A user-centered model for designing consumer mobile health (mHealth) applications (apps)

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A B S T R A C T

Background: Mobile technologies are a useful platform for the delivery of health behavior interventions. Yet little work has been done to create a rigorous and standardized process for the design of mobile health (mHealth) apps. This project sought to explore the use of the Information Systems Research (ISR) framework as guide for the design of mHealth apps.
Methods: Our work was guided by the ISR framework which is comprised of 3 cycles: Relevance, Rigor and Design. In the Relevance cycle, we conducted 5 focus groups with 33 targeted end-users. In the Rigor cycle, we performed a review to identify technology-based interventions for meeting the health prevention needs of our target population. In the Design Cycle, we employed usability evaluation methods to iteratively develop and refine mock-ups for a mHealth app.
Results: Through an iterative process, we identified barriers and facilitators to the use of mHealth technology for HIV prevention for high-risk MSM, developed 'use cases' and identified relevant functional content and features for inclusion in a design document to guide future app development. Findings from our work support the use of the ISR framework as a guide for designing future mHealth apps.
Discussion: Results from this work provide detailed descriptions of the user-centered design and system development and have heuristic value for those venturing into the area of technology-based intervention work. Findings from this study support the use of the ISR framework as a guide for future mHealth app development.
Conclusion: Use of the ISR framework is a potentially useful approach for the design of a mobile app that incorporates end-users' design preferences.

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1. Background and significance

Mobile health technology (mHealth) is a promising tool for engaging patients in their own health care because most people own and regularly use a mobile phone and mHealth can be an appropriate medium for delivering health information [1]. In specific, mHealth can be used as a powerful health behavior change tool for health prevention and self-management as they are ubiquitous, carried on the person and are capable of advanced computational capacity [2,3]. Given the great potential of mHealth, it is not surprising that current estimates suggest that there are more than 40,000 mHealth applications (apps) [4].

As these mHealth technologies proliferate, the design of effective tools is becoming increasingly important [5]. mHealth apps continue to proliferate with little evidence for their effectiveness and little support for understanding how best to design the apps [6]. Many current mHealth interventions are designed on the basis of existing healthcare system constructs and may not be as effective as those that involve end-users in the design process [7]. Apps need to be produced with adequate consideration of the needs of their intended users so that they are easy to use and perceived as useful [8]. In a healthcare system already burdened with suboptimal outcomes and excessive costs, premature adoption of untested mHealth technologies may limit positive health behavior change. mHealth tools may then ultimately fail to accomplish their

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objectives and may be ineffective or, at worst, yield adverse outcomes [9].

Our study focused on designing a mHealth app for men who have sex with men (MSM), a population who are heavily affected by HIV and frequent users of mobile technology [10]. In response to this need, we set out to use the ISR framework to design a mobile app for improving prevention behaviors in high-risk MSM.

2. Objective

With the proliferation of mHealth apps, there is an increased need for design processes that result in apps that are robust, usable, and effectively support healthful behaviors in consumers' daily lives. The purpose of this paper is to report on a process that can be employed as a guide for the design of mHealth apps. The user-centered design processes that are reported in this paper have been used in previous formative work (e.g. focus groups [11] and participatory design sessions [12]), however they have not been widely applied to the design of mHealth apps. More importantly, while user-centered methodologies have been independently applied in technology development, the holistic approach, reported in this manuscript, incorporates a series of different methodologies which are iteratively applied across the design process. Our approach is unique since it incorporates multiple user-centered design methods (focus groups, participatory design sessions, usability evaluation methods) and end-user feedback to inform the design of a mHealth app.

3. Methods

3.1. Theoretical framework: the Information System Research (ISR) framework

The Information System Research (ISR) Framework guided the implementation of user-centered human–computer interaction research methods to identify mHealth needs of user, mobile app design preferences, and the barriers and facilitators that prohibit or encourage the uptake and sustained use of mobile apps for HIV prevention, treatment and care [13]. The ISR Framework (Fig. 1) employs various design processes in order to build a product or design an artifact such as a mHealth app. As applied to this project, it comprised three research cycles: the *Relevance Cycle* in which we sought to understand the environment of the end-user by determining requirements through a series of focus group interactions with stakeholders; the *Design Cycle* in which artifacts were produced and evaluated; and the *Rigor Cycle*, in which evaluation

of theories and artifacts contributed to the design science and application domain knowledge base [13]. The cycles do not need to be conducted linearly. In fact, it may be preferable to conduct them in an iterative process, which was the case in our research activities. We briefly summarize published work related to the Relevance and Rigor Cycles to emphasize the interactions among the cycles and then provide detailed methods and results from the Design Cycle for the mHealth MSM app.

To illustrate the use of the ISR framework for the design of a mobile app, we conducted a series of design processes with high-risk MSM. In this paper, we illustrate the operationalization of the ISR framework employing user-centered design methods for the design of a mHealth app for MSM. Similar procedures for the formative development for an app for persons living with HIV (PLWH) are reported elsewhere [10,14]. The overarching goal of this project was to inform the design of a mHealth app for HIV prevention and to identify technology preferences and features, HIV-related content requirements, design specifications, and issues related to long-term appeal and maintenance of apps in at-risk or affected populations.

3.1.1. The Relevance Cycle

To meet the goals of the Relevance Cycle, we conducted a series of focus group sessions with intended end-users. Eligibility criteria included: Men who reported having unprotected (condomless) anal sex with HIV-positive or unknown-status male partners, age 13–64, had the ability to provide written consent/assent and the ability to read and write in English or Spanish, and self-reported being HIV-negative or of unknown HIV status. Exclusion criteria included: consistent condom use over the past year for both receptive anal intercourse (RAI) and insertive anal intercourse (IAI), or monogamous unprotected anal intercourse (UAI) with partner of certified seronegative status. Flyers detailing the study were distributed at community-based organizations in New York City and at the Harlem Pride Day, an event celebrating the lesbian, gay, bisexual and transgender community in New York's Harlem neighborhood. Interested persons were screened over the phone.

From July–November 2013, we conducted five focus groups with 33 high-risk MSM ages 18–57 years to identify the desired functions and design of the proposed mobile app. Thematic analysis of the focus group session revealed five categories of functional requirements: My Information Management, Staying Healthy, HIV testing, Chat/Communication Function and Resources (Table 1). Each of these categories was discussed during later sessions with end-users to identify the desired content and functional requirements of a mobile app [15].
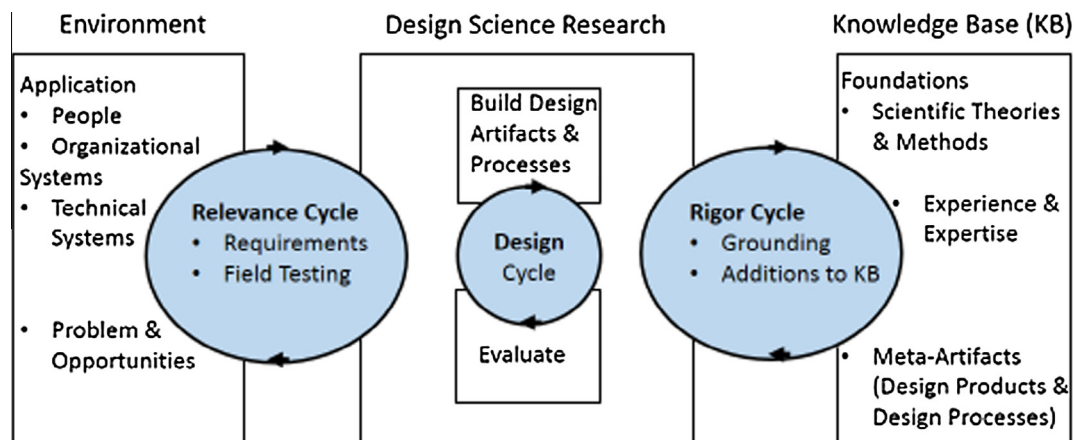

Fig. 1. The Information System Research (ISR) Framework.