different meanings and existential issues - Different behaviors may be retraced to the same meanings and existential concerns - Sense-making activities impact on how behavior change is managed 	<ul style="list-style-type: none"> - Used technology does not intentionally drive the process of meaning construction - Used technology may trigger sense-making but is often not able to sustain it over time 	<ul style="list-style-type: none"> - People may not find the right meanings that make the behavior change effort worthy of being pursued - People may not develop knowledge to sustain the behavior change effort over time 	<ul style="list-style-type: none"> - Support sense-making using conversational agents or "existential" video games - Provide explanations about the behavior change recommendations and intimate virtual spaces
Life circumstances	<ul style="list-style-type: none"> - Changing behavior is connected with a nexus of life circumstances - The starting or the ending of a behavior change attempt is often tied to "favorable" conjunctures - Life circumstances affect how the process of change is perceived and managed 	<ul style="list-style-type: none"> - Technology use is tied to the life conditions occurring in the individual's life - Used technology focuses on the target behavior cutting off its links to life aspects 	<ul style="list-style-type: none"> - People may bump into life circumstances that hinder the process of change 	<ul style="list-style-type: none"> - Widen the focus of the intervention to the context in which the behavior change process takes place
Life course	<ul style="list-style-type: none"> - Behavior change unfolds over long periods of time - Present attempts may have roots in the individual's distant past and be projected into an imagined far future - Behavior change may evolve over different "phases of life", in which the meanings ascribed to change may vary 	<ul style="list-style-type: none"> - Technology use may change over time - Technology use often occurs when the behavior change process is already started - Used technology focuses on present behaviors 	<ul style="list-style-type: none"> - People may find it difficult to integrate their present behavior change attempts with their own "temporality" 	<ul style="list-style-type: none"> - Support people in reflecting on their own past and in envisioning their own future
Successfulness	<ul style="list-style-type: none"> - The successfulness of a behavior change attempt can be connected to the individual's existential issues 	<ul style="list-style-type: none"> - Technology may be appropriated by the participants - Technology may produce double-edged effects 	<ul style="list-style-type: none"> - People may become dependent on technology 	<ul style="list-style-type: none"> - Support the individual's proactivity

connected the target behavior and the process of change to meanings that have a personal and existential value to them: in this sense, sense-making is an important part of the process of behavior change. However, participants also noticed that the technology they used was rarely able to support the construction of meaning, more often leaving them alone in developing the right knowledge for producing an enduring change.

Then, we report that the participants stressed that their endeavors in changing behavior were always intertwined with a nexus of life circumstances, which were fundamental in determining the beginning, the evolution, and the end of a behavioral change. Nonetheless, in their eyes, the technology they used focused almost exclusively on the target behavior, being often not able to acknowledge the life circumstances characterizing their everydayness, as well as to provide a rich experience that may connect the behavioral change to a wider "lifeworld."

Subsequently, we emphasize that the participants perceived the temporality of behavior change as blurred and extremely long, possibly lasting for the whole life course. While the behavior change process may have roots in the individual's distant past and be projected far into the future, the used technology appears to focus mostly on the present behavior.

Finally, we underline that in the participants' perspective, the successfulness of the behavior change attempts may not be related to the target behavior, being connected to the existential problems that they try to face in their daily life. In fact, when a behavior is successfully modified with the help of technology, undesired side effects may also emerge. Table 2 provides a snapshot of the main findings of the study.

4.1 Meaning

4.1.1 Changing Behavior is Always Meaningful. For all the participants, changing behavior is not an achievement that is merely important per se. When describing their behavior change experiences, they highlight that both the behavior and the process of change are tied to matters that have a personal, and often existential, value to them. In their recounts, behavior change always points to additional meanings that are rooted in their internal dynamics and intimate life. U4, for instance, emphasizes that smoking cigarettes is a kind of resource that he has for facing stressful moments in his life. It is something that can be traced back to his infancy and linked to the *maternal sucking or the feeding bottle*, which gives him a sense of security and protection. At the same time, however, smoking is also experienced as conflicting, because it can take over in difficult times making him feel not in control of his life: *I had a turbulent emotional phase that ended in March, and I had 5 days when I smoked like an obsessive*. Interestingly, also the act of changing behavior is thought of as a resource that he has at his disposal to manage difficult life moments. He explains that at certain times he tried to quit smoking right after an unpleasant episode happened in his life. However, these attempts were not really addressed to the modification of the behavior. Rather, they were a means to keep himself busy and regain control, like a coping strategy that, although not decisive, could postpone the time when he would have to deal with his existential issues, like the deep dissatisfaction with his sentimental relationship, which made him feel alone: *at that moment I wanted to stifle certain thoughts or certain feelings, so focusing on something new, which requires an effort, a lot of mental effort... focusing on something like that could be a way to silence certain thoughts or feelings*. In his perspective, therefore, both the behavior and the process of change have meanings that are linked to the existential concerns that he came to experience in his daily life.

Being behavior change so heavily meaning-laden, it comes as no surprise that the very same behavior to be changed can be associated with extremely different meanings by different participants. U5, for example, stresses that trying to make more physical activity has a fundamental “embodied meaning for him,” which ultimately refers to a physical sensation and a feeling of pleasure: *then there was a brief moment of total emptying and I realized that it made me feel good in that period [...]. It was always a difficult thing to achieve, because, as time went by, I was more and more trained and paradoxically it was more difficult to reach that state [...]. It's really a matter of experiencing the sensations that physical activity can give you*. Differently, U18 highlights that for him doing more physical activity is a way to *improve himself*, as he strongly intertwines physical fitness to his intimate self: trying to have a better body shape through trials and errors reflects his attempts to understand where he is going wrong in his life in order to *become a better person*. Instead, U6 links physical activity to a duty that she has to fulfill and, at the same time, to a struggle rooted in the fundamental laziness that characterizes her personality, which often prevents her from being committed to the process of change. However, later in the interview, it turns out that such laziness is connected to an underlying fear of moving coming from her distant past, thus being more pressing than a simple inclination of her character. Doing or not doing physical activity, for her, is tied to the frailty of the existence and the worry of being harmed, which accompanied her throughout her life: *Because of my hip problems at birth, so for protection I could not do many things... so even my education from my parents and my infancy was pervaded by this problem and was related to the fear that I could hurt myself*.

Conversely, heterogeneous behaviors to be changed may undergo similar processes of sense-making, because they respond to the need to fix the same existential matters, like the desire to control life, the fear of pain and death, the willingness to please others, or the need to feel safe. U9, for example, specifies that *when I was a child, nutrition was managed by my family, but as I*

grew older, I began to become aware of my physical appearance and so this had to be managed by controlling my diet... for example, during high school I counted calories at certain times, but a more systematic control came later and was linked to a desire to manage my diet on my own, since I had never received a dietary education, everyone in my family was lazy and ate badly [...]. However, for me being thin and fit was above all a question of identity because as a child I was like that, and I didn't want to let myself go, be like my family. Later in her life, however, she shifted this desire of control also to other behaviors, which were more related to her physical health than her appearance, in a period when she perceived a wider perturbation in her life. For instance, she downloaded an app to give order to the aspects related to a chronic illness that she discovered to have, as she perceived not to be in control of the daily management of her medicines: *I'm trying this route and to get the disease a little bit more under control. Then, even the medications become part of those things that you keep under control.* This also resulted in attempts to change her overall lifestyle, doing more physical activity, eating better, changing her daily schedules and the social relationships that could jeopardize this desired regularity.

It is worth noticing that the complex sense-making activities carried out by the participants with reference to their own behavior are not merely post-hoc lifeless interpretations but directly impact on how they manage the change. In other words, their willingness to achieve the change, the evolution of the process of change, the sense of having succeeded or failed are deeply affected by the meanings that they construct. For instance, by connecting the target behavior to the negative experiences lived in her infancy, U6 still sees physical activity as a potential harm to her own body, inducing ambivalent attitudes toward the change itself. For her, the underlying fear of re-experiencing the past is still a barrier to fully achieve the desired change, inducing her to find justifications for not increasing her daily movements: *the time is employed in studying, working, my parents, my daughter. As I have to balance the forces, I choose maybe to sacrifice the gym.* In her eyes, changing how she looks at the target behavior would be the only way to yield an enduring change: however, this has not yet been achieved. Conversely, seeing the target behavior as a major means for self-improvement allows U18 to look at the increases of his daily physical activity as a bettering of his whole being, motivating him to persevere in the effort: *I still like the sofa, but if I can take a few more steps I prefer now [...] because you improve yourself... the improvements are in turn a push to reach the goal.*

In sum, behavior change does not merely point to the outside shell of the behavior. Rather, it intertwines with the subjective meanings that individuals build throughout their lives, making each process of change rather unique. Although from an external point of view certain behaviors (and the attempts to change them) may look identical, when explored in their internal dynamics, they may reveal the idiosyncratic senses with which they have been associated. By contrast, heterogeneous behaviors may undergo similar processes of sense-making, which may signal that their meaning lies deeper in the individual's intimate life and point to the same existential concerns. In any case, the sense-making activities that characterize behavior change deeply affect the process of change itself.

4.1.2 Technology is Not Always Meaningful. When recounting their experience with technology, most participants underline a fundamental lack of support for meaning making. U15, for example, explains: *[the app] provides raw data, superficial... the body gives you signals about you, about how you are facing 'your moment', it's like a set of lights in the car, if too many lights are turned on, then you ignore them, and the car doesn't work anymore, and the app gives you the lights, but the manual is missing, of what they mean.*

This is not to say, however, that the use of technology does not yield new meanings related to the target behavior or to the whole process of change. In certain cases, the participants did

modify their perception toward a particular behavior through the usage of a certain app or device. However, this looked more like the result of chance than the outcome of an active, deliberate, help provided by the used technology. In fact, the developed meanings were not always those hoped for by the participants. U1 recounts her attempts to change her sexual behavior with the aim of getting pregnant by using a mobile application. These endeavors obviously involved her partner and entailed profound transformations on the rhythms and “schedules” of their sexual activity. However, the constant tracking of the ovulation periods and the adjustments of intercourse to the suggestions provided by the system changed the way she looked at sex: *until now the frequency and intensity of intercourse were dictated by our tiredness, our commitments and the willingness to stay together... instead now they are strictly linked to my fertile period, so, on the one hand, I feel a bit sorry because they really seem to be dictated only by the achievement of a certain goal [...]. At this time, we have daily intercourse for that week of the month in which in theory I ovulate [displayed by the app] and so this intensity is not so much dictated by passion, or by the love that binds us [...], we do it anyway, but with another purpose that is not just to be together.* Here, technology reinforced the idea that sex could be treated as a means with a mere instrumental value, and this resulted in an overall worsening of the experience. The numbers referring to the “right days” and the suggestions on intercourse frequency prompted by the app superimposed new meanings on sexuality: from a moment of passion and intimacy with her partner, it became a matter of managing a mundane activity.

In certain cases, however, technology did allow participants to produce meanings supporting the process of change, making them more comfortable with and aware of their target behavior, as well as more willing to endure in their attempts to change. Nonetheless, this again does not appear purposefully driven by the technology: the systems used by the participants may casually trigger the individual’s sense-making, but then they are mostly incapable of supporting the person during the process. U3 explains that by means of an application for diet management he had the occasion to change his approach toward eating, from a mindlessly executed behavior to a conscious and careful day-to-day choice: *Yes, before and after the app it changed [...] before it was really what I liked, what inspired me the most... after it becomes thinking about the type of food, the variety, it’s a result of reasoning. [...] I started to check what and how much I was eating... then I became aware of the ethics behind food, the consumption of certain elements rather than others, the attention paid to the origins, the production of food, how much impact a food has, which are, however, the result of other information that I have sought on the subject.* Technology here only stimulated an initial transformation in how U3 looked at food. Then, the app was soon deleted, and he kept developing meanings on his own, autonomously searching for further information and adapting his behavior according to this new knowledge: in his eyes, the app did not help him in making more sense; rather, it sparked something in his mind, in a moment when he was open to consider an alternative perspective on food.

Likewise, U7 emphasizes that the mobile application that he used for dieting made him more aware of the calories contained in his daily intakes, which led him to take a more conscious approach toward food. He has been using the app for almost a year reporting how it enabled him to regulate his weight and see the food eaten in its constituents, like carbohydrates, fats, and sugars. Nevertheless, U7 also points out that when he downloaded the application, he had already started seeking information about dieting from other sources, and the usage of the app paired a process of knowledge building that he carried out autonomously. It was only the combination of this self-developed knowledge and the data displayed by the app that helped him keep the desired behavior over time, allowing him to take a *different approach to food... more conscious, in the sense of what I put in my body, in the sense of quantity, quality and type... [...] I know that now some things are bad for you, like sugar, that too many carbohydrates become fat, if you don’t exercise.* Therefore,

finding information and building knowledge around the behavior allowed these participants to better integrate their behavior change attempts into their overall personal goals, preexisting beliefs, and values, making them better understand whether the change was truly important to them and why. Gaining knowledge about the behavior and its “surroundings” also helped these participants interpret the data collected by technology in a more meaningful way, linking the numbers representing the behavior to the meanings that mattered to them.

Instead, when the participants did not proactively construct knowledge on their own, or when the meanings prompted by technology did not integrate well into the individual’s previous knowledge, data and suggestions displayed by the instrument mostly remained a dead letter. U13 explains that the application she uses to adopt a healthier lifestyle has never been able to turn her intentions into real actions: for her, the data collected by the app, like those related to the heartbeat, daily intakes, number of steps, are a mere source of curiosity, which nonetheless remain pointless for reaching her objective. U13 specifies that she does not have the willingness to autonomously undertake a process of sense-making that may transform how she sees herself and the target behaviors, and technology does nothing to support her in this endeavor. So, she is content with the micro-rewards that the app gives her from time to time (*From the app I see something, ‘oh my God I lost 100 calories this is beautiful’*), and this is the main reason why she keeps using it; but in the end, such gratifications do not really mean anything to her, because she cannot link the numbers displayed by the app to the meanings that really matter to her. Similarly, U4 stresses that the application that he uses to quit smoking has never been capable of changing the meanings he ascribes to the act of smoking itself: for him, smoking remains a tool that gives him protection and security, and technology could not modify this way of seeing things. This is also why, in his eyes, he is still smoking. U20 says that during the national lockdown due to the COVID-19 pandemic, his lifestyle became much more sedentary, so he decided to do more physical activity and regulate his daily food intake by downloading different apps. U20 was a sports person when he was younger, so that he already had background knowledge about the target behaviors he wanted to change. However, the numbers that the apps were proposing were not the “right meanings” for supporting him in the process of change, as they did not integrate with the knowledge he already had: *The food app makes me see food as macronutrients, because it talks about proteins, carbohydrates, lipids [...] so yes, the food as numbers [...]. I’ve never seen food as calories, I see it that way since I work out [...] the workout app, in my opinion, conveys a message of general wellbeing, because there are videos of healthy, fit people [...] it conveys a bit of an illusory message [...]. I don’t want to look like an Instagram model, also because I’ve done it, I know what it’s like, it’s an infamous life, I want to indulge in my glass of wine, my drunkenness with friends and dessert after dinner.* In this sense, while the apps gave him some suggestions on the exercises that he could do at home, he rejected the meanings that they conveyed as they could erase the pleasure that he was finding in food at that time, nor he developed new ones. As a result, as he says, he did not lose the weight that he wanted.

As behaviors are intertwined with meanings that pertain to the individual’s personal and existential matters, behavior change technologies may go beyond the fixing of a target behavior when used in practice. They may contribute to the sense-making activity that the person is enacting about the behavior that she wants to change. However, often such contribution appears not to be purposefully designed, rather being a product of chance. As a result, at times the meanings yielded by technology may not support the behavior change process. At other times, technology might indeed trigger the construction of useful meanings, but it should be accompanied with an activity of knowledge building that the person has to carry out by her own, which is needed to make her understand the reasons why change is important to herself and how it relates to her overall personal goals, beliefs, and values. When new sense is not constructed or the meanings proposed by the systems are not accepted, because they do not integrate with those that the person already holds,

the entire process of change may be jeopardized: in these cases, the technology may not become an effective and long-lasting support for modifying behavior.

4.2 Life Circumstances

4.2.1 Changing Behavior is Embedded in Life. The participants highlight that their endeavors in changing behavior are intertwined with a network of practices, routines, and relationships that eventually point to the complexity of their life. This is to say that, in their eyes, changing behavior is not a local event, but a process inserted into a nexus of life circumstances that directly affect the change itself. U23, for instance, recounts how his oscillations between quitting and restarting smoking were tied to the wider life context in which he was situated from time to time: *going for a drink, going out... it was easier to start smoking again. And then the important relationship in my life ended badly, a very stressful period at work, with the consequent difficulty in finding a new job. In short, there were months of great turmoil, and they favored the resumption of smoking [...] for a change like this, like quitting smoking, I need to be mentally stable. [...] with novelty it comes a series of things, adrenaline, desire to do things and this very neurotic, excited behavior, is linked to the cigarette. In those moments, for me to stop smoking is very complicated, compared to when I have stability.*

In fact, several participants stressed that the beginning of the processes of change was often linked to a “Kairos”, a term that for the Ancient Greeks indicated the experience of being in an opportune moment [Harrison and Cecchinato 2015], whereby not only they were predisposed to change, but also a number of favorable conjunctures had occurred in their lives. U8, for example, explains that he seriously started to put effort in caring for his mental wellness through meditation only during the summer, when he had more time for himself, and in the period right afterward when a variety of coincidences allowed him to persevere in such effort. He then started not only to use an application for meditation but also underwent a series of linked transformations, like reading books about mental wellness and spirituality and attending a yoga course: *this summer I had a lot of time at the beach in Greece [...] to devote to this thing trying to contribute a little bit to my well-being [...] Now it's due to the fact that the work I'm doing is lighter, I work from home, I'm here in a phase in which I feel a little bit more free to devote myself to myself [...]. Surely the gym membership sold to me by a neighbor has facilitated it [...] otherwise I would hardly have taken the initiative to go to a specialized center that deals with this type of practice. And then my mother, yes, she brought me, we do the course together.* Likewise, U10 stresses that it was only when he returned from holidays and had a break from his work, which was encouraging him to drink habitually, that he stopped drinking alcohol and started changing his lifestyle: *it is a moment that happens to you when you compare yourself at some point and you say, okay I exaggerated [...] I was on vacation with people who have known me for 10 years who love you and they say 'hey wait compared to 7 years ago, [...] you weigh 10 kg more.' Then, I was back from vacation in the summer [...] I was in XXX [name of the city] in August, there was no one around, the city was empty, and I said 'well, let's see if I can really stop drinking alcohol for a period after so many years.' Then, I downloaded the app and tried to manage the calories, 'ah okay so this thing has these calories, but I never thought about it,' I connected everything and then started.*

By contrast, unfavorable life circumstances may end a process of behavior change, as U3 points out with reference to his endeavors in doing more physical activity: *Then, it was around the summer, so then the routine changed, I went on vacation, I didn't have the routine I had before and that definitely contributed. It became more complicated for me because I was always moving, sometimes I was visiting friends etc., so having lost the routine, I stopped.*

The role of life circumstances, therefore, appears determinant in making participants either succeed or fail in their behavior change attempts. The participants' willingness and effort in starting

and persevering in the process of change is heavily influenced by the mundane matters of their everyday life, like working conditions, relationships with significant others, daily habits, particular periods that break the regularity of their routines, and so on. These are not ancillary details but are central parts of the process of behavior change. For the participants, behavior change is only an aspect that they have to manage in their life and needs to fit in between the many other activities and conditions that constitute their everydayness. In other words, most of the participants show that the relevance given to the target behavior and its transformation deeply depends on the life context in which it is “lived.” This is particularly visible in participants reporting how the COVID-19 national lockdown, which entailed a drastic change of their daily practices, impacted the process of change: for some of them, like U12, it has been a push for beginning a serious process of behavior change; for others, like U18, it erased the willingness to do any physical activity also increasing his alcohol consumption, and only when the lockdown completely ended, he found the right conditions to put effort in bettering his physical wellness.

The difference in outcomes of an apparently identical life event (the national lockdown) clearly shows that life conditions, at par of behavior change processes, are meaning-laden. For instance, for U12, who saw the lockdown as an opportunity to take more time for himself, behavior change was an effective means to testify this renewed focus on himself. Conversely, for U18, who perceived the lockdown as a moment of stress, behavior change could not be kept anymore: rather, losing control over behavior was seen as a strategy that helped him manage the pandemic crisis. When the crisis conditions ended, he returned to put efforts in doing physical activity.

4.2.2 Technology Use is Embedded in Life, but Mostly Targets only a Narrow Portion of it. In their recounts, the participants stressed that not only the behavior change process itself, but also the adoption of a certain technology for addressing the target behavior was obviously embedded in a wider life context, which conditioned the beginning, continuation, and end of the use of that device or application. U22, for instance, well explains that he downloaded an app for changing his spending behaviors only when other circumstances occurred, and that how he used the technology over time was affected by changes undergoing in other aspects of his life: *I was living alone, but before I wasn't 100% autonomous because I wasn't working... so it came in a moment of transition, of change or in any case of novelty, because I had just started working and I had to manage money [...]. [With the app] I realized that I spent so much on coffee, and at the bar, I spent on breakfast, then lunch and coffee, [...] so I started doing breakfast at home and preparing meals at home.* Then, U22 decided to change his job to have more money to spend. In that moment, the use of the technology was modified as well, as the need of saving was less pressing and new rhythms and constraints affected its usage: technology appeared not to be able to adapt to the new circumstances of his life and it was then abandoned. In this perspective, technology use may represent only a part of a wider nexus, as U8 stresses with reference to the meditation app: *downloading the application did not change my life, but it is a piece, and together with others it can change maybe half a day, but it is enough.* U8 connected the use of technology with the attendance of a meditation course and the reading of books and articles about spirituality, as well as an overall change of his life rhythms: *I know that in some way it can contribute and that it surely gives me a few minutes, maybe even a little more of well-being... trying to do it in compatible schedules [with work]. [The app] is a piece of the mosaic.*

Even though both behavior change and technology use appear deeply intertwined with “life,” many participants emphasize that the behavior change systems they used do not consider the links between the target behavior and the wider life circumstances. The focus of these technologies is on the behavior to be changed, cutting off every life aspect that is apparently distant from it. For a minority of participants, this is certainly a strength because what they seek is a local,

precise change and are not willing to undertake wider modifications of their life. Nonetheless, for a variety of participants, this narrow focus may be a reason for stopping using the technology, for considering it ineffective, or for seeing it only as a temporary substitute for more meaningful activities that are connected with a “lifeworld.” U2 well exemplifies how a technological instrument may provide an impoverished experience if compared to more meaningful alternatives. He used an application for doing more physical activity in a period when he was completely sedentary. However, after only one month he decided to stop using it. Then, after some other months, he returned to attend the pool to do water polo, as he was doing during high school: *While in water polo there is also a team game, the satisfaction of scoring a goal, the schemes, in short it is something that I like more. And it was a nice environment, I found guys I knew, friends, new people with whom I established a relationship. So, it was nice, just the moment you find yourself in the stands, laughing, joking, the moment after the shower. Yes, water polo helps to get you back in shape, but there was also the aspect of having the whole environment with your friends, while with this app you are alone at home [...], you do your laps, then you stop make a chat, then it happened to go out and go for a drink near there ... at the end you spice up the activity with other things.* For U2, water polo is a “tool” that he employs to change his behavior toward a healthier lifestyle but is much richer than the technology he used. Water polo is connected with a “lifeworld” made up of e.g., people, social practices, rewards, and routines that revolve around the target behavior although, apparently, they are not directly related to it: the willingness to persevere in the change, for U2, comes from this lifeworld, which, instead, is cut off by the app. A similar experience is reported by U5 who has been using an application for doing physical activity, which has then been abandoned as soon as he started climbing and doing martial arts: *the great thing about climbing is the whole context of when you go out and live your day, so it's not limited to physical activity.*

In sum, technology use is intertwined with the life circumstances that constitute the participants' everydayness and is deeply affected by them. However, the behavior change technologies employed by the participants mostly address only the target behavior, without considering the links between behavior change and the wider participants' life. As a result, for several participants, technology is a palliative that can only be used for a limited period of time: by targeting exclusively the behavior to be modified, it impoverishes the experience of change, which, instead, is seen as embedded in a whole lifeworld.

4.3 Life Course

4.3.1 Behavior Change Evolves Over Long Periods of Time. Changing behavior may result from a specific event that can be isolated in time, triggering the participants' willingness to undertake or put an end to their attempts to change. U19, for instance, recounts that it was a moderate but unexplainable weight gain and the concomitant upcoming marriage that pushed her to buy a wearable device and to start monitoring and doing more physical activity: *because I weighed less before, so not having changed my diet I couldn't understand why there was this sudden increase. [...]* *It was something that was going around in my head, 'why was I eating like before, but the weight wasn't going down?' so, I thought to start monitoring how much I was moving.*

However, in most cases, the process of behavior change cannot be circumscribed to well-defined boundaries, being rooted in the (even distant) past and projected toward the future, along a temporality that may point to different ages of the individual and even to her entire life course. This is even visible in those examples about the Kairos, which we reported in the previous subsection: although they refer to a precise moment in time when the behavior change process appears to begin thanks to favorable circumstances, on a closer look, their temporal dynamics are far more complex. For instance, U8 emphasizes that his decision to take more care of his mental well-being through meditation originated long before his present attempts, when he started attending

psychotherapy sessions: *the choice to address certain things arose 3 years ago and resulted in the start of this therapy. [...] This last year has been a little bit tougher, [...] a period when I have a stronger need to regain some serenity than two years ago.* Similarly, U9 highlights that efforts put in dieting and doing physical activity accompanied almost her entire life course and date back to her distant past, whereby the present endeavors, and the meanings that they bring along, deeply interact with the past ones: *For me, getting back into shape meant giving priority to a part of me, namely my physical appearance, and since in the past I was obsessed with it, that is, it was an important thing... but it still is, but it had been in a way that was perhaps not so healthy. I don't know, it was almost more a fear of going back to the old me, in the end, so it had been a sort of internal resistance, that is, I don't want to do what I did before, and before, exercising, dieting, all these things were quite an obsession. I used to spend a lot of time on them, but beyond time it was just a matter of needing to appear, to relate to others and so on, and as I began to see this as a weakness, over time I realized that it was almost negative, not so much the fact of getting back in shape, because if I could magically get back in shape tomorrow, of course, I would be happy, but the process needed to get there is a process made of efforts, it requires a certain obsessiveness, because you have to be regular.*

On the other hand, behavior change may be linked even to a distant, imagined, future, into which the participants may project the evolution of change. This future does not merely refer to the future achievement of an abstract goal, rather often entailing the envisioning of a “path” made up of expectations, barriers, and possibilities wired into the existential concerns that the person will likely encounter, a “rich scenario” in which the attempts of change are connected to new life conditions. U2, for instance, explains that soon after he decided to return to practicing water polo, it happened that he went through a moment of instability, often changing residence for work, and, for this, he had to stop attending the pool. In doing so, he started using the technology again: nonetheless, he projected the restarting of a “real” change into a quite distant future, imagining a moment when he could reach greater stability and find again the way to change his own behavior in a “proper way.” Similarly, U17 thinks of a future when she could resume her trainings, imagining what could happen in the next months and how she could regulate her life to restart exercising regularly: *Except for October, when I'm here to resolve some issues, in November I would like to return to training, but some things have changed, I don't work anymore... then the environment that was familiar before has changed, the management has changed [...], so I'm aware that I'll have to change the gym, the type of training, then those commitments that I have. [...] It won't be as before [...] The idea of transferring itself is not easy... when I was 20 I did it quietly, but at this age, if it is not the right thing, what should I do? And you may think that training could be the least of the problems.*

If behavior change may unfold over such long periods of time, it comes as no surprise that how the process of change is perceived and managed may be transformed as time goes by. Many participants stressed that the target behavior changed in their eyes as their personalities and life circumstances were modified over the years. U21, for instance, recounts how her attempts to regulate nutrition span across many years and different “phases of life”: when she was younger, she did not care about food, then she transitioned to an almost obsessive phase, and at present, she found herself in a more relaxed situation. She says that *my boyfriend influenced me a lot on this, because he made me become a little softer. Because obviously if you live with rules you have to be alone [...]. Then he explained these things to me, because he too is interested in these things, in a different way, of course, as a man... maybe more about putting on mass... and so you share, you learn. I learned many things from him, and my rigidity faded a bit away.* Similarly, U15 explains that the importance of modifying his physical activity level changed from ‘who cares,’ to ‘I should care,’ to ‘who cares’ again, to ‘you look like a fat man’ and then ‘who cares’ again, [...] *depending on my self-esteem and on the context in which I was, for instance if in a certain period my best friends were physically normal and not thin like me I felt uncomfortable.*

To summarize, behavior change processes may evolve over long periods of time and current attempts of change may be rooted into a distant past as well as projected into an imagined future. In other words, behavior change is strictly tied to the individual's personal history: not only it connects with the meanings that the person has developed in the present time, but also with the universe of sense that she has constructed throughout her life course, even pointing to the existential matters that she could encounter in possible futures.

4.3.2 Technology Use Evolves over Time, but Mostly Targets the Present Behavior. As the process of behavior change often unfolds over long periods of time, so the use of technology for changing behavior is not exempt from temporal evolutions. Most participants highlighted that their use of technology changed over the years, paralleling the transformations through which the process of change has been undergoing.

U21, for instance, recounts how she used an app for dieting in completely different ways in two different "phases" that characterize her behavior change process: *the first time it was a more rigid setting, I wanted to keep track of calories in a stricter way, more severe... the second time I already knew how the app worked and I had a different maturity on the topic of nutrition and physical activity... so I didn't use it as an obsessive control anymore, but to have feedback on something that I already knew.* U15 recounts that *at first it was just out of curiosity... [...] Then in July I had a week of panic attacks, where my heart rate was 160/180, and from that moment on, for three or four months, I was always looking at the heart app, I was worried... then I had a cardiology check just before the lockdown and he told me it was absolutely nothing [...] and from there I put my heart at rest and never had the need to check again. [...] Since then, [...] I don't need an external spy to tell me anymore. [...] So, the role of the app changed over time from a control to just an accessory.* A similar experience is reported by U19, who says that when she discovered that her increased weight was due to a pathological condition, she changed both the use of the app and how she perceived its role in her life: *And that's when I realized that it wasn't me, but something invisible [endometriosis]... then I continued to use the app, I always tend to keep an eye on the steps I take... but in the beginning there was the motivation to understand better, while today it's really just a curiosity.* In sum, how the participants use the technology is not static and the role of the instrument may evolve over time.

Nonetheless, many participants highlight that how systems are designed does not really account for the transformations of their experience. As a result, a technology may start being perceived as less useful and meaningful, being not capable of addressing the new appraisals of the target behavior, as well as the new existential matters and life circumstances arising from the flowing of time. U22, for example, stresses that he stopped using the saving app, when he saw that its usage did not fit in between his new working routines anymore and he reached a sort of new "maturity," *as I had less time to keep receipts for everything and in the evening to correct and put in the app what I had forgotten. [...] in fact, I've started eating breakfast out again. [...] Today I know how much money you need for the things you need... before I used to worry if I had too little and get excited if I had too much, [...] whereas now that I'm older I know what it means to have a lot of money, I know how to manage it and see it in the right way. [...] I think it's generally the maturity of a person.*

Moreover, most participants highlight that their use of technology is part of a process that has already begun months or even years before, so that the adoption of a system occurs when behavior change is already underway, being inserted into a flow that already has its temporal dynamics. U5 emphasizes: *I went through a bit complicated years of mental confusion and physical activity worked as an antistress, when I realized that I had begun to run a little more than occasionally I was curious about the number of miles made... so it was this [that made me download the app].* However, in the participants' recounts, the technology they used mostly appears neither to acknowledge the pathway that led the person to seek a technological support, nor to account for the meanings that

she has developed in the past. It follows that its use at a certain time point may yield unexpected outcomes. U9 well exemplifies how a technology, by not recognizing her past life experiences and existential matters, may prompt interaction modalities that push away the willingness to change, rather than providing an effective support: *The app that I downloaded worked in this way, I had to set a weight goal, so a calorie goal and you had to record every day what you ate ... That's exactly what I used to do in my head many years ago without the app, that is, I used to count calories, I used to write it down in my notebook or on my phone [...] and so that app reproduces exactly what I think a person who has problems with food does, like I did as a teenager [...]. Before food [during the adolescence] was an enemy to control, more recently it has become a form of gratification, but when I started to use the app, it contributed to reinforce the idea that it was something to be controlled, and so again it took me back so many years.* By using the app, U9 was traced back to an undesired past when the meanings associated with eating prevented her from being comfortable with food, a past from which she had moved on, but now threatened to return by means of technology.

U23, instead, emphasizes that he could not figure out what his life would be like if he seriously started the diet that he set out to do. The positive outcomes in terms of an improved health remained unclear for him, while he was afraid that changes in his habits might reduce the pleasure he got from food, consequently impacting on his mood and his social relationships. By using the app, he did not really understand how his habits would change in the long term and how his physical and mental wellness would be positively affected, so he abandoned the instrument after a while.

In sum, while both the behavior change process and the use of technology evolve over time, the technology that participants used seems not to be designed to fully account for the flowing of life. These systems mostly focus on the present target behavior, ignoring how it came to matter to the person, so that detrimental outcomes may occur. Likewise, when the perception of behavior and the process of change is transformed, but the instrument is incapable of paralleling such transformation, a technology may become obsolete and be abandoned.

4.4 Successfulness

4.4.1 Successfulness May go beyond Behavior Change and Relate to Existential Issues. The intended goal of every behavior change instrument is allegedly to change the target behavior, so that to be “successful” the technological intervention must lead to the behavior modification. However, several participants reported that they did not care much of whether the technology had changed their behavior or not; what mattered to them was whether it had supported them in tackling their existential concerns tied to the target behavior. This means that, for these participants, “successful” behavior change technologies should not necessarily (or not only) lead to actual behavior modification. Rather, being behavior change linked to important existential matters, technology should help them address such matters for being successful. For instance, U12 extremely appreciates the support provided by the device that he used. During the interview, however, he reveals that beyond the help given for doing more physical activity, the Fitbit connects him to a community where he can compete with others and expose his physical improvements. For him, behavior change points to the desire of being recognized by others, who may strengthen his self-image and improve his self-confidence, as well as to the underlying idea that life efforts are meaningful only if they are seen by someone else. The use that he makes of the device, then, perfectly works to this aim: *the competitive aspect, putting yourself in competition with others, I walked 20,000 steps just to overtake someone I've never seen in person in a virtual competition. It is a personal satisfaction, [...] of having reached a high position in the ranking. And even if in reaching this goal you have maintained your weight [...]. People like those who are competitive, because automatically you stimulate others.*

Many of these participants “appropriated” the technological instrument, using it for aims that clearly go beyond the intended support inscribed in its design. In so doing, they assessed its

“success” according to such “unintended” (by designers) use: instead of employing the “standard” criteria for evaluating a behavior change technology, which allegedly relate to the achievement of the behavioral objective, they used their own “existential” criteria. For example, U16, who has been using a Fitbit for four years to do physical activity more regularly, emphasizes that she employed the app mainly to gain a feeling of security and be reassured about her health status: *Since 4 years ago I found out that I have this osteoporosis that is worsening and I have my mother who is in a wheelchair [...]. Having a monitoring, it could be stupid or unreliable from a medical point of view, but it gives me security, I have my own history that I can analyze [...]. [The Fitbit] convinces me to say that what I’m doing is not wrong, despite the fact that from the point of view of clinical examinations it doesn’t show any improvement, but at least the Fitbit convinces me that what I’m doing is not completely useless [...] it sends me back a more positive image of my health... it gives comfort, security, and continues to give it to me.* For this participant, changing behavior is tied to an important existential issue pertaining to the fear of becoming seriously ill: the Fitbit is thus evaluated in terms of its capability of pushing this fear away.

Technology appropriation and the usage of “existential,” rather than “standard,” criteria to judge the success of the technology is also evident in U21’s experience. For her, dieting was more a way to exert control over her own life than a solid need of changing an unwanted behavior. Therefore, every time she felt really in control of her own behavior, she considered her attempts as successful, regardless of whether she had lost weight and “formally” achieved her goal. Talking about the dieting app that she was using in the first “phase” of her behavior change process, U21 reports that *it helped me realize that I was already doing well... I thought in my severity ‘oh my god I ate this and this, I must have eaten so much today’ and then I uploaded information to the app and saw that I wasn’t... I realized that I was better than the app, so again I got confirmation that I was doing fine and then I used it a little bit then I got bored.* In the first phase, U21 used the app mainly as a means to reinforce her self-confidence and her sense of control, rather than as a help to effectively modify her eating habits: since for her dieting and exercising pointed to a wider need to control “life”, the app gave her the confirmation that she was actually in full control of the situation. When she became reassured, she abandoned the system. Later on, she transitioned to another phase when technology was used in a different way.

In all these cases, therefore, the effectiveness of the technological instrument in modifying the behavior goes to the background in the participants’ eyes, whereby what is important is the opportunity to address an existential concern. This is even more apparent in those participants who were not able to change their behavior at all, and yet judged their efforts to be successful. For example, U4 stresses that he failed to quit smoking so many times but does not consider this a complete failure: often, his behavior change attempts were only a means to be engaged in an effortful activity, which allowed him to cope with stressful moments in his life.

To summarize, these participants appropriated behavior change technologies finding in them meanings and uses that were not intentionally or primarily inscribed in their designs. In their perspective, the successfulness of the technological intervention did not only relate to the achievement of a behavior change goal. Rather, it should be traced back to the possibility of addressing the existential matters that were tied to the behavior that they wanted to change.

4.4.2 Successfulness in Changing Behavior May be Double-Edged. The participants’ usage of behavior change technologies rarely led to a plain and univocal “success” in the “standard” terms of fully achieving a behavioral goal. As we have seen in the previous subsections, some of the participants reported that they abandoned the used technology after a while, because they thought that it did not really help or was not useful and meaningful anymore. Others stressed that the instrument may give only some “cues,” which nonetheless may be ambiguous and obscure, whereby

the main agent of change is “knowledge” that needs to be built autonomously. In certain cases, technology use may turn into failure, because the meanings that the device provides are not what the individual expects at that particular moment of her life. The narrow focus of the technology on the target behavior may hinder the process of change, especially when the participants are not able to appropriate the instrument and exploit it to address their existential issues.

Of course, there are cases in which the participants effectively changed their own behavior using a technology and were satisfied with its behavioral support, thus finding it successful on the basis of the “standard” criteria for evaluating a behavior change tool. However, such an achievement was not always exempt from side effects. U11, for example, started using the Apple Watch for doing more physical activity and in doing so, he seldom looked at his heartbeat. While the device and the related app encouraged him to exercise regularly, the displayed data made him more anxious, so that he started constantly monitoring the oscillations in the heartbeat: *Sometimes it makes me even more anxious because if after 10 minutes the heartbeat is above 150 it vibrates. A couple of nights it happened to me, but also recently, that for 10 minutes I went below 50 and it makes me even more anxious, then every now and then I open the app I look at the chart [...]. At work I notice it in some moments of stress, sometimes you feel a little more chest pressure, so I look at the application I see that I'm at 100 [...]. I don't want that maybe, I don't know, that it's something worse.* The device seeped into an underlying fear that U11 had about the precariousness of his health, reinforcing a variety of meanings related to the frailty of his condition and the remote possibility of dying, so that it increased his everyday anxiety. Data also amplified certain body signals, making him on the alert for certain signs that could indicate a possible dangerous condition: on the one side, checking the device reassured him that everything was fine; on the other side, the more the device was used, the more his attention was oriented toward the inner process of his body, raising his level of worry.

In other cases, technology may become almost an obsession, something that needs to be checked continuously in a compulsive manner. U1 explains that the usage of the app for changing her sexual behavior after the first two months became *a more obsessive use... In the sense that even if I know perfectly well that during these days it is useless to look at it, because I have my menstrual cycle. Still, I look at it to make sure that my boyfriend is here in the useful days. [...]. There is almost an obsession behind it, that is, I have to make it, I have to make it, I have to see exactly the day, the time.* Constantly using technology to this aim is also reported as increasing the overall stress in the person's life, as U17 explains: *for me it was stressful, because you had to put in the calories and I never got into it, I didn't know what to eat [...]. I actually stay with this constant control [...]. So in that period how was I? I was stressed even more. Mostly from the device, I didn't know what to eat, I was aware that it was a big deal for me, but I'd rather have taken it easy.*

At other times, the control that the system exerts over the behavior turns into a loss of agency for the person. U7 notes that the possibility of delegating the responsibility for the process of change is one of the strengths of this kind of instruments: *it gave me consciousness, because [...]. in the end it's the app that does the things... when I eat and realize I'm eating so much, in the end it is thanks to the app that I know it, that I have this consciousness.* Similarly, U17 compares the usage of an app against the rapport with a personal trainer at the gym, explaining that while with a human you can establish a “dialogic” relationship in which both the parts interact and have control, *I use these systems when my head is empty and I don't want to think about anything, I look at the app and I follow it, as if I were lobotomized and I don't think about anything.* The shift of responsibility from the human to the device, however, may eventually lead to a state of dependence on the technology, as U15 points out even with reference to the period when he used the wearables as accessories: *I realize that I've become addicted to it. I want to know at any moment how I slept at night, how many steps I've taken.* U1 reports a similar experience when she notes that *I think 'this week I won't drink, because it's a good week, because the app says so'... so I have the goal in my head, but it's all driven*

by the app. So sometimes I'm almost ashamed to say that some aspects of my life are regulated by this tool.

To summarize, the behavior change technologies used by these participants appear effective in modifying a specific behavior in certain cases. However, the lack of consideration of the user's personal meanings, history, and life circumstances in their designs may produce some unexpected side effects: even when the behavior is successfully changed, it may happen that other aspects of the participants' life worsen, making it more difficult to assess the overall positive impacts of the technology.

5 DISCUSSION

5.1 An Internalistic Perspective on Behavior Change

Using interviews and IPA allowed us to focus on aspects of the behavior change experience that are rarely investigated in previous research. The first contribution of this study precisely lies in an in-depth account of behavior change dynamics that are still underexplored, which may provide important insights on how people appraise and manage the process of behavior change, which in turn may lead to the design of more engaging or effective technologies.

Our first research question was: *How do individuals experience and account for the changes that they want to produce in their own behavior?* The participants in our study highlighted that behavior change tackled matters that went beyond the mere modification of a target behavior and made each process of change quite unique. From the participants' accounts it emerged that: (1) both the behavior and the process of change are heavily meaning-laden, whereby the meanings constructed by the participants are rooted in their internal dynamics and intimate life, often revolving around important existential issues; (2) behavior change is embedded in a variety of life circumstances, which represent not ancillary details but central aspects of the process of change, deeply affecting how it develops: in this sense, the behavior change attempts are only a part of the life matters that the participants have to manage in their daily life; (3) behavior change unfolds in very long periods of time, having roots in the past of the participants, changing across their different "phases of life," and being possibly projected into an imagined future.

These findings parallel those reported by Rapp et al. [2019] with reference to the characteristics of "general change," showing that behavior change makes no exception in being a fundamentally internal process. In particular, the role of internality clearly emerges in the importance that sense-making has in behavior change. The phenomenological perspective that we adopted allowed us to investigate how meanings were constructed by the participants, also depending on the different life circumstances in which they were situated and the diverse "phases of life" that they were living. This perspective at first glance may resemble those technological approaches that consider the cognitive aspects of behavior change (e.g., Spruijt-Metz et al. 2008; Macvean and Robertson 2013), like the role of self-efficacy [Bandura 1991] and that of motivation [Ryan and Deci 2000], which are allegedly seen as "internal" constructs. However, in such approaches, the "internal" factors of behavior change are mostly objectively and quantitatively appraised, which means that they can be effectively manipulated and studied without taking into account the subjective experience of the person. For instance, motivation may be tackled in its different degrees and types, like intrinsic and extrinsic motivations [Ryan and Deci 2000], but the subjective meanings that motivate people, that is the reasons why they are motivated to change, may be ignored: in other words, what is important is that the person is motivated by a specific motivation type (e.g., extrinsic), not the meanings that she ascribes to the motivation (e.g., "I want to change because I am afraid to die").

Our study suggests, instead, that researchers start qualitatively considering how individuals subjectively appraise and make sense of the behavior that they want to change and the internal processes that may lead to the desired modification. This is in line with the approach of the third

wave/paradigm of HCI, which focuses on the individual's lived experience [Bødker 2006] and her ways of perceiving and understanding the world [Harrison et al. 2007], and with work on health coaching noticing the importance of meaning in behavior change process [Rutjes et al. 2019; Ryan et al. 2022]. For instance, one individual might want to do physical activity because she believes that it is a way to improve herself. Another individual might want to exercise more because it is a means to exert control over her life. Another one might wish to be less sedentary because she wants to be recognized by others. Our participants showed that these meanings do matter because they entail different modalities to start, enact, and maintain (or not) the process of behavior change. This may require the design of different strategies to support the process of change, depending on the particular universe of sense within which the behavior is framed. The novelty of our findings lies mainly in showing that behavior change may be tied to meanings that ultimately connect with important existential concerns, like the need to have control over life and the fear of suffering. In this sense, behavior change may become an existential concern itself, because it may be lived as a central part of the individual's existence and have relevant implications for her whole life. Moreover, we point out that building "knowledge" may help people make sense of their attempts to change. This mirrors Bhattacharya et al.'s [2018] research findings, which highlight that individuals may proactively seek external information that may increase their understanding about their behavior. We specify that the construction of knowledge about the behavior change process may help people better understand how behavior change can fit in between their overall personal goals, beliefs, and values and how technology can become a support, potentially leading to better outcomes.

Our study also emphasizes that it is not possible to isolate the attempts of changing a behavior from the life circumstances in which it unfolds. Behavior change is not an isolated practice that is enacted in the void, but a situated endeavor that interacts with other daily routines and is affected by a variety of life conditions that may determine the success or otherwise of the process. These circumstances are not superficial details, which can be ignored when designing a "surgical intervention" that targets only the behavior, but central part of the process. These findings connect with studies exploring people's behavior and activities as "social work," namely complex experiences entangled with social dynamics [Shin et al. 2022], as well as with previous work on the impact of context factors on behavior change [Bhattacharya et al. 2017; Murnane et al. 2018; Rutjes et al. 2019]. For instance, Bhattacharya et al. [2018] noticed that external conjunctures, be either "negative" like an unexpected illness, or "positive" like starting a family, may lead people to increased resolve toward making the change. Likewise, Agapie et al. [2016b, 2018] emphasized that people feel that it is important that behavior change plans accommodate their routines and everyday constraints. Moreover, our study echoes behavior change research that relies on social practice theory, which highlights the role that collective routines, broadly accepted social norms, physical environment, and near materiality have in shaping behavior [Blue et al. 2016; Entwistle et al. 2015; Twine 2015]. However, in social practice theory, the subject plays a minor role. The person is only a carrier of collective practices, which are independent from her [Schatzki 2002]: the individual may perform such practices, reproducing them over time [Reckwitz 2002], even with variations and resistance [Shove and Pantzar 2005]. Nevertheless, the real agents of change are the practices themselves.

With respect to this previous work, our study better points out the active role of the individual in managing her behavior change attempts, as well as in leveraging the circumstances of her everyday life. Moreover, we point out the meaning-laden nature of life circumstances: in this sense, it is not possible to identify absolute "positive" or "negative" conjunctures, as they are informed by subjective meanings that may have an idiosyncratic value to the individual. In fact, despite being constrained by circumstances that go beyond their control, our participants are not at their mercy.

Rather, they are often able to exploit the right situation, what we have called the Kairos, to begin or reaffirm their endeavor to change. Here, the impact of “life” on behavior change is neither deterministic nor irrelevant: rather, it appears that the individual interacts with the conditions in which she is cast, giving meaning to and reinterpreting them. In so doing, she adapts her behavioral attempts to the varying life constraints and opportunities that she encounters, trying to find a balance among the different matters that make up her everydayness.

Furthermore, the study findings pinpoint the role that temporality has on the process of behavior change. Obviously, behavior change is intrinsically temporal because it occurs in time: but its temporality is not limited to the moment when the change is undertaken. Instead, behavior change may have roots in the distant past of the individual, take place over many years returning in different forms, and be projected into an imagined future. This temporality differs from that implied by technologies based on the “behavioral model” of change, which sees behavior change as an isolated event and focuses on the well-circumscribed time of the behavioral intervention [Rapp et al. 2019]. The TTM, for example, sees individuals progressing through six stages when attempting to change a behavior (pre-contemplation, contemplation, preparation, action, maintenance, and termination) [Prochaska and Velicer 1997]. This temporality, however, refers to the proximal time in which the behavior change occurs: contemplation, for instance, is meant as the moment in which people are intending to change in the next 6 months and is commonly the first stage tackled by technology, being pre-contemplation referred to a moment when the individual does not intend to change, thus falling outside the scope of the technological intervention [e.g., Li et al. 2010]. Likewise, albeit most self-tracking systems are past-centric in nature, addressing the retrospective aspects of data collection and analysis [Lee et al. 2020], the past that they consider is a “near past,” strictly related to the behavior to be changed, like past performances and successes [Kersten-van Dijk et al. 2017]. This proximity is shared by systems that look at more future-oriented interactions [Rho et al. 2017; Lee et al. 2020], considering a future that is close to the site of the intervention. In this narrow temporality, therefore, there is no room for the impact that the experiences rooted in the individual’s distant past may have on the present modification of the behavior. By contrast, our study points out that behavior change may have roots in a distant and meaningful past, possibly embracing the individual’s whole life course. Moreover, we highlight that people may imagine future life trajectories that evolve far away from the present and relate to imagined future existential concerns. In this sense, the behavior change temporality emerging from our findings is far more subjective, meaning-laden and “stretched” than that tackled by previous research.

In sum, our study depicts behavior change as a fundamentally internal process. This means that behavior change concerns more the internal, subjective aspects of the individual’s life, than the external manifestation of the behavior. Being behavior change heavily meaning-laden, and being meanings subjectively constructed by the person, each process of behavioral modification is rather unique. Despite the uniqueness of each process of behavior change, however, some tentative patterns can be identified: the importance of the existential concerns that are connected with the behavior to be changed, the relevance of the life circumstances in affecting the process of change, and the prominence of a dilated time.

5.2 A life Perspective on Behavior Change Technologies

Our second research question was: *How do technologies used to address behavioral matters connect to the wider aspects of people’s life?* Our study confirms and deepens the scattered findings reported by those HCI studies that attempted to explore behavior change outside the “behavioral model,” which highlighted that technology puts too much emphasis on behavior to the detriment of the person’s lived experience [e.g., Rutjes et al. 2019]. Moreover, the study resonates with HCI research on mental health and difficult life moments, which emphasized the role of sense-making and

reflective experiences when people use technology to find support [Iacovides and Mekler 2019; Loke et al. 2021; Boldi and Rapp 2022; Boldi et al. 2022]. Building on top of these previous studies, we analyzed more in depth and systematically how technology for behavior change is used by people “in everyday life,” finding that the technologies used by our participants were often unable to help them develop the meanings required to effectively enact the process of change.

This lack of support for sense-making aligns with the findings of research examining the features of popular self-tracking tools [Cho et al. 2022], as well as of work exploring tracking practices in domains like sports and chronic illness management. For instance, amateur athletes may find no guidance in popular sports self-tracking instruments to interpret their own body data, so they may “read” such data as intrinsically valuable numbers: this approach, however, fetishizes the data and might jeopardize the achievement of long-term goals [Rapp and Tirabeni 2018, 2020]. Likewise, Mamykina et al. [2006, 2008] noticed that popular glucose monitoring devices for diabetes management may not be sufficiently helpful in driving people’s sense-making processes, and simple presentation of data may reinforce individuals’ preconceived notions instead of facilitating genuine discoveries. From our study participants’ recounts, however, it appears that sense-making is always enacted when individuals use a certain technology, so that, if such technology is not intentionally designed to support the meaning construction, its outcomes may be unpredictable.

Many of our participants also stressed that as the behavior change systems they used do not consider and tackle the wider life context in which behavior change is situated, they either may fail when such circumstances are modified, or may simply appear more sterile in comparison with other meaningful activities that are wired into a lifeworld. Even though this may not be a bad thing per se, if the person is able to find a more engaging way to change her own behavior, it may signal the inability of some technologies to offer a valid alternative to richer but more “complex” activities (e.g., sports), which clearly require stronger effort to be enacted and may not be suitable for everyone. The poorness of the lived experience reported by several participants when using behavior change systems may further explain the reasons why people abandon them [e.g., Lazar et al. 2015], thus requiring that designers focus more on designing supplementary activities “surrounding” the behavioral intervention, so to create a richer lifeworld and elicit more engaging and meaningful experiences.

Systems used by the participants showed also to ignore the temporal evolution of behavior change, whereby different support may be needed in diverse phases of life. By providing the same modalities and features regardless of the “phase” the person is in, technology risks offering outdated help, thus leading to a rapid abandonment. These “phases” of life, however, are different from the “stages of change” tackled by many personalized persuasive technologies that use models like the TTM [Prochaska and Velicer 1997; Oyeboode et al. 2021], where the focus is on the stages’ “objective” characteristics (e.g., “people at the pre-contemplation stage tend to be strongly motivated by self-monitoring”, Oyeboode et al. 2021): in such technologies, the aim is to identify patterns of framing and enacting the change at a particular point of a “standardized” path, in order to deliver an intervention tailored to that point. Instead, the phases highlighted in this study point to the particular universe of sense that a person connects to the behavior at a particular moment in her life, being thus intrinsically subjective. For an individual, different phases of life may entail different ways of framing and managing the process of change. Likewise, different individuals may progress to completely different phases and universes of sense. This perspective aligns with previous research that explains how behavior change goals evolve over time, stressing that technology should account for such evolution [Niess and Woźniak 2018]. With respect to this previous work, however, we point out that the flowing of time may entail completely different life phases, whereby not only the goals, but also the meanings ascribed to the process of change may be modified. This would mean to provide more individualized programs and interaction modalities that take into

account the evolution of the person's meanings and design for the temporal evolution of technology use, considering changes of modalities of usage, modifications of the role of technology, and transformations of the meanings attributed to the behavior.

Finally, several participants underlined that the successfulness of the intervention can be achieved by following alternate paths that are not inscribed in the technology designs and may point to the existential concerns that are tied to the target behavior. In doing so, they showed that they were able to appropriate the technology. Appropriation [Dourish 2003; Lally 2002] refers to the person's ability to adapt the use of technologies to her needs, in ways that were not foreseen in their original designs [Quinones et al. 2013]. Appropriation may take several forms, being semantic, behavioral, or technological [Muller et al. 2016]. In this study, we found that several participants were able to ascribe to the technology meanings that were useful to partially address their existential issues. When the participants did not show sufficient competence to drive the process of change through technology, however, several unexpected side effects could also appear. For example, the person may experience a loss of agency and become dependent on the technology, an effect that has been observed even with reference to self-tracking in the sports domain [Rapp and Tirabeni 2018]. Moreover, she may become obsessed by data, as prior research on fertility tracking [Figueiredo et al. 2018], health coaching [Rutjes et al. 2018] and weight monitoring in the context of eating disorders [Eikey and Reddy 2017] has also pinpointed. The novelty of our study, therefore, lies in suggesting that these side-effects might be due to a common root, that is the lack of consideration of the user's personal meanings, life circumstances and time in technology designs.

HCI researchers should then always acknowledge and account for the potential dark sides of technology-based behavioral interventions. More transparency in communicating their potential double-edged effects to individuals could mitigate the risk, especially with reference to people that do not hold sufficient knowledge about the target behavior, thus possibly becoming excessively dependent on technology. The findings of this study could thus inspire the HCI community to focus more on the double-sided impacts that behavior change systems may yield.

5.3 An Existential Model of Behavior Change

On the basis of the study findings, we will now develop a preliminary theoretical model of behavior change that puts in the foreground the internal and existential aspects of the process and embeds the modification of behavior in the wider context of life. At this stage, this is a tentative model, which will require further empirical testing to prove its validity.

The model is thought of as an alternative to the dominant behavioral model of change. The behavioral model primarily focuses on behavior, which is conceived as a "quantum" that can be isolated from the wider life into which is situated and from the life course in which it happens, and is studied "objectively," from a third-person point of view that considers almost exclusively its external features [Rapp et al. 2019]. Instead, the model that we propose gives value to the internal meanings that people develop throughout their lives and accounts for the existential matters that are intertwined with their behavior change attempts, shifting in this way the focus from the behavior to be changed to the life in which it is situated. It is worth pointing out that this "existential model of behavior change" is not meant to criticize or substitute the behavioral model. Rather, we suggest that it may offer an alternate perspective that may integrate, develop, and amplify the impact of what has been previously done under the behavioral account.

The model highlights that the behavior change process is influenced by:

(i) the *meaning* that a person ascribes to the target behavior and the process of change. The term "meaning" refers to the sense-making activity that people enact during the process of change: individuals link to behavior change the additional sense that is rooted in their internal dynamics and intimate life. This meaning, in fact, is subjectively constructed by the individual and often

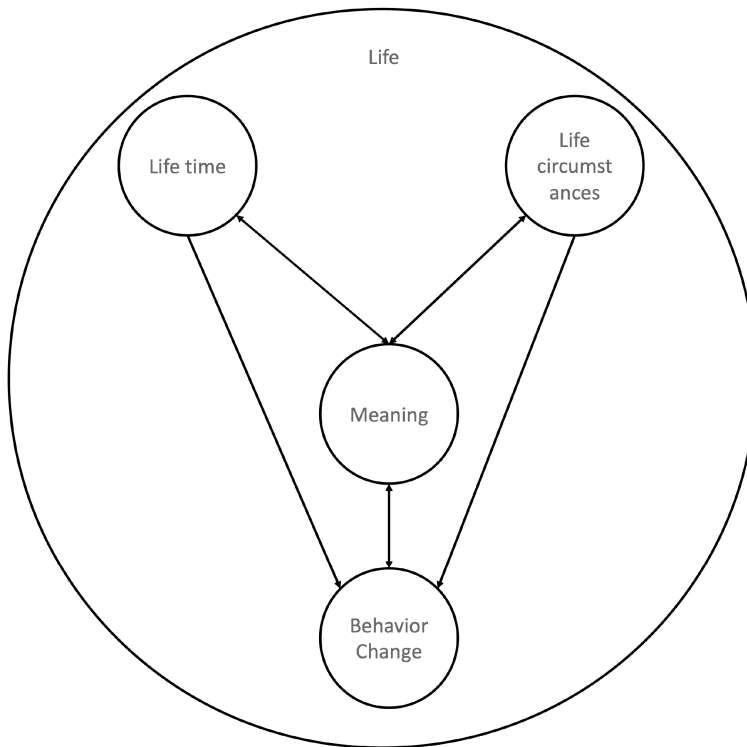


Fig. 1. The existential model of behavior change.

points to important *existential concerns*, framing the interpretation of behavior change: one person may interpret quitting smoking as a way to protect her health and to stave off the fear of death, while another as a means to have more control over her life and be more authentic.

In this sense, the constructed meanings heavily impact on the process of change (Figure 1, Arrow *Meaning*→*Behavior change*), affecting e.g., how people see the behavior and the effort they put in the endeavor to change, their sense of having succeeded or failed, and their decisions to maintain the change or relapse into a previous state (e.g., *I am afraid of dying and quitting smoking may help to prolong my life, I must persevere in my attempts at all costs, otherwise it is a failure vs. quitting smoking is a way to regain control over myself; however, in certain difficult moments losing control can be positive for me, so it is not bad to momentarily resume smoking*). In other words, the meaning puts in the foreground certain aspects of behavior change process, while leaving in the shadow others, modifying how people understand and thus enact their effort to change. This finds confirmation in studies grounded in the phenomenological tradition, which highlights the subjective nature of meanings [Rapp and Tirassa 2017], as well as in research that points out the importance of sense-making, personal motives, and goals in the process of change [Rutjes et al. 2019; Bhattacharya et al. 2018; Rapp et al. 2019].

In parallel, people can also derive meaning from making a behavior change, modifying for example how they interpret their own identity (Figure 1, Arrow *Behavior change*→*Meaning*). For instance, a person who starts exercising may eventually come to identify herself as a sports person, and find meaning in that identity. These identity shifts may then further impact behavior change. This aligns with work emphasizing that when a behavioral attempt is successful, an identity shift begins: the increased self-awareness and self-confidence that follow may then fuel continued change [Kearney and O’Sullivan 2003].

(ii) the *life circumstances* in which the behavior change attempts take place. Life circumstances are all those everyday conjunctures that the individuals consider to be intertwined with the process of behavior change, which do not necessarily pertain to its immediate “surroundings” (e.g., the environment where the behavior change happens), but may involve the practices, routines, and relationships that are seen as connected with the behavior to be changed.

On the one hand, life circumstances directly impact on the process of change, as they constitute a nexus of everyday activities in which behavior change needs to fit in between (Figure 1, Arrow *Life circumstances*→*Behavior change*). For example, a person may not be able to accomplish her everyday exercises because she has to deal with family and work matters, like accompanying children to school, overwork, and so on. This resonates with those studies that emphasize the influence of routines and constraints on behavior change [Rutje et al. 2019; Murnane et al. 2018; Bhattacharya et al. 2017, 2018; Agapie et al. 2016b, 2018].

On the other hand, life circumstances may change the meanings that are ascribed to the target behavior and the process of change (Figure 1, Arrow *Life circumstances*→*Meaning*). Such meanings, then, may modify how the person manages the change. For instance, when a person is with her partner, she may see food as a way to share experiences; instead, when she eats alone, food becomes nutrients that need to be controlled: in the former case, persevering in the effort of changing behavior may become far more difficult.

In parallel, life circumstances are meaning-laden, so that they have a personal and often existential value for the individual. For instance, a person may ascribe to a situation of forced isolation (like a lockdown) an opportunity for being more authentic, which may fuel her willingness to control behavior to align with her “true self.” Another person, instead, may see the same situation as a threat to her personal freedom, so losing control may become a means to regain liberty: this may stop her behavior change attempts. It follows that modifying the meanings attributed to life circumstances (Figure 1, Arrow *Meaning*→*Life circumstances*) may provoke a modification of how the behavior change is managed by the person (e.g., making her see her current situation in a different light may increase her willingness to change).

(iii) the *life time* in which the behavior change unfolds. Life time is the time that is experienced by the person in her everyday life and may point to different ages of the individual and even to her entire life course [Rapp 2022]. In this sense, this time aligns with the time of the phenomenological tradition [Zahavi 2012; Husserl 1962], which is fundamentally subjective, embracing not only the (even distant) past of the person as she has experienced it, but also the possible (distant) futures as she imagines them to be.

On the one hand, life time may directly affect the behavior change process, as the flowing of time may transform the life circumstances, the personality, or the body of the individual, and consequently, her willingness to put effort in the change (Figure 1, Arrow *Life time*→*Behavior change*). For instance, a person may lose interest in doing exercise simply because she becomes lazier or less energetic as she gets older. This is in line with research highlighting the temporal evolution of behavior change [Niess and Woźniak 2018].

On the other hand, life time may transform the meanings that are ascribed to the behavior and to the process of change (Figure 1, Arrow *Life time*→*Meaning*), which, in turn, may impact on behavior change. An individual, for example, may pass through different “phases of life,” in which food is first seen as a source of pleasure, then as a means to exert control over the world, and finally as an experience to be shared with others: as meanings change with the passage of time, the way she manages the change will also be transformed.

In parallel, life time is not “neutral” for the individual, but imbued with meanings potentially pointing to existential concerns. In this sense, the person’s past may be seen as a time when certain existential matters have been addressed or not, and her future as a field of possible alternatives

where novel existential issues could arise. For example, a person may start applying the meanings that pervaded her past, when she perceived her body as frail, to the present time. Another individual, instead, may imagine that in the future she would not be able to persevere in any endeavor. In both cases, the meanings associated with the person's life time may undermine her present willingness to exercise. It follows that modifying the meanings attributed to life time (Figure 1, Arrow *Meaning*→*Life time*) may yield a transformation of how the behavior change is handled by the person (e.g., making her see the future in different terms may encourage her to accomplish the change).

In sum, the existential model of behavior change is intrinsically contextual and temporal. The context and the time that the model accounts, however, are not those that are commonly tackled by behavior change technologies. On the one hand, the notion of context in the behavior change technology field has been traditionally taken by early context-aware research, where it has been conceived as the sum of the physical features of the environment in which the user's action takes place [Dey et al. 2001; Grudin 2001]. Although the debate on context within HCI and Computer-Supported Cooperative Work studies evolved over the years, highlighting the situatedness of our everyday experience that depends on material, social, and cultural circumstances [Suchman 1987; Dourish 2004; Räsänen and Nyce 2006], and widening the notion of context to routines and practical constraints [Rutje et al. 2019; Murnane et al. 2018; Bhattacharya et al. 2017, 2018; Agapie et al. 2016b, 2018], in the behavior change technology domain context is still mostly understood as any information that may characterize the physical (or external) situation of the user [e.g., Prost et al. 2013]. Instead, in the model we propose the context of behavior change becomes internal and “existential,” pointing to all the life circumstances that the person has to deal with in her daily life: these are not only the everyday practices in which the person is routinely involved, but also the meaning-laden conditions that may be connected with the existential issues that she has to face. In other words, the model encompasses a view “from the inside” of the context, whereby more than its material, and even social and cultural aspects, it comes to matter its internal and existential ones.

On the other hand, the time commonly addressed by behavior change technologies is the “time of the machine,” which is also the time traditionally tackled by HCI [Rapp et al. 2022]. In fact, time in HCI has been commonly framed within the “clock perspective” [Rapp et al. 2022], a mechanical instrument that allows the recording of the exact quantity of time, as a measurable, objective, and uniform entity [Starkey 1989]. Even though this view on time has been counteracted by strands of research seeing time as design material [e.g., Odom et al. 2014; Harrison and Cecchinato 2015; Odom et al. 2018], or focusing on the social and cultural organization of time [Lindley 2015; Taylor et al. 2017; Pschetz and Bastian 2018], time as an internal, existential matter, has received far less attention [Rapp et al. 2022]. Likewise, in behavior change technology research, relevant time remains that of the clock, which may refer to the timeliness of the intervention [Lee et al. 2017], the management of eventual relapses [Agapie et al. 2016a], or the duration of the user's adherence to the behavioral program [Kovacs et al. 2021]. Moreover, whether referring to the past or the future, behavior change time is usually narrow, being close to the site of the intervention [Kersten-van Dijk et al. 2017; Rho et al. 2017; Lee et al. 2020]. The model we propose, instead, points to a time that is similar to the time tackled in HCI studies on death [Massimi et al. 2011; Gulotta et al. 2016], legacy [Gulotta et al. 2017; Gulotta et al. 2014], and rituals [Petrelli and Light 2014]. This is an “internal” and “existential” time that is fundamentally tied to the meanings that stem from the individuals' sense-making of their own existential issues and is affected by how their entire course of life unfolds.

5.4 Using the Model

The existential model of behavior change is still a tentative model, as it needs to be empirically tested in the future. However, in line with other HCI behavior change and data tracking models,

developed from single empirical studies and not immediately tested on the field [e.g., Li et al. 2010; Epstein et al. 2015; Murnane et al. 2018; Niess and Woźniak 2018], we believe that it could offer a valuable contribution to HCI research from the theoretical point of view. Recent HCI studies confirming the meaning-laden, contextual, and longitudinal nature of behavior change [e.g., Niess and Woźniak 2018; Bhattacharya et al. 2018; Rapp et al. 2019; Rutjes et al. 2019] further strengthen its validity.

The usage of the model also has practical implications that could aid the design of future systems.

First, the model emphasizes the pivotal role of sense-making in behavior change, thus implying the need to use more prominently inquiry techniques that allow researchers and designers to capture what kinds of meanings people attribute more likely to a specific behavior, using them to inform the whole design process. In this sense, the model can provide guidance in identifying those meaningful aspects that potentially affect a particular behavior change experience. Each aspect of the model, then, could be inspected at best through specific research methods. Interviews as unstructured as possible, projective techniques for the elicitation of meaning [Porr et al. 2011], and IPA for uncovering individual idiosyncrasies [Smith and Shinebourne 2012] may be the optimal solution to study how people make sense of a behavior change. The individual's past time may be best inspected by using life story interview, which is the story a person chooses to tell about the life she has lived, told as completely and honestly as possible, and what is remembered of it [Atkinson 1988]: this technique has been used in HCI to explore how individuals use technologies during the entire life course [Pena et al. 2021]. As for the individual's future, motivational interviews make available a set of tools for supporting participants in envisioning alternate futures [Miller and Rollnick 2013]. Life circumstances, instead, may be better studied using ethnography, observation, and contextual interviews, with a particular focus on the meaning that certain environments, relationships, and practices may have for the person.

Second, the model is intrinsically dynamic as it highlights that how the individuals appraise behavior change changes over time and depends on the life circumstances in which they are situated. This implies that designs that are not "adaptable" and "malleable" might not fully work in the behavior change domain. "Adaptable" systems may tailor their own behavior to the characteristics of the user [Brusilovsky 2001; Frias-Martinez et al. 2006] or other relevant factors, exploiting either user's self-reporting or automated means, like machine learning techniques to extract high-level information from sensors [e.g., Banaee et al. 2013; Perera et al. 2014], lifelong user models, which model user goals and preferences in the long term [Kay and Kummerfield 2009], and data-mining techniques applied to time series to detect anomalies [Izakian and Pedrycz 2014] and rare motifs [Begum and Keogh 2014], which may signal "turning points" in life time. In this sense, the existential model may help designers in identifying those factors that, when they vary, are more susceptible to impact on behavior change. The model also suggests that designers think about their designs not in terms of "complete" and "fixed" products, but as malleable and mutable. This may entail a "modular" approach to design, where multiple design features and behavioral strategies may be made available to the user, who may activate or deactivate them depending on the situation and life phase; or where systems are left open to "add-ons" that could be delivered in response to specific concerns that users may have at a certain time point. This is in line with research recommending that designs should be configurable to support evolving personal goals [Cordeiro et al. 2015].

Third, by emphasizing the subjective nature of behavior change, the model encourages researchers to use more prominent evaluation techniques that consider the users' subjective criteria for determining whether a system is successful or not, as "objective" assessments may not fully capture the impact that a certain technology may have on the user: for instance, the behavior is modified by the system, but the user perceives that she became more obsessed by caloric intakes. In this perspective, the model may give guidance to researchers on what are the important

metrics for evaluating behavior change, like what kinds of meanings the user connects to behavior change before and after the use of the system; whether the system helps her in addressing the existential concerns that are linked to the behavior change; what kind of sense she makes of the intervention and the technology, and whether this sense changes over time or within specific life circumstances. Moreover, the model may help researchers recognize side effects arising from the usage of the technology identifying the reasons for their emergence (e.g., the technology changed the meaning associated with the target behavior in a negative way). This entails the need to explore evaluation methods focusing on internal processes [Baumer et al. 2014]. Diaries, for example, where the user can keep track of her perceptions, feelings, and interpretations over time, may help researchers understand the meanings that users developed during the intervention, tackling their longitudinal nature [Carter and Mankoff 2005; Sohn et al. 2008]. Likewise, experience sampling allows researchers to collect data about the internal aspects of human life (e.g., thoughts, sensations) through self-reports provided by participants, who are proactively triggered at various points throughout the day [Larson and Csikszentmihalyi 2014; van Berkel et al. 2017].

Finally, it is worth noticing that the existential model of behavior change in some cases could lead users to engage in unexpected or undesirable behavioral goals, as well as designers to implement systems that may produce detrimental side-effects. In fact, a behavioral intervention that only relies on the user's meanings might be based on information that does not "reveal the truth" about the user and her behavior, as she may self-deceive [von Hippel and Trivers 2011]. For instance, a person may think that her incapacity to increase her physical activity is due to a fundamental laziness that characterizes her personality, whereby it is actually due to an almost unconscious fear of being harmed while exercising. Trying to change the image of her personality as a lazy person into a more active one, therefore, would not make her exercise more. Likewise, a person may design, with the help of technology, self-experiments that increase the biases about herself (e.g., through a self-confirmation bias effect): for example, she may keep trying to decrease the daily caloric intake to see if her body improves and actually think that this is happening, when in fact it is damaging her health. These potential side-effects suggest that in certain cases, the existential model should be paired with other perspectives that either look more at the "objective" and "external" aspects of the process of change or delve deeper into the often unconscious "truth" of the individual.

Further tensions may arise when implementing the model with reference to the focus on life circumstances. Applications that pay particular attention to the activities surrounding the behavioral intervention, adapting their features to the varying conditions of the user's life and goals, might undermine her capability of appropriating the technology and adapting it to her own ends and needs. As we have seen in the study findings, users may become dependent on technology. Moreover, by delegating tasks to the instrument, people may lose the abilities underlying the execution of those tasks. Besides the well-known effects of automation bias in the Artificial Intelligence field [Goddard et al. 2012], it has been shown that an overreliance in self-tracking instruments, for example in the sports domain, may undermine the opportunities for sense-making [Rapp and Tirabeni 2018]. Designing systems that adapt to the user's life may thus similarly reduce her opportunities for constructing meaning and appropriating technology for her situated goals. This necessitates an approach that values the person's autonomy, developing her sense-making and adaption skills rather than replacing them.

Likewise, applications that pay attention to the user's life time, accounting for her entire history, may reinforce meanings that the user would prefer to dismiss. For example, focusing on the user's past might reduce adaptive forgetting by interfering with adaptive biases, since re-presenting past events may act like rumination [Sas and Whittaker 2013], triggering perseveration on events that might be better forgotten [Konrad et al. 2016]. Moreover, systems offering a life-long, life-wide, perspective may exert more power over the individual. In principle, behavior change technologies

inscribe in themselves instances of power that define why and how we should behave in a certain way [Baumer et al. 2012; Rapp 2019]. In this sense, using the existential model of behavior change may encourage designers to address the intervention not only to a specific, circumscribed, behavior but potentially to the individual's whole life. This clearly opens possibilities for designers to control, surveil, or coerce the user [Purpura et al. 2011], subtly shifting her priorities, beliefs, goals, and meanings, without her being fully aware of it. This implies that designers ethically reflect on the (even long-term) consequences of their designs and provide the user with means to rebalance the power relation: for instance, transparency, explainability, and scrutability [e.g., Miller 2019; Kay and Kummerfeld 2013] may allow users to inspect, understand, and change the image of their self on which the system relies, thus empowering them.

To summarize, the existential model of behavior change suggests that researchers and designers start considering the internal and existential aspects of behavior change because such aspects are essential in determining how the behavior change process is accounted for and managed. On the basis of the study findings and the model we surfaced, we will now point out a series of barriers that users of current behavior change technologies may encounter and design suggestions that could help people overcome them.

6 IMPLICATIONS FOR DESIGN

We will now point out a series of barriers that the participants found in changing their own behavior as well as several design suggestions that may help people overcome them. By and large, all the suggestions are meant to support the proactivity of the individual. A relevant risk in the usage of behavior change instruments is that the person becomes dependent on technology: when the importance of technology is excessive not only the person may feel powerless and at the mercy of its decisions, but also become obsessed and anxious, continuously checking the instrument to find answers to her concerns.

The suggestions revolve around the three main aspects identified by our “existential model” of behavior change, namely meaning, life circumstances, and life time. They do not focus on technical aspects and are kept on purpose at a high level of abstraction so that they can be used even in contexts that do not pertain to health. In so doing, we want to open new opportunities for behavior change designers, more than identifying specific design guidelines.

6.1 Support Sense-Making and Knowledge Development

Barrier 1: People may not find the right meanings that make the behavior change effort worth being pursued. From the study findings, it appears that people that are not able to change the way they look at the target behavior are more likely to weaken their efforts in modifying the behavior. Often the behavior is tied to relevant existential issues and may be “used” to cope with them: for instance, smoking may provide the person with a sense of protection during periods of stress, while eating may give pleasure during a difficult life moment, as some participants suggested. Changing such meanings associated with the target behavior, so that the person becomes aware that its modification is important, appears thus essential for keeping the efforts over time. To this aim, current technologies seem to give little help, being often not able to support sense-making: even current self-tracking tools, which are allegedly addressed to support self-awareness and self-knowledge [Rapp and Tirassa 2017], often lack features that encourage user-driven reflection, limiting meaning-making and frustrating nuanced insight generation based on lived experiences [Cho et al. 2022].

Novel designs should then encourage sense-making through reflection on the target behavior in connection with the relevant existential matters that the individual has tied to it. To this aim, some insights may be found in clinical practice. Values exploration, for instance, is a strategy used

to support behavior change by asking people to describe their most important life goals and values [Miller and Rollnick 2013; Webber et al. 2008]. For instance, the therapist may ask: *what do you want most in life? What things are most important to you? How does your (behavior) fit in between what really matters to you?* Focusing on discrepancies between ideal life conditions and actual conditions may induce a desire to recalibrate behavior to be more congruent with deeply-held beliefs, or shift the focus away from “bad” behaviors to a more deeply satisfying lifestyle that can be pursued [Hardcastle et al. 2015].

Designing technologies that incorporate this or similar strategies is obviously an extremely complex endeavor, as even in clinical practice these personal insights are achieved through multiple sessions of conversation with an expert therapist. A first strand of research that may be in line with this goal can be found in conversational agents. This body of work has produced agents that simulate active listening [Lim et al. 2019], present themselves as collaborators [Olafsson et al. 2019], and foster empathetic responses [Lisetti et al. 2013]. While progresses are certainly promising, current technology has serious limitations with reference to its capability of tackling conversational topics that fall outside the narrow domain of expertise of the agent [Rapp et al. 2021]. Being behavior change linked to existential matters that go beyond the domain to which pertain the target behavior, it is difficult to deliver sensitive interventions that really encourage sense-making around the person’s relevant issues. A design strategy could be to use the agent to prompt “stories” of people that had similar behavioral problems, who enacted the change in different ways in order to provide alternative perspectives. Alternatively, the agent could deliver open questions aimed at stimulating thinking rather than providing suggestions. Prior experiments on conversational agents aimed at eliciting reflection have shown that this could be an effective strategy. *Robota*, for instance, supports employee self-learning by prompting questions that e.g., focus on realizing relations between activities and goals, as well as barriers to goals accomplishments [Kocielnik et al. 2018a]. *Reflection Companion* is a mobile conversational system that supports reflection on physical activity data through mini-dialogues, which guide the user to progressively deeper levels of reflection [Kocielnik et al. 2018b]. Similarly, Lee et al. [2021] designed a chatbot to deliver guidance for people to practice journaling skills, improving self-reflection and self-awareness.

Another research line that seems promising comes from video games. Research suggested that video games may constitute a meaningful activity [Mekler and Hornbæk 2019], as players may reflect on gameplay and how it relates to their personal life [De Schutter and Vanden Abeele 2010; Bopp et al. 2016; Rapp 2018; Zhang et al. 2020; Boldi et al. 2022]. Wong et al. [2021], for instance, designed a serious game to make habitual health choices unfamiliar in order to promote players’ contemplation about their personal reasons for health. Insights may also come from “existential video games”, which encourage existential reflection [Chittaro and Sioni 2018]. In this line, game designers could develop games that allow people to experiment with different scenarios depending on the values that the main character embraces and to “live” how the experience of change could vary accordingly, thus simulating how different priorities could lead to very different evolutions and outcomes. These games could also highlight contradictions (e.g., by showing how the search for a sense of security in smoking could eventually lead to an extremely unsafe outcome like having difficulties in breathing and being exposed to respiratory illnesses), or “constrain” players to choose and then exacerbate the consequences of their choices (e.g., by allowing the player to choose all the food that improves her mood from time to time and then showing that this “search for happiness” may lead to profound sadness and depression when discovering to be seriously ill). However, instead of adopting a “paternalistic” approach, thus conveying underlying moral messages about the player’s choices, the game could favor the exploration of different values and goals and the possible impacts that they may have, possibly highlighting that no choice is exempt from side effects, so that it is the player’s responsibility to consciously choose what she really

thinks better for her. Non-playable fictional characters could also present stories that contrast or parallel the choices made by the main character so as to provide different takes on the same problem.

Barrier 2: People may not develop knowledge to sustain the behavior change effort over time. The findings coming from our study pinpoint that people may not be able to keep their behavior change endeavors when they do not develop knowledge about the target behavior and the process of change. Without knowledge, even the data and the suggestions provided by technology may remain a dead letter. Behavior change designs should then sustain knowledge development, especially in less “expert” individuals and people that are not able to build knowledge on their own.

For instance, behavior change technologies could help individuals formulate hypotheses about their data, prompting questions about the possible significance of particular trends and partial achievements, providing possible “solutions” and plans, which the person should be invited to choose, reflect on, modify, and experiment in practice. Then, the system may provide further explanations about the possible reasons why the plans worked or not, or connect data points with relevant background knowledge: for example, the knowledge that explains why a particular parameter or value is important for the person given her current characteristics and goals, or which connects the collected data to e.g., body characteristics and processes that contextualize the value, or information outside the particular domain to which the system is targeted (e.g., w.r.t. dieting, by providing information about how the food is produced, the ethics about food, etc., thus linking the target behavior to a whole universe of meaning that may enrich or change the person’s perspective on it).

From a theoretical point of view, researchers may also rely on the notion of reflective practicum [Slovák et al. 2017], which stresses that designers should scaffold the learning process to facilitate reflection; on Fleck and Fitzpatrick’s [2010] levels of reflection, which identify five different degrees of reflection, from description and dialogic explanation, to transformative reflection and critical reflection; or on constructivist approaches to learning, which emphasize, for example, the need for involving collaboration with more capable peers [Huang 2002] to develop knowledge. The instrument may thus avoid simply presenting behavior change recommendations or defining behavioral programs (e.g., “You should do these exercises for one hour today”), explaining instead the reasons resting behind such recommendations and programs. Alternatively, designers could provide “online spaces” for discussion, where small groups of peers may share their behavior change attempts and some “expert individuals” may take the role of mentors, helping others develop knowledge and understand better how to face the change. Previous research has shown that “others,” whether experts or not, may support people in their attempts to change [Agapie et al. 2016b; Bhattacharya et al. 2017; Rutjes et al. 2019]. These virtual spaces should elicit a sense of intimacy and “safeness,” aiming at making people more inclined to publicly share their doubts about the change, express their existential concerns, or listen to others.

6.2 Capture the Wider Context of Life and Integrate it into the Behavioral Intervention

Barrier 3: People may bump into life circumstances that hinder the process of change. Data coming from the interviews highlight that behavior change needs to fit in between the other matters that individuals have to deal with in their daily life. The “context of life” impacts how the process of change is managed. For designers, this means that the life circumstances in which behavior change is enacted are not ancillary details but should be part of the intervention itself.

This may lead to greater consideration of the life circumstances of behavior change, meant as the set of everyday practices and existential matters that are intertwined with the process of change. On the one hand, this context needs to be recognized. Even though Ubicomp research keeps

advancing sensing technology to track contexts [e.g., Perera et al. 2014], the subjective nature of “life context” makes a fully automated detection difficult. Technology could then use the “objective” features of an environment or activity captured by these techniques, and then ask people to label the captured data even at a later moment. Alternatively, “objective” data collection may also rely on users’ self-reporting: for instance, research on food journaling suggests that a combination of lightweight capture through photos and active reminders could keep users involved in data gathering [Cordeiro et al. 2015]. The system, then, may detect that a specific meal has been made at a restaurant with other people, and then the person could specify that she was out with friends and did not want to follow the diet in that occasion, because she wanted to have fun and feel less alone, and eating was a means to achieve these important objectives. To encourage such manual annotations, gamification techniques may be employed [Rapp 2017]. The system could then start recognizing that for that user in certain situations, the behavior change goal may be put in the background, thus tuning the behavioral program accordingly. Moreover, collected “objective” data could be used as material in coaching-client interaction, as Rutjes et al. [2019] suggested. This would mean to design for human expert involvement in behavior change, whereby the technology can work as a facilitator: here, data could work as triggers and remain ambiguous (e.g., about the why of the behavior), whereby the interpretative level could be left in the hands of the human coach interacting with the client through collaborative reflection [Rutjes et al. 2019].

On the other hand, the life context may become a relevant variable of the intervention itself. Systems may invite users to act not only on their own behavior but also on the life circumstances that impede the process of change, by providing suggestions addressed to change the situation in which certain behaviors are performed: for example, the system may highlight that whenever the person spends too many hours at home in a day, she tends to increase her daily calories intake; then, it may suggest that she takes some short breaks going outside, trying to modify the environmental conditions rather than directly acting on the behavior itself. Likewise, when certain life conditions change, the system may adjust the behavioral program to find a “new place” for the intervention given the new constraints and opportunities: for example, if the person has changed her job, having much less time to exercise outdoor, the system may recommend to do physical activity at home for a period, reworking her daily schedules and highlighting a time slot in which this can be done, also adapting the kind of exercise suggested according to the new context.

Moreover, technology may encourage people to reflect on the life context in which behavior change is embedded prompting open questions about the conditions that affect the process of change (e.g., for a freelancer who is trying to lose weight: *Did you notice that every time that you work too much you tend to drink more alcohol and eat foods with more fat? Why do you think this happens? What does it mean to you to work?*). In so doing, the system may display situations in which the person behaved differently to make her aware of how the circumstances may affect her behavior change attempts (e.g., by highlighting periods in which the person is on vacation and tends to eat healthier). Then, the person may be invited to change such context (e.g., trying to distribute more evenly the working hours, by suggesting different schedules or pauses, or enacting some relaxation techniques to reduce stress in periods of overworking), or to reinterpret the existential matters that are tied to the context itself (e.g., supporting the person in reflecting on the fact that overworking for her is a means for reaching a sense of security in her life, but when prolonged this condition may even reduce her overall safeness by compromising her health).

6.3 Connect with the Person’s Temporality

Barrier 4: People may find it difficult to integrate their present behavior change attempts with their own temporality. The study findings point out that behavior change needs to integrate into the past experiences and meanings of the individual to be successful, as well as be projected into the future

to make the person aware of how it will develop. This has nothing to do with features about the collection and display of past behavioral data offered by many self-tracking instruments [Elsden et al. 2016], or with the possibility of setting a future behavioral goal in behavior change systems [Consolvo et al. 2009]. Instead, it concerns the acknowledgment of the experiences that led the person to seek support in technology, the meanings that she ascribed in the past to the process of change, and the relevance of her past and future “selves” [Rapp and Tirassa 2017] to the present attempts.

Elsden et al. [2016] provided suggestions for remembering with self-tracking instruments, for example, by designing for recollecting specific moments. Rapp and Tirassa [2017] further recommended that designers should organize past data around the turning points of the individual’s life. Here, we suggest that systems could encourage people to specify how current behavioral data may be tied to relevant past experiences and meanings, as well as to annotate past data in order to connect them with relevant existential matters occurring at those times. These “enriched data” may then be used as a basis for elicit reflection on how the process of change evolved over time. For example, the system could prompt questions like, *why was I eating so much 15 years ago? What were my objectives at that time? Why did I have them and how did they form? How did I feel and what did eating mean to me? What does it mean to me now and why am I still trying to lose weight?*

Different kinds of interaction modalities and visualizations could then be made available [Rapp and Cena 2015] in order to avoid that certain ways of displaying data can elicit dysfunctional meanings (e.g., by allowing people to inhibit the quantification of nutrients, and proposing, for instance, a qualitative “classification” using colors that simply highlight how much healthy the food is for the individual). In other words, the person’s past should be used as a basis for the personalization of both the interaction and the intervention.

On the other hand, the clinical context may provide insights for widening the temporality of the system to the individual’s future. “Looking forward” is a strategy that encourages the person to imagine two possible futures, whereby the first future depicts a scenario in which she continues on the same path without any change, while the second future is if she decides to make a change [Hardcastle et al. 2013]. Systems could support people in envisioning such futures by prompting open questions like *what that future may be like if you did decide that now is not the time to change? If you were to change, what would life be like in the future? How would you feel? How would things be different?* [Hardcastle et al. 2015]. Alternatively, they may allow people to “compose” future scenarios, by offering simulation tools that, given the present collected data and behavioral goals, enable the person to vary certain conditions and see how the data and the whole lifestyle will evolve: such tools could allow the person to experiment different futures, both positive and negative. In comparison to future-oriented designs that forecast people future behavior and expected goal achievement rates [Rho et al. 2017], or anticipate events close to the site of the intervention to help people manage their effects [Lee et al. 2020], such scenarios would be far “richer,” in terms of connections of the behavior with the person’s future life, and “more distant,” allowing for the exploration of the long-term consequences of behavior change.

7 LIMITATIONS

This work presents some limitations. First, it has been conducted in only one country, so the findings that we pointed out may be culturally dependent: further studies involving participants from diverse cultures should be conducted. Second, we focused mainly on the health domain, paying more attention to dieting and exercising. Even though we accounted for other behaviors, like smoking and drinking, and also included an outlier, our findings may have limited generalizability to other domains, like sustainable behaviors: however, exercising and dieting appear extremely common tackled behavior in behavior change and persuasive technologies research, so that our

findings may be useful to a broad community of scholars and designers. Moreover, most participants (apart from U9, U16, and U19) did not have chronic illnesses urgently requiring a behavior change effort, so that our insights may not be applicable to cases in which behavior change is a matter of life and death. In fact, people adopting technology to understand and tune their behavior around a chronic illness may need even more to build knowledge about the behavior to be changed (e.g., to understand ambiguous symptoms and find effective behavioral solutions to mitigate them) [Mishra et al. 2019]. However, they may also avoid health-related information and meaning-making as a psychological defense mechanism [Burgess et al. 2019]. In this perspective, reassurance could play a major role [Singh et al. 2014]. Moreover, on the one hand, “objectivity” of the tracked data could combat tendencies toward denial that could lead to the worsening of the condition [Mishra et al. 2019]. On the other hand, tracking behavior could be a constant reminder of difficulties of people’s health condition and the stress associated with tracking could even contribute to symptoms [Schroeder et al. 2018]. This tradeoff, therefore, should be taken into account in the design process.

It is further worth noticing that the model is not specifically tied to behavior change technology, yet is informed primarily by interviews that only included people using technology for behavior change. This potentially widens the applicability of the model but might also diminish its validity. However, the findings coming from this study align with those discovered in previous research on people undergoing “changes” regardless of technology use [Rapp et al. 2019], which may thus further ground the validity of the existential model. Future work exploring how people change specific behaviors with and without technology could confirm the findings of this study and the model based on them.

Finally, using interviews and IPA allowed us to focus on individuals’ personal meanings in a way that is not possible to achieve through quantitative methods, which however could have possibly hindered the emergence of the “external aspects” of behavior change”. Nonetheless, we did not encourage the participants to provide “internal or existential accounts” of their changes. We simply asked them to recount them and to explain to us how they evolved, and what kinds of impacts they had. The importance of “existence” and “internality” thus emerged spontaneously. The freedom we left in recounting experiences allowed us to grasp what the participants considered important.

8 CONCLUSION

In this article, we adopted a phenomenological lens to understand how people perceive, account for, and enact their behavior change attempts. The empirical study we presented made emerge four relevant themes about the behavioral changes recounted by the participants, which brought insights in the design of behavior change systems.

First, we emphasized that, for the participants, behavior change is tied to meanings that point to personal and often existential matters. While sense-making about the target behavior impacts on how the process of change is managed by the participants, the technology used by the participants appears not to provide sufficient support for the construction of meanings. Second, we highlighted that behavior change is connected with a nexus of life circumstances that are essential part of the process. Nonetheless, used technologies mostly focus on the target behavior ignoring the links to the life aspects that are intertwined with the behavioral attempts. Third, we noticed that behavior change unfolds over long periods of time and may evolve over different “phases of life.” The behavior change systems used by our participants, nevertheless, focus on present behaviors, targeting a narrower temporality that does not account for past experiences or distant futures. Finally, we pointed out that the successfulness of a behavior change attempt may not merely refer to the achievement of the behavior change goal but may be connected with the individual’s existential issues and may also yield side effects.

On the basis of these findings, we surfaced an existential model of behavior change that accounts for the meaning, the life context, and the life time to which behavior change is linked: this model puts in the foreground the internal and existential aspects of behavior change. Finally, we suggested that future behavior change technologies could give more relevance to people's sense-making, account for the life circumstances in which they are cast and acknowledge the long temporality of behavior change. We take both the model and the design suggestions to be preliminary and in need of further testing to disconfirm or strengthen their validity [Hekler et al. 2013].

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