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Understanding women's mobile phone use in rural Kenya: An affordance-based approach

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Abstract

Increases in mobile phone ownership and Internet access throughout Africa continue to motivate initiatives to use information and communication technologies (ICTs)—in particular, mobile phones—to address long-standing socioeconomic problems in the "developing world." While it is generally recognized that mobile phones may help to address these problems by providing pertinent information, less widely known is exactly how (and if) a handset's human–computer interface—that is, its software and hardware design—supports this form of communication. The concept of "affordances" has long been used to answer such questions. In this paper, we use Hartson's definition of affordances to qualitatively investigate rural Kenyan women's interactions with their mobile phones. Our detailed analysis provides empirically grounded answers to questions about the cognitive, physical, and sensory affordances of handsets used in our field sites and how they support and/or constrain mobile communication. We then discuss the implications of our findings: in particular, how this affordance-based approach draws attention to mobile phones' design features and to the context in which they and their users are embedded—a focus which suggests new design and research opportunities in mobile communication.

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affordances, design, Kenya, mobile phones, rural, women

Introduction

Mobile phone penetration rates across Africa are approaching 79%, and nearly 25% of the continent's population is using the Internet (International Telecommunication Union [ITU], 2017). The widespread and growing adoption of information communication technologies (ICTs) continues to generate optimism that they can be used to address persistent socioeconomic problems by providing marginalized groups—especially women—information on agriculture, education, healthcare, etc. (Vokes, 2016). Researchers and practitioners in information communication technology and development (ICTD) continue to develop mobile services to facilitate communication and information exchange by, for example, using short message service (SMS) to support maternal care (Perrier et al., 2015), to send farmers crop price information (Wyche & Steinfield, 2016), and to provide people with opportunities to earn money (Eagle, 2009). As with the mobile phone, greater access to the Internet is touted for its potential to create economic growth and inclusive development on the continent (Liew, Vaithilingam, & Nair, 2014). While it is generally recognized that mobile phones may help to address these problems by providing pertinent information, less widely known is exactly how (and if) a handset's human–computer interface—that is, their software and hardware—supports communication between users and these computational devices (Gane & Beer, 2008). Usability studies conducted in developing countries suggest that mobile phones are difficult to use (Medhi et al., 2011), and efforts to understand whether their design features (handset form, buttons, screens, etc.) are suitable for rural users are scarce. Such analysis is important, because even the best designed services are useless if their target audience cannot access information on their mobile devices, or if the devices themselves are not designed for the context in which they are used.

The concept of affordances has long been used to study people's interactions with technology to inform design (Norman, 1988). In this study, we used Hartson's definition of affordances to investigate the relationship between women in rural Kenya and their mobile phones. This definition—"affordances are characteristics of user interface objects and interaction design features that help users perform a task" (Hartson & Pyla, 2012, p. 643)—was developed to make the concept more specific and applicable to the context of design, and includes four complementary types of affordances: cognitive, physical, sensory, and functional. The following research questions guided our study:

RQ1: What are the affordances of mobile phones used in rural Kenya?

RQ2: How do these affordance types (especially the physical, sensory, and cognitive ones) (a) support and (b) constrain rural women's usage practices?

Our answers come from qualitative data collected as part of an ongoing project investigating rural women's mobile technical literacy, that is, their ability to use a mobile phone, especially its nonvoice and core functions (Global System for Mobile Communications GSMA, 2015; Wyche, Simiyu, & Othieno, 2016; Wyche, Steinfield, Cai, Simiyu, & Othieno, 2016). Our focus on women was deliberate, because they tend to have lower

levels of technical literacy than men (Dodson, Sterling, & Bennett, 2013). Furthermore, despite having been the targets of many ICTD interventions (Donner, 2008; Vokes, 2016), these women's mobile phone use practices are not well understood; hence, producing practical knowledge about women's experiences using mobile phones may lead to improvements in their design. We travelled to sites in Western Kenya in September 2014, June 2015, and March 2016. During each research trip, we conducted observations of, and group interviews with, women phone owners to learn about their mobile phones and their usage practices (a total of 24 group interviews, eight per field research trip; 55 women were interviewed three times). Data collection also included documenting which handsets the women had ($n = 116$).

Our findings suggest that Hartson's schema, especially its focus on mobiles phones' design features, provides a useful starting point for examining handset use in rural Kenya. Specifically, we detail how handsets' physical, cognitive, sensory, and functional affordances readily support some activities (e.g., receiving voice calls and deleting SMSs) but not others (e.g., sending SMSs, accessing the mobile Internet, and secure handling). We also found user-created affordances (i.e., "trails"; Hartson, 2003), discovered that many respondents wanted to buy discontinued handset models (e.g., Nokia 1100), and learned that poor design contributed to high handset turnover within our sample. Taken together, these findings contribute to a more comprehensive understanding of affordances, of rural women's mobile phone use practices, and raise questions about the effectiveness of developing SMS services for this context. We use these findings to discuss the benefits of using an affordance-based approach in studies of mobile phone use in rural Kenya, and elsewhere in Africa. In particular, we argue that such an approach draws attention to the complexity of rural women's interactions with their devices and to parallels between geographic regions, as they relate to mobile devices' design features.

Theoretical background and related work

An affordance perspective

The literature on affordances is vast and spans multiple academic disciplines (e.g., computer and information science, communication, design, and sociology). We do not review these literatures here; instead, we limit ourselves to introducing the concept and describe Hartson's (2003) efforts to make it more specific and applicable to the context of design. Nearly 30 years ago, psychologist James Gibson coined the term "affordance," to explain how animals perceive their environments. He suggested that animals observe not what an object is, but rather what kinds of uses it affords; he called such perceptions of an object's utility an "affordance" (Gibson, 1979). Don Norman (1988) popularized this idea among designers: because affordances provide strong clues to how things work (e.g., the shape of a coffee mug handle affords lifting, doorknobs afford turning, and the buttons on a mobile phone's keypad afford pushing), they are widely used to guide the design of usable products and graphical user interfaces (GUIs). Norman admits his definition is ambiguous—a lapse which has contributed to misuse of the word, and which he attempts to clarify in later writings by introducing the terms "real" and "perceived" affordances (Norman, 1999).

Table 1. Summary of affordance types.

Affordance type	Description	Example
Cognitive affordance	Design feature that helps users in knowing something	A button label that helps users know what will happen if they click on it
Physical affordance	Design feature that helps users in doing a physical action in the interface	A button that is large enough so that users can click on it accurately
Sensory affordance	Design feature that helps users sense something (especially cognitive affordances and physical affordances)	A label font size large enough to read easily
Functional affordance	Design feature that helps users accomplish work (i.e., the usefulness of a system function)	The internal system ability to sort a series of numbers (invoked by users clicking on the Sort button)

Note. Reproduced from Hartson (2003).

Hartson's definition: Affordances in interaction design

Wanting to make these terms more "useful and applicable concepts for interaction designers and practitioners," and working with a focus on "practical design issues" (e.g., font and button size; Hartson, 2003), Hartson extended and elaborated upon Norman's definition of affordances, writing: "Norman's perceived affordance becomes cognitive affordance, helping users with their cognitive actions. Norman's real affordance becomes physical affordances, helping users with their physical action" (Hartson, 2003, p. 316). He continues by introducing "sensory" and "functional affordances." A technology's sensory affordances help users with their sensory actions (i.e., see, hear, and feel), and their functional affordances, or design features help users accomplish work by adding purposes to physical affordances (e.g., such as software's ability to sort numbers, which happens after a user clicks a "sort" button; see Table 1).

A drawback of Hartson's definition is that it ignores a great deal of the context in which the theory of affordances originated (i.e., Gibson's original definition [1979]), and overlooks high(er) level interactions which are related to mobile media use and which are accounted for in other definitions of the term (e.g., communicative affordances; Schrock, 2015). However, this definition's emphasis on desgn features does have advantages: in particular, the way it draws attention to which features are available to users (and how those features are used; Fulk & Gould, 2009), and to the device's materiality ("the character . . . of objects that makes them useful and useable"; Lievrouw, 2014, p. 25). We use Hartson's (2003) schema for these purposes and contribute to the understanding of affordances by applying it to our study of mobile phones in rural Kenya, where ownership is becoming as widespread as it is in countries where much of our understanding of affordances originated.

Affordances and mobile phones in sub-Saharan Africa

Prior research into mobile phones and affordances in Africa includes Wyche and Steinfield's use of affordance theory to explain why so few Kenyan farmers use

M-Farm—a commercially available mobile application designed to send farmers pricing information via SMS (Wyche & Steinfield, 2016). The theory of affordances also guided Watson and Atuick's study of handset use in rural Ghana, in which they detail how the devices are changing everyday life there (Watson & Atuick, 2015). Bailur and Masiero use a definition of affordances to study mobile Internet use among women in urban Kenya (Nairobi), Ghana (Accra), and Uganda (Jinja); they conclude that handsets' affordances do provide some "new mechanisms for income generation," but fall short in "guarantee[ing] empowerment" for women (Bailur & Masiero, 2017, p. 77). Donner mentions affordances when explaining "beeping," in Rwanda. He observes that this widespread phenomenon of dialing a phone number and hanging up before the mobile's owner can answer, "utilizes the technological capabilities of the mobile." He adds that accounting for handsets' affordances "helps re-frame some questions about the role of mobile communication technologies in developing countries" (Donner, 2007, p. 3). We agree with his conclusion and argue that this reframing must include deeper analysis, which accounts for Hartson's physical, cognitive, sensory, and functional affordances (2003), and which considers how design features support and constrain use.

Our initial answers to these questions advance this prior literature by providing the aforementioned deeper analysis that results from using Hartson's schema to study mobile phones in rural Africa. We conducted a long-term study that included three research sessions with participants. Another distinguishing factor of our research is the incorporation of Kenyan researchers' perspectives into data collection, analysis, and authorship of this work. Further, and unlike these prior studies, we based our study on this practical and user-centric definition of affordances, because it is aligned with our interest in design and usability.

Method

Research design

A qualitative approach guided our study for the following reasons: there is limited information on mobile phone usability in rural Kenya; it is generally considered useful for allowing voices of marginalized individuals to be foregrounded; and it is recognized for providing the rich, contextual insights that are useful for understanding people's experiences with ICTs (Salvador, Bell, & Anderson, 1999). Over a 19-month period, we travelled to sites in Western Kenya in September 2014, June 2015, and March 2016. To answer our research questions, we conducted group interviews and observations of women performing tasks on their handsets. Lastly, we documented respondents' handsets, observing which models they had and how these changed over the course of our research.

Research context. Kenya exemplifies the remarkable and swift mobile revolution experienced throughout much of Africa, and recent reports suggest 93% of the country's households own mobile phones (Communications Authority of Kenya, 2015). However, Kenya—as is the case with many African countries—has a substantial urban–rural divide which affects ICT access. An estimated 70% of the country's population live in rural areas, where employment opportunities are few, and where people tend to be less educated and less informed about the latest ICTs (Freeman, Ellis, & Allison, 2004). Rural

households typically lack access to water and electricity; despite these challenges, mobile phones are present here and have been for nearly a decade, although—as is the case with many technologies—men were the first to have them (Murphy & Priebe, 2011). While women's access to mobile phones has grown, traditional gender roles have been slow to change and, especially in rural areas, women remain subordinate to men socially, economically, and politically (Chege & Sifuna, 2006).

Our field sites were in Bungoma and Homa Bay counties, both of which are located in Western Kenya (about a 7- to 9-hour bus ride from Nairobi) and have a predominantly rural character. The most recent figures suggest that households here mostly rely on small-scale farming as a source of income, 70% of households in these counties earned less than 5,000 Kenyan shillings (about US$50.00) per month, and more than half of them have mobile phones (Kusimba & Wilson 2007, cited in Kusimba, Yang, & Chawla, 2016). We focused on these rural areas because they are where critical technical and social challenges to using mobile phones are most salient (Wyche & Olson, 2018). We interviewed mothers, grandmothers, wives, widows, girlfriends, and members and leaders of community groups. A few owned small businesses or worked as teachers, but most identified as smallholder farmers. Broadly speaking, our participants are representative of people meant to benefit from ICTD efforts.

Researcher reflexivity. A cross-cultural team, embodying both African and Western perspectives, conducted the research. The primary author is a 42-year-old Caucasian female American professor, who has been conducting human–computer interaction research in Kenya since 2007. The other authors are from, and live in Western Kenya. Both are fluent in English, Kiswahili, and other languages spoken in our field sites (i.e., typically Bukusu in Bungoma and Luo in Homa Bay). They are trained qualitative researchers who collaborated with the first author for the duration of this project.

Participants. To recruit participants, we relied on contacts made through our personal and/or professional pursuits, and selected women who reported having a mobile phone because they would be most capable of answering our questions about using them. We conducted eight women-only group interviews, three at sites in Bungoma County and five in Homa Bay County (a total of 24 group interviews, each with 6–8 participants). Sessions took place in respondents' homes, community centers, and (on two occasions) in churches. Sixty seven women initially enrolled in the study; of these, 55 participated in each session. Over the course of our 19-month project, some respondents moved away, two died, and others were unable to attend sessions because of other commitments.

Respondents ranged from 20 to 72 years of age, and nearly all reported their primary residence as being in a rural area. Fifteen women were in their twenties, 21 were in their thirties, 19 were in their forties, 11 were in their fifties and sixties, and one was 72. Women under the age of 40 typically had some primary school education and a few had attended secondary school; four women in our sample were college-educated professionals. The vast majority had experience using mobile phones (although their familiarity with the devices varied), and most told us they had first came to own a mobile phone between 6 and 10 years ago, a finding that corresponds with prior analysis of the introduction of mobile phones into Western Kenya (Murphy, 2007).

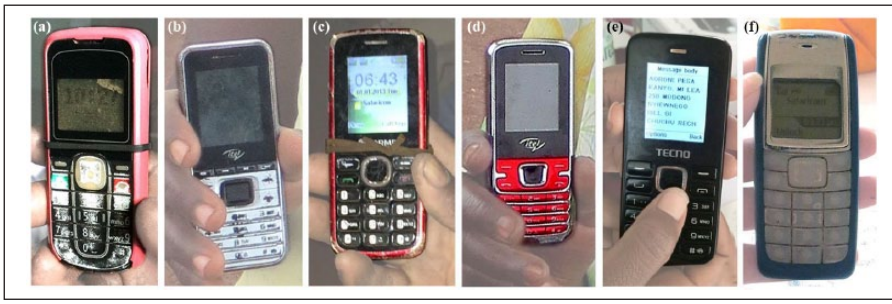

Figure 1. Representative handsets: (a) Nokia 1202; (b) Itel 2180; (c) Forme M9; (d) Itel 2020; (e) Tecno T340; and (f) Nokia 1110i (counterfeit).

Data collection

The second and third authors moderated sessions, and women were encouraged to speak in the languages they were most comfortable with. Each session began by explaining the purpose of our research and asking for informed consent; all women agreed to participate. In September 2014, we collected demographic data (i.e., name, age, and education level) and asked introductory questions (e.g., "Where did your mobile phone come from?"; "How long have you owned your handset?"). We then asked questions aimed at eliciting answers that would provide insights into their devices' affordances, and what activities they supported or constrained. These questions included "What do you use your mobile phone for?"; "Which handset buttons do you most frequently press?"; and "Which functions on your device do you most frequently access?"

In June 2015, we returned to our sites, and shared and discussed findings from our prior field research trips with the women. During these sessions, we asked women to engage in activities frequently mentioned during our prior trip: delete an SMS; make a voice call; send an SMS. While participants performed these tasks, the primary author observed, took notes and photographs, and recorded some short videos. We returned to our field sites in March 2016, and focused on the mobile Internet, asking women what they knew about it and how to access it. As in the prior sessions, we also asked respondents to update us on their handsets—in particular, whether they had a different mobile phone from our earlier visits, and if so, why.

The length of sessions varied; meetings with 4–5 women typically lasted an hour, while larger groups comprised of 8–11 women lasted around 2 hours. Following the first and second visits, respondents were thanked and given a 100 KES ($1.00) mobile airtime scratch card. After the last visit, each received a *lesso*—a decorated piece of cloth—valued at 150 KES (about $1.45) as compensation for their participation.

Documenting mobile phones. An important component of each session was photographing respondents' handsets: women with mobile phones were asked to show them to us and, with their consent, we photographed them to document their model types, condition, and design features. We photographed 116 handsets: 43 in September 2014; 39 in June 2015; and 34 in March 2016 (see Figure 1 for representative models). Most respondents

reported having a phone, but some did not have it with them at the time of our meetings because they had left it to be charged, to be repaired, or because the device was shared and someone else had it. Lastly, of the 55 women who participated in all sessions, nearly half had changed their phones between our initial and final visits, suggesting significant turnover in phone ownership—a finding we discuss later in the paper.

Data analysis. The same approach was used to analyze data collected from each field research trip.

Our analysis began in the field; after each interview session, the authors wrote field notes, and then discussed similarities and differences in their observations. The recorded group interviews were then translated and transcribed by the second author and a hired consultant. Thematic coding was used to analyze these data: it was also applied to the photographs of women's mobiles phones, to our field notes, and to the short videos.

This process involved identifying consistent themes related to the devices' design features (e.g., buttons, screens, shape, and size), to women's interactions with them, and to our observations of them using the devices (Boyatzis, 1998); we also worked to uncover themes not presented in prior research. Additional rounds of coding were performed to fill categories related to Hartson's (2003) affordance types (i.e., physical, cognitive, sensory, and functional). On the occasions when the authors found themes within the data which could be assigned to multiple categories, they discussed the issue until they reached a consensus. The credibility and trustworthiness of our findings were enhanced through member checking (Creswell & Miller, 2000)—that is, by meeting with the participants three times, we were able to get their feedback about, and thereby refine, our findings. Engaging in data triangulation also ensured the credibility of our results.

Findings

To answer our first research question, we describe the affordances that women's mobile phones had, primarily focusing on the 116 documented features of handset design. To answer our second question, we detail how these devices' physical, sensory, and cognitive affordances supported receiving voice calls and deleting SMSs. Here we also describe how missing affordances constrained use, including sending SMSs, and contributed to the high rates of handset turnover. This, in turn, further constrained use by complicating participants' ability to learn about mobile phones' cognitive affordances, in particular how to access the mobile Internet. Throughout our findings, we note women's modifications to their phones or (to use Hartson's [2003] terminology) "trails"—that is, "often inelegant but usually effective artifact[s] added by frustrated users" that draw attention to improvements "that designers should consider" (Hartson, 2003, p. 326).

Women's mobile phones and their affordances

Responses to our questions about phone acquisition revealed that most respondents' phones were second-hand (typically coming from a husband or boyfriend), a finding that Burrell also observed in rural Uganda (Burrell, 2010). This is significant because these handsets' physical (design features that help users in performing a physical action) and

sensory affordances (design features that help users sense something) drastically differ from those of new phones. These mobile phones tended to have cracked screens, missing buttons, and keypads with rubbed-off numbers. They also frequently lacked other essential components such as functional batteries and charging cables—all missing features that complicated women's interactions with their devices.

The majority of these handsets (~65%) were "China-makes" (a colloquial term denoting inexpensive, counterfeit, and/or substandard handsets), and the rest were "originals" (typically authentic Nokia, Samsung, Tecno, or Huawei models). At first glance, a counterfeit phone may appear identical to a genuine model, because counterfeiters mimic these models' design features. Fake models resemble original ones, but tend to be made out of low-quality and lightweight materials. Most respondents told us they were unable to distinguish between fake and original handsets, and frequently asked us for information about how to tell the difference because China-makes were known to not last long, and original models were valued for their durability.

Our analysis also revealed consistencies in handsets' physical affordances. Of the 116 phones we documented, two were touchscreen smartphones, three were "portrait QWERTY" (also known as the BlackBerry form factor), and two were flip-style handsets; the remaining 109 were *kaduda*: bar-shaped feature phones which have a "torch" (flashlight) and which provide voice and text messaging in addition to basic multimedia and Internet capabilities. Although their shapes and features were similar, there were vast inconsistencies in how handsets' physical and cognitive affordances worked together to support accessing these features. For example, on an Itel 2180, the flashlight function could be turned on and off by pressing a single button that was prominently featured on the handset's keypad. Conversely, with a basic Samsung handset, turning the flashlight on required locating the handset's "Settings" menu, scrolling to the menu's bottom, and then pressing it. Women told us they preferred pressing buttons that, when activated, resulted in an immediate action (e.g., turning on the torch), rather than "going deep inside" the phone, a phrase frequently used to describe accessing mobile functions that lack corresponding physical affordances on devices.

Receiving voice calls and deleting SMSs

Here we answer our question about what activities handsets' affordances supported, which was predominantly receiving brief voice calls. Although this finding is hardly surprising, and has been documented elsewhere in Kenya (Crandall, 2012), it is important to draw attention to how mobile phones' physical, cognitive, and sensory affordances work together to readily support this activity. Receiving a voice call is one of the few activities that is automatic—that is, it has become a habit among nearly all respondents—and handsets' design features contribute to this. Bar-shaped phones are small objects made to be grasped with one hand and positioned between the ear and the mouth. Receiving a call is also a straightforward process that on most models requires just pressing a single button and that provides receivers with immediate feedback—typically the caller's voice, speaking a shared language. Women closely linked this activity to pressing the "red and green buttons" on their devices, and remarks similar to this one were frequent, "I don't understand all the features, but I use the phone for communication. We just touch the red and green—receiving phone calls."

These buttons tend to be located below the screen on most phones, are typically larger, and colored (frequently red and green): sensory affordances that make them noticeable and distinguish them from others on a handset. The wear on these buttons, as exemplified in Figure 1a, indicates the frequency of their use as compared to other buttons on many respondents' handsets. Other sensory affordances, such as large piezo speakers that indicate an incoming call by emitting a tinny-sounding ring and/or a vibration, also support this activity.

Prior studies of the affordances associated with mobile phone use have concluded that they "afford users rapid access to . . . other users" (Cousins & Robey, 2015, p. 39). However, we found that the process of making a call is *not* rapid; rather, mobile phones' design features contribute to making this process a time-consuming one; they also make it difficult to use the devices for other purposes. Keypads often had buttons whose numbers had been worn off, or were printed in fonts too small to be readable; as such, making a call was difficult, since users had no visual cues as to where the numbers were located and had to rely solely on memory (see Figure 1a, 1b, and 1f). Font size is also an issue that has been reported previously (Wyche, Simiyu, et al., 2016). Women in our study frequently complained about how they could not read the numbers and letters on their keypad buttons and their handset screens—a consequence of widespread presbyopia (an eye condition associated with difficulty in seeing close objects) among rural women (Sherwin et al., 2008). This also suggests that respondents' handsets lack appropriate sensory affordances.

Even when respondents had phones with visible numbers, they still faced impediments: we observed that, before making calls, some women had to first assemble their phones—a procedure which involves adding credit to the device, removing the backplate, and then inserting a charged battery (which requires first *having* a charged battery). Most handsets lack physical affordances to support easy and frequent removal of backplates (and accessing the battery inside); as a consequence, our participants had to pry backplates off using hairpins or their fingernails—a process which, over time, weakened (or broke) the plastic. The end result was that the backplates became loose and would not stay attached to the phone, which led to a widespread modification observed on more than a quarter of phones: a piece of rubber tied around the handset to hold the backplate in place, thereby replacing an inadequate physical affordance (see Figure 1a and 1c).

This was not the only reason that our respondents reported using rubber bands to hold their phones together. Low-quality batteries have a tendency to become physically bloated over time, after which they will no longer stay within the receptacle's electrical contacts without being held in place. Other women told us that rubber bands were useful for holding together the parts of a phone that has been dropped—a frequent occurrence. Using a piece of rubber to hold a handset together is an example of a trail, which reveals how users redesign objects to suit their needs.

Lastly, we observed that while women rarely sent SMSs, all regularly received them—typically unsolicited, and most often advertisements from Safaricom, Kenya's dominant network provider (around three to seven per week). Our participants told us that they frequently deleted such messages from their phones, a process which we observed. Deleting SMSs was a routine and straightforward process, which typically involved accessing the handset's menu and then "messages," then "delete," and then

confirming by pressing "OK." Women performed this operation weekly in order to free space in their handset's limited memory. Screens displayed a blinking (or, as some women described it, "dancing") envelope icon—an understandable cognitive affordance to communicate that a handset's inbox was full. Women wanted to make sure there was available memory on their phones so they could receive important SMSs, such as notifications from M-Pesa, the popular mobile-phone-based money transfer service.

Constraints: Sending SMSs

Here we comment on what actions the women in our study did *not* perceive their mobile phones as affording—in particular, sending SMSs. Prior research attributes infrequent use of SMSs to low literacy (Medhi et al., 2011) and to not trusting SMS content exchanges with strangers (Crandall, 2012). We found that poor design is also a contributing factor.

Mobile phones have numeric keypads that consist of 12 keys (0–9, *, #), which also include letters (i.e., the number "2" button shows the letters "ABC," the "3" button includes "DEF," and so on)—cognitive affordances that are intended to help users know that one of these characters will appear on their handset's screen when the button is pressed. However, we observed that SMS—in particular the "multitap" text entry system available on most respondents' handsets—lacks clear and understandable cues for how to use it. To operate multitap, users must first locate the key for the desired letter, press it, and—if the desired letter does not appear—keep pressing the key until it does. We previously described how poor sensory affordances complicated some women's ability to locate keys, and also observed the need for design features that provide other information necessary to use multitap. For instance, it was challenging for participants to know how long to press a button before its input changed from a number to a letter, and then from one letter to another, with one woman describing it as "When I go to write messages, if I press buttons and try to write words instead of those things, those words, it just comes numbers." Other challenges included changing between upper and lower case, with one participant describing it as "When I started writing the message, it was in capital letters, so the problem is changing to small letters."

Respondents typically did not hold the buttons down for long enough, or did not press them quickly enough, to advance a letter and/or change its case; this resulted in SMSs made largely of repeated numbers and capital letters. Further, most keypad buttons lack cognitive affordances that could help users know how to switch between T9 and ABC methods, or how to create a blank space between words; indeed, when we observed our respondents attempting to compose an SMS, few included spaces between their words.

Handset turnover and Nokia 1100

Here we continue to describe the activities our respondents' handsets did not readily afford, including accessing the mobile Internet and, more practically, grasping them securely. Over the course of our 19-month project, we observed that phone turnover was high. Our March 2016 meetings included questions about whether women had phones different from the ones observed during the prior sessions; in two of eight groups, nearly

half the respondents did not have the same phones observed during our first and second visits (and in fact, some lacked phones entirely). Donner, Gitau, and Marsden (2011) also found frequent handset turnover—"churn"—when investigating women's mobile Internet use in South Africa. They argue that this phenomenon must be understood as a "design problem"; we agree with their conclusion and elaborate on it by describing how handsets lack necessary physical affordances—that is, design features that support secure handling to prevent devices from being easily dropped.

Respondents' reasons for having changed their handsets varied: some had been stolen, some misplaced, but the most frequent reason was that the phone had been dropped into water or on a hard surface. Dropping devices often resulted in them breaking or becoming "spoiled"—a regular feature of everyday life in Western Kenya, and one which has spurred an active repair industry there. Women told us they were especially prone to dropping phones because they were more likely than men to wear garments that lack pockets; as a result, they typically carry their phones tucked into their bras or folded into the cloth tied around their waists—both insecure methods. Because handsets lacked physical affordances so that they could be securely carried, some women put their phone in a *kipochi* (Swahili for "purse") around their neck—another instance of trail. Some respondents told us that increased frequency of phone fragility was a relatively recent phenomenon, which they attributed to the influx of China-makes into Western Kenya. In one woman's words:

> I was given a Nokia original in 2006 and it served me well. The latest one they brought me, I don't like. I prefer Nokia original. The old one last longer, the parts are durable—the new ones have been modified.

She and other women recalled having owned the Nokia 1100, a handset model which was introduced in 2003 and discontinued in 2010 (Murph, 2007), and which was—at 200 million units sold—the "best-selling consumer electronic device ever." It had design features absent from new handsets, and which led respondents to describe it as "durable," "hearty," as well as "easy to use"; these features included "anti-slip sides to provide a better grip as well as reduce the risk of dust and rain damage" ("Nokia 1100 Phone Offers Reliable," 2003), and replaceable keypads so that when numbers rubbed off owners could buy a new one. Respondents also consistently asked us why the 1100 had been replaced by models which they perceived to be of lower quality (Figure 1f)—a question to which we had no answer.

The phones' fragility, especially when dropped, often meant that women had to temporarily do without handsets; worse, when they got replacement phones, these were typically more complicated, with more features, and the women had to relearn how to use them. In terms of their physical and sensory affordances, these newer models lacked the boldface text, consistent icons, and straightforward horizontal scrolling from one screen to the next—design features for which the Nokia 1100 phone was greatly valued. Instead, models had more complex five-way navigation buttons which supported different types of navigation, as well as smaller font size, inconsistent menu layout, and unfamiliar icons. Although these handsets had more functional affordances than the Nokia 1100 model (notably, Internet access), few women took advantage of this, mostly because they

did not know how, as illustrated by one woman's comments: "This new Itel phone . . . am not used to it, I mostly don't go deep inside, I only use small things. The others I do not know how to use." Just seven of our 55 respondents told us they had accessed the mobile Internet via their phones; very few of our respondents were able to complete this task upon request during our sessions.

Discussion

Returning to our research questions, our long-term, close-up analysis of these women and of their mobile phones' physical, cognitive, sensory, and functional affordances suggests that Hartson's schema (2003) is useful for examining handsets in rural Kenya, in particular for the attention it draws to how design features frame women's real and potential actions with their devices. Our findings confirm and extend those from prior studies conducted in rural Africa and in other developing contexts; they suggest that mobile phones' design affords voice communication, but that they mostly lack affordances which would support novice users taking advantage of their other functions, including sending SMSs and accessing the mobile Internet (Crandall, 2012; Sey, 2011). We also found that phones lacked physical affordances which could contribute to secure handling; this omission appears to contribute to the problem of handset turnover. Further, we observed that it is important to recognize that the phones' affordances—especially the physical and sensory ones—deteriorate over time, and that these changes affect how they are used (de Souza e Silva, Sutko, Salis, & de Souza e Silva, 2011). These findings suggest that Hartson's schema can provide greater detail with respect to technology's features and the context in which their users are embedded (see Fulk & Gould, 2009). Here we elaborate on why such detail is important in mobile media communications research.

Our detailed descriptions of these women's experiences with their mobile phones draw attention to the complexity of their interactions with the devices. None of the women in our study waited passively for their devices to provide them "useful information" via SMS (Vokes, 2016); instead, their interactions mostly involved receiving the occasional voice call and M-Pesa notification, deleting spam SMSs, protecting their handsets, and figuring out how to keep their batteries charged, as well as how to use changing design features (i.e., accessing the mobile Internet). The trails we observed, such as using pieces of rubber to hold handsets together, putting the devices in pouches to prevent them from being dropped, and noticing the wear on handsets' buttons (to indicate which buttons are most frequently used) draw attention to the creative ways in which women modify their devices so that they can use them in their rural context. These findings offer additional support for more "situated" approaches to studying women's mobile phone use (Svensson & Wamala Larsson, 2016): research efforts that focus on how rural women in Africa *actually* use mobile phones (i.e., to receive voice calls), rather than focusing primarily on how they *are intended* to be used (i.e., to access information on business, education, healthcare, etc.). More broadly, our research suggests that questions about usability and about how it is affected by the context of use must be considered before investigating what (if any) role is played by mobile applications in, for example, improving health and education outcomes. An affordance-based approach can be used to answer these questions.

What also emerges from using Hartson's schema (2003) is an understanding of the parallels between geographic regions as they relate to design features and mobile communication. The women in our study were not the only ones who mourned the discontinuation of the Nokia 1100, as perhaps evidenced by the reintroduction of this and other basic feature phone models in February 2017 (Bershidy, 2017). Phone-dropping is not unique to rural Kenyans, and neither is confusion about how to access the mobile Internet (Schaub et al., 2014). These and other problems our participants experienced when using their handsets, are similar to those encountered by older (60+) inhabitants of the US and the UK when using mobile phones (Kurniawan, 2008). These populations similarly use mobile phones for limited purposes, rarely send SMSs, and similarly attribute usability problems to missing cognitive and sensory affordances (e.g., small font size). An affordance-based approach emphasizes the utilitarian problems that all populations encounter regardless of where they live, rather than humanitarian development-oriented ones (such as health and education) that receive the most attention from ICTD researchers and practitioners. This suggests novel research efforts; for example, considering how to apply what has been learned in developing-world studies of usability to developed-world contexts. Other possibilities include considering how future mobile phone design can build upon people's knowledge of design features (e.g., accessing the mobile Internet should be as straightforward as answering a voice call).

Limitations, future research, and conclusion

Findings from this study provide a rich and detailed account of women's interactions with their mobile phones, especially in relation to the phones' design features and related affordances. These findings raise questions about the utility of SMS communication in this context, and draw attention to research opportunities that consider the usability challenges faced by rural populations in Kenya (and more broadly, throughout Africa) in terms of mobile communications. This study is not without its limitations, and we acknowledge that our use of Hartson's (2003) schema has drawbacks: in particular, our results should not be taken as an exhaustive classification of mobile phones and their physical, cognitive, sensory, and functional affordances in rural Kenya. As noted earlier, this study is an initial attempt to link the vast literature on affordances with research on mobile phone use in Africa; we recognize that future research may reveal categories that are not included in our results, and that it may benefit from using different definitions of affordances (e.g., communicative affordances). This qualitative study points to several promising directions that could be investigated using a large-scale survey. A quantitative methodology would enable greater generalizability than is possible in a qualitative study. Future research should also include rural men's experience with mobiles phones as part of the analysis.

Our findings suggest that researchers' priorities may not account for the more mundane problems affecting mobile phone use in rural Africa—most significantly, that widely used handsets predominantly lack suitable physical, sensory, and cognitive affordance for rural users. We do not want to suggest that design alone can address the usability challenges we observed in our study. However, we conclude that there is an

important role for designers in developing human–computer interfaces that are better aligned with rural women's capabilities, and that this focus must first be considered before developing mobile interventions that target socioeconomic problems.

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