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THEME ARTICLE: MENTAL STATE, MOOD, AND EMOTION

Unboxing the Clinical Health Technology Deployment

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Recent years have seen numerous clinical deployments of digital technologies in support of new practices of healthcare. Mobile devices in particular offer many advantages in regard to their deployment for the purposes of shaping care. Yet, these systems and their implications for practice are not predetermined but crafted, often in unforeseen ways, by design. Amidst growing knowledge of complex clinical contexts, human–computer interaction researchers have come to understand the need to approach design as participatory, iterative process grounded in research, and informed by the experiences of stakeholders broadly defined. In this article we build upon prior efforts to support care, by making the case for a recentering of the artefacts we perceive as "designed," "designable," and "design-worthy" in the creation and implementation of the digital health intervention. In doing so, we draw on the example of a mobile health technology platform to support mental healthcare through Danish primary care.

I t is increasingly to pervasive, digital technologies that we turn today when implementing any new vision for the practice of healthcare—from mobile applications to virtual reality headsets.

These technologies and their implications for practice however, do not come to us predetermined, readily implemented, nor often easily understood. They are instead crafted, often in unforeseen ways, by design— process and practice now the focus of fields from design thinking to implementation science, science and technology studies, computer science, and human–computer interaction (HCI).[1,2] The efficacy of these interventions is today understood to hinge on conceptions of their design as comprising not only aesthetic considerations but as craft and process, methodology, and epistemology for the purpose of realising new ways of being and relating to ourselves and others as much as new practices and experiences of care.[3]

Yet successfully deploying digital technologies in clinical practice remains no easy feat. As designers, we aspire to support enthusiastic and sustained patterns of adoption, engagement, and appropriation, yet often encounter medical professionals whom speak instead of their "hatred" for their computers.[4] While the combined efforts of medical, HCI, and social science researchers have long granted us knowledge of clinical practice,[1,5] we require also the effective means of leveraging this insight in support of new and improved practices of care.

In this article, we build upon prior efforts to design for care by making the case for a recentering of the artefacts we consider "designed," "designable," and "design-worthy" in the creation and implementation of the digital health intervention. By artefacts "designed," we refer in this work to the at-times narrow category of tools and systems we seek and act to shape by design (e.g., often the primary features of a mobile app). By "design-worthy," we refer to the middle-range category of those materials and technologies we might consider as yielding a sufficient impact on practice to merit active engagement in their design (e.g., often including paper-based materials to support system setup and use). By "designable," we refer to the

broadest category of artefacts and practices, which we might possibly consider amenable to design (e.g., from packaging to nametags).

Each of these categories are always in-flux and open to interrogation, often not known at the outset of health technology deployments, and typically not discussed in the literature. Here, we explore these important design considerations, drawing on the example of the design and deployment of a mobile health technology platform to support mental healthcare in Danish general practice.

IMPLEMENTING CARE BY DESIGN

The capacity of digital technologies to shape our actions, experiences, and even beliefs has made improving health and wellbeing the de-facto objective and implicit ethical imperative of many HCI and computer science researchers. This has in turn given rise to the design of numerous personal and public health interventions in recent years with myriad digital technologies at their center, from mobile applications to smartwatches and heart-rate monitors.[6]

Each of these interventions consists of an attempt to bridge theory and practice in the real-world implementation of a particular vision of care, elevating the critical role of design in affecting change. Proponents and theorists of design thinking were among the first to posit formal definitions of design, typically as practices for the resolution of "wicked" problems permitting only "best possible" solutions.[7] Victor Papanek, for example, conceived of design as "the conscious and intuitive effort to impose meaningful order,"[8] and Herbert Simon as an approach to problem solving grounded in "satisficing" rather than optimization, "shaping and squeezing" real-world problems to requirements.[9]

Recent advances in digital technology have yet only amplified the need for knowledge of the ways in which systems, services, and individuals interact to produce and enable new practices and experiences of care by design—leading HCI researchers, in particular, to develop a wide range of design research methods, value-sensitive, participatory, user-, service-, and human-centered in nature.[3] Positioning design as non-deterministic, iterative process, grounded in research and informed by factors medical, technological and interpersonal in nature, HCI has therefore done much in recent years to promote a broad conception of that which matters in the design and deployment of the digital health technology intervention.[1,2]

Digital health technology design is of course crucially also a practice not only of knowledge production but decision-making in regard to particular artefacts; entailing the "inscription of modes of use," as Akrich and Latour write, limiting or forbidding certain actions while allowing or requiring others.[10] The consumer technology industry has long embraced this philosophy, as perhaps best exemplified in the form of the "unboxing experience," wherein design choices made in relation to artefacts diverse in nature are collectively leveraged to produce a particular user experience. In this article, we attempt to likewise advance our capacity to shape care by design, and expand the clinical health technology discourse, by articulating the many and diverse artefacts of the digital health technology intervention.

MENTAL HEALTH AND HEALTHCARE IN DENMARK

Novel digital health technologies are more and more often developed as means to address a growing variety of increasingly complex health challenges. "Severe mental illnesses" (SMIs) including major depression, bipolar disorder, and schizophrenia represent one such global public health priority, due to both their growing incidence and significant impact on individuals' quality of life.[11,12] In Denmark, it is estimated that 5% of the population will experience one form or another of SMI in their lifetime, living as a result on average 5–15 years less than the general population.[13]

Importantly, this significant reduction in life expectancy has been shown to be associated with the underdiagnosis and undertreatment of comorbid physical conditions rather than individuals' mental health,[14,15] inspiring multiple public health efforts in recent years to implement increasingly holistic practices of care.[16,17] Change, however, has proved difficult to realise, leading public health researchers to call for the development of new and increasingly collaborative approaches to care, including new "ways, tools or questions" to support the disclosure of discarded patient knowledge.[14,15,18]

The broadest remit for the provision of care within Denmark rests with general practitioners (GPs), described not only as "gatekeepers" to care but "the last station" for patients in need.[19] Despite a long-standing focus on person-centered care in Denmark however, GPs still speak of struggling to reach a patient group—those experiencing SMI—whom themselves speak of feeling unseen and unheard.[18]

THE SOFIA RESEARCH PROJECT

It was these challenges and opportunities alike, which led to the development of the SOFIA project; a

national Danish research collaboration devised to reduce early mortality and improve quality of life among patients experiencing SMI, by improving the treatment of comorbid mental and physical health conditions in primary care. This effort to develop and deploy in practice a new structuring of care is supported by an interdisciplinary project team comprising medical doctors, public health researchers, epidemiologists, anthropologists, computer scientists, and HCI researchers—as by a particular framing of the role of digital health technology in supporting care.

Designing a Public Health Intervention

While much prior work has focused on mobile technologies as means of gathering data about patients for the purposes of informing professional practices of diagnosis and decision-making, we employ Monsenso, the digital health technology platform at the heart of this project, for the explicit purpose of facilitating more effective conversations and developing more effective relationships between patients and GPs—as legitimate means in their own right to more effective care.[15]

To implement this particular vision of care, we devised a project plan comprising three phases of mixed methods, iterative, and participatory design research. First, a qualitative research phase to develop insight into the practice and experience of mental healthcare, involving interviews and design workshops conducted with public health researchers, GPs, and patients. Second, a small-scale feasibility study of the technology configured for use in clinical practice by 20 patients distributed across five primary care practices for a period of two to four weeks, beginning and ending with structured consultations each 30 minutes in duration, and finally, a randomised controlled trial of the technology in use at scale.

In this article, we focus on the second phase of this work, and in turn on the design, for implementation in practice, of a digital public health intervention part of a small-scale feasibility study comprising the following seven steps for the engagement of stakeholders.

1) First, GPs would be approached, by phone, email and in-person, to elicit expressions of interest.
2) Members of the research team would then visit interested clinics to walk both GPs and selected clinical staff through the study and technology design, obtaining consent and demographic information, registering Monsenso platform accounts, working with GPs to draft a list of potential patient participants, and instructing clinical staff in regards to their recruitment.
3) Clinical staff would then make calls to these patients until a total of four are recruited, each of whom is sent participant information by post.
4) Information sessions for each participating patient would next be conducted, during which researchers would introduce the study in-person, answering questions, collecting completed documentation, registering Monsenso platform accounts, and setting a date, in collaboration with clinical staff, for the patient's first consultation.
5) This 30-minute consultation would entail a structured discussion of the patient's health and wellbeing, experiences for self-report using the Monsenso app during the next two to four weeks, and a simple, personalised "care plan."
6) During the second and final consultation, GPs and patients would then review both this self-reported data and the original care plan. Following this consultation, patients would be asked to complete a poststudy questionnaire and to participate in an interview 1-hour in duration.
7) Finally, upon completion of each clinic's participation, both clinical staff and GPs would complete poststudy questionnaires and participate in 45-minute interviews.
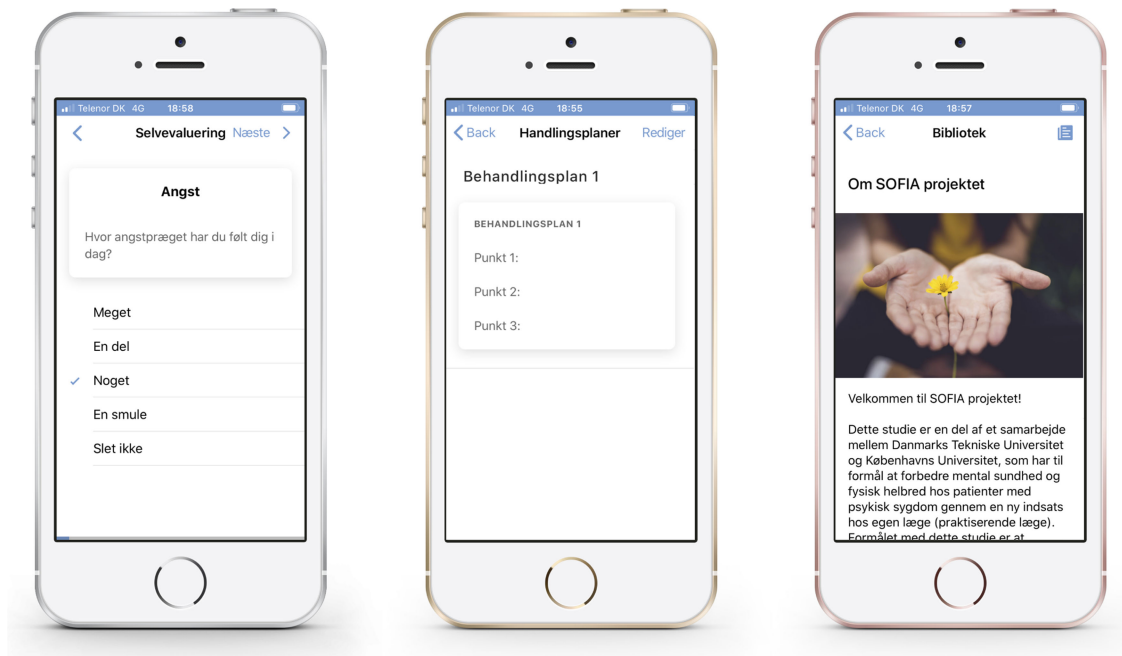
Designing a Digital Health Technology Platform

Of course, how this vision for care would be precisely realized in practice is a function of design, and design process, and, our design efforts pertained in particular to the digital health technology at the heart of this intervention.

a) A digital center

The first phase of this process involved the conduct of semistructured interviews with patients and GPs, as well as participatory design workshops conducted with collaborating health professionals including GPs, psychiatrists, and epidemiologists. Insights gained during these interactions with stakeholders led to the configuration of the Monsenso mobile app to enable patients to self-report selected information regarding their health and wellbeing in daily life, examine care plans created during consultations with GPs, view data shared, consult sources of support and information in regard to the research project, and adjust a variety of settings including the timing and composition of the questions posed each day (see Figure 1). The clinical web interface in turn was configured to

FIGURE 1. Design materials | The SOFIA Mobile Digital Health Technology Platform [Monsenso], showing examples of self-reporting (left), care-plan (center), and patient-information (right) features.

grant GPs the capacity to view information shared by patients, not for the purposes of monitoring but for discussion in-person, and to enter digital care plans developed during consultations.

These systems were therefore composed, as any technology, of myriad design choices, on whose communication hinges our capacity to understand their implications for practice. Taking as an example, the self-report component of the patient app, this feature was configured to enable patients to select from a list of 28 prepopulated constructs—five denoted as possible default options, and two mandatory—or add new questions of their own choosing (see Figure 1). These design choices were made with users' autonomy and engagement in mind, striving to ensure that information shared would reflect what matters most to patients, streamline the configuration process, destigmatize and surface conversations highlighted as valuable during our own and related prior research, and provide the research team with a limited population overview.

As became clear however, the design for implementation in practice of a digital health technology intervention is about much more than the digital health technology itself.

b) A diverse periphery
Through our design efforts in collaboration with stakeholders, it became evident that this intervention was comprised of not only the digital technologies at its center but of numerous "peripheral" artefacts also— each with a role in the scaffolding of practices of recruitment, participation, research, and engagement in addition to the installation, configuration, implementation, and use of the technology platform. This included, and came to include, digital and paper-based materials from participant information leaflets to webpages, appointment cards, information booklets, and more (see Table 1).

The design decisions made in relation to these artefacts were equally numerous and diverse in nature. Taking the *information booklets provided to GPs* as an example, this 16-page A5 brochure came to include welcome information, step by step instructions for GPs' participation, a guide to the setup and use of the web interface, a consultation structure and checklist, information regarding the study's aims, data management, expectations for participation, sources of support, and space for notes (see Figure 2). The content of each of these sections was presented using concise phrasings and familiar vocabulary, modern readable fonts, color highlighting, custom graphics, and accessible illustrations, not only to create a pleasant and professional user experience but to inspire and communicate key values and practices in support of the overarching objectives of the digital intervention.

TABLE 1. Design materials | Selected component parts of a clinical health technology deployment.

Patient Components	GP Components	Clinical Staff Components	Researcher Components
Mobile App	Web Interface	Appointment Card	Web Interface
Patient Booklet (incl. a Welcome, Step by Step Instructions, a Guide to the Mobile Platform, Sources of Support, and more)	GP Booklet (incl. a Welcome, Step by Step Instructions, a Guide to the Web Interface, Consultation Structures and Checklists, and more)	Staff Booklet (incl. a Welcome, a Checklist and Tables for the Recruitment of Patients, Data Management Information, and more)	Researcher Booklet (incl. a Telephone Script, Email Templates, Checklists for GP and Patient Information Sessions, and more)
Consent Form	Consent Form	Consent Form	Social Media Recruitment Banner
Participant Information Leaflet	Participant Information Leaflet	Participant Information Leaflet	University Recruitment Webpage
Pre-Study Questionnaire	Pre-Study Questionnaire	Blank Stamped Envelope	Patient Post-Study Interview Guide
Post-Study Questionnaire	Post-Study Questionnaire	Post-Study Questionnaire	GP Post-Study Interview Guide
–	-	Lead Researcher University 'Business' Card	Clinical Staff Post-Study Interview Guide

Pages 8 and 9 of this booklet, for example, provide a structure for the first consultation (see Figure 2). The verso page outlines in text form a conversation comprising first a general discussion of the patient's health and wellbeing followed by configuration of the digital health platform; concisely presented in a visually engaging fashion to facilitate use immediately prior to each consultation. The recto page simultaneously provides a full-page graphic outline of the default self-report constructs made available to patients, intended for use during the consultation itself, as an anchor for conversation in support of the envisioned use of the digital technology.

Of course, not all materials part of an intervention are as comprehensive, nor their design as involved, as these instruction booklets. At other times, the act of design consists as much in an artefact's inclusion or exclusion. This study design also entailed, for example, the provision of a custom stylised *appointment card* to each patient prior to each consultation (see Figure 3). The purpose of this card was of course to serve as a physical reminder for patients—a population group often strikingly difficult to engage in primary care. It was also however, introduced with the aim of inspiring belonging, ownership and reciprocity among patients, and clinical staff alike; as a sense of feeling seen, heard, and cared for.

The *envelopes* used to deliver participant information to patients in advance of their first appointment were similarly designed in terms of the choice of a university branded envelope to foster trust and enthusiasm, the addition of white stickers to facilitate clear address placement for clinical personnel, and the prior application of postage stamps individually applied for a

personalized look and feel. The placement of the lead researcher's *"university business card"* among the materials for clinical personnel was likewise seen as a small contribution toward a more complete experience of trust, comfort, collaboration, and communication.

c) An integrated whole

The successful implementation of any health technology intervention then requires attending both to the composition of the artefact ecology as a whole "across" the intervention as to the respective design of each component part multiple levels "down."[20] The combination and contrast of these materials was therefore a question of design in itself, in a clinical context where pressure on time and cognitive resources is a constant factor.

We designed a project logo and visual theme for the purpose of communicating a coherent and consistent project identity, yet also worked to enable participants to quickly and easily distinguish different materials. This was achieved for paper-based artefacts through the use of diverse physical forms and printed formats. The instruction booklets intended for frequent consultation during the study, for example, were printed as A5 brochures, all other participant materials requiring slower paced reading in A4 form, and appointment reminders in business card size for ease of transport (see Figure 3).

d) Comprising many stakeholders

The implementation and conduct of the intervention at the heart of this study then required the involvement of

FIGURE 2. Design materials | Opening pages of the GP brochure.

multiple stakeholders, whose engagement and ownership of relevant artefacts it became important to consider. It is worth highlighting in this respect our inclusive definition of researchers as participants themselves in the progressive realization of a new practice of care, and as stakeholders for whom documentation was also designed with the interdisciplinary makeup of the project team in mind. We equally found it important to consider which elements of the intervention and study design were communicated to which participants and to which level of detail. We chose, for example, to include within the patient booklet and app a brief explanation of the GP's envisaged use of the clinical interface during consultations—setting expectations for patients, highlighting the consultation as locus of care, emphasising the participatory, and patient-centered ethos of the intervention, and in turn granting patients not only the knowledge but confidence to participate in decision-making.

It is the sum of these many small acts of design, which makes an intervention; its implementation, patients' and health professionals' experiences, and our ability as researchers to understand its effects.

COMMUNICATING A VISION FOR HEALTHCARE PRACTICE

Public health intervention design is therefore in large part, about communicating a particular vision of healthcare.

The efficacy of any intervention hinges first and foremost upon the clear communication for consistent implementation of its component parts. The communication design of an intervention is also however, not only about information transfer but values, tone, and ethos also. The design decisions we make give rise to new socially situated experiences as much as digitally mediated interactions, and years spent developing a new care pathway may prove less- or even ineffective should the documentation provided to a vulnerable patient population prove outdated, confusing, or employ stigmatizing language.

Our capacity as a research community to generate knowledge and inspire progress in regards to health intervention design, therefore, rests furthermore upon our ability to articulate processes followed and decisions made in support of implementation.

RECENTERING THE DESIGNED, DESIGNABLE, AND DESIGN-WORTHY

In this work, and by means of this example, we make the case for a recentering of the artefacts "designed," "designable," and "design-worthy" in the creation and implementation of the digital public health intervention (see Figure 4).

First, what we design. Recruitment websites, app store listings, online user guides, paper-based consent

FIGURE 3. Design materials | Paper-based artefacts part of the SOFIA Mental Health Technology Deployment.

forms, questionnaires, and appointment cards, even stamped envelopes; these are all mechanisms of action and means of influence, component parts of our interventions and designed elements of the user experience. Reflecting on that which we already consider "designed"—particularly if narrowly defined—therefore advances our capacity to identify, define, and understand our interventions as they evolve in design and practice. Second, what else might we design? If an intervention to us comprises only an app, it is very likely that we are missing opportunities to realise and reinforce the technology's potential for change. One decision we can make in this respect is to design actively rather than passively, and to embrace design as process and craft in relation to artefacts digital, tangible, and interpersonal in nature. The impact of choices made in the design of these artefacts can equally be weighed through the lens of concepts amenable to design including a sense of ownership, professionalism, trust, care, and reciprocity—each in their own ways levers for change. Finally, it is worth asking ourselves of what consists a worthy focus of our design efforts. Of what is the center of our intervention comprised, what is ancillary yet meaningful, and what is truly peripheral? The task of the mobile health intervention designer is then to exert influence over a highly complex ecology of care in support of a particular vision for practice, while granting human users and participants the autonomy required for the system as a whole to flourish. For many years, the commercial technology industry has recognized the value of embracing and expanding the opportunities at our disposal for shaping users' experiences—as exemplified in the out-of-the-box, plug-and-play, and unboxing experiences. By following in these footsteps, we argue, designers and researchers of mobile health interventions may likewise expand our capacity to shape care by design. The design vocabulary introduced in this article, it is our hope, offers diverse pathways toward realizing these aims, by serving as a framework to inspire reflection and facilitate design, a checklist to enable improved understanding of study designs and interventions, and a tool for the consistent scientific communication and documentation of artefacts.

UNDERSTANDING WHAT WORKS AND WHY

Of course, the aim of realizing change in public health-care is complicated by and contingent upon the need to study the effects of our design choices. As
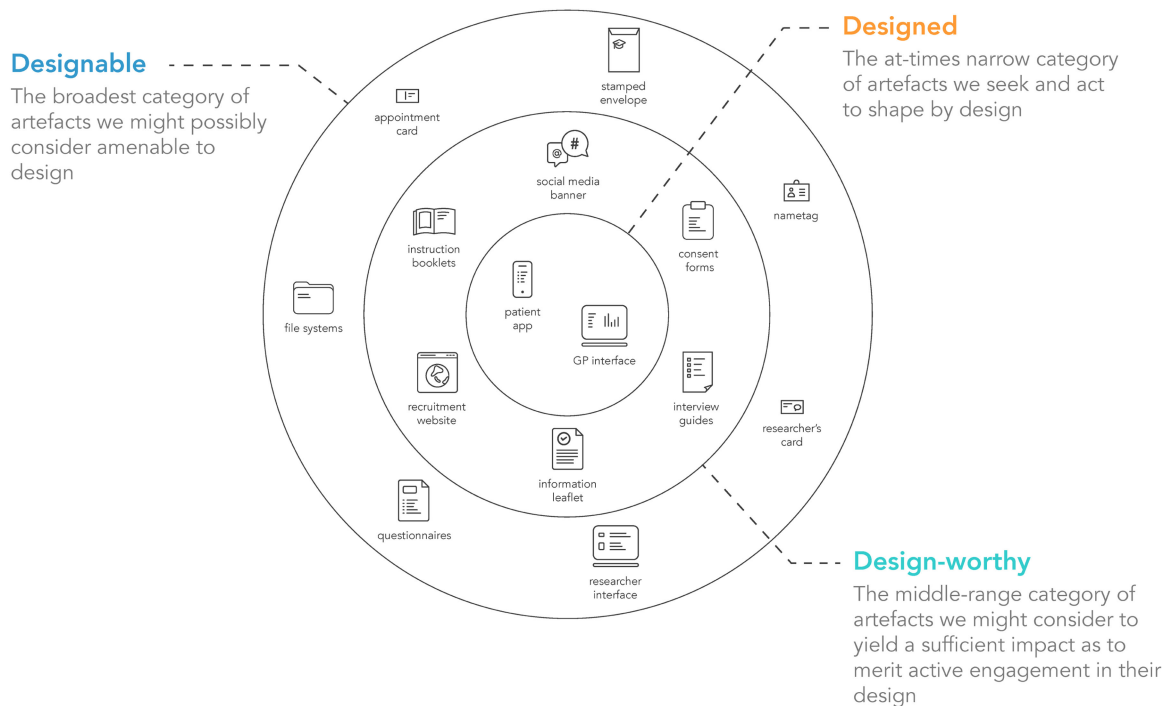
FIGURE 4. Health technology intervention components often considered designed, designable, and design-worthy.

researchers we are interested not only in the creative act of design but in understanding what works and why, and yet the scaffolding we build around many technology deployments to support research must be accurately viewed as itself a part of the user experience and therefore the intervention, rather than as purely ancillary structure or as solely facilitating scientific understanding.

A broader conception of the component parts of our interventions may render the process of generating knowledge of their effects more complex, yet also more insightful, when approached with certain potential pitfalls in mind. First, it is important to ensure that the implementation and experience of an intervention stray not too from our vision of and for it. This requires us to generate knowledge not only of the overall impact of our interventions, but of their precise mechanisms of action, and the ways in which their implementation might deviate from our vision of and for their design. Second, it is important that the interventions we study differ not too significantly from the same interventions as they might be implemented in practice without the adjacent scaffolding of a research study. By elevating awareness of the design choices made in regard to study materials also, we can help to close this research-practice gap.

These considerations apply to technology deployments and studies of all shapes and sizes. If patients experience a mobile app as unappealing, stigmatizing, or untrustworthy, this will have an impact on the efficacy of the intervention it is designed to communicate. The outcomes of a feasibility study with 10 participants and a randomized controlled trial with 2000 may equally hinge on the wording of a consent form never described in the scientific articles, which follow their conclusion. The lines between research and consumer technologies are increasingly blurred by numerous factors including, as in this example, a growing focus on the ethics of sensitive personal data collection and the need to obtain truly informed consent.

To realize new and improved practices of care, it is therefore essential that we work not only to create innovative digital health interventions but to know and communicate our design choices in relation to the many and diverse artefacts of which any digital health intervention is composed.

CONCLUSION

In this article, we argue for a recentering of the artefacts "designed," "designable," and "design-worthy" in the creation and implementation of the digital health intervention. By writing of the practice of design, broadly defined, in mobile health intervention design,

we hope to broaden our conception of the means by which change is realized in practice.

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