

Research and Reality: Using Mobile Messages to Promote Maternal Health in Rural India

Divya Ramachandran, Vivek Goswami, and John Canny

Abstract—Rural health workers in India do not always have the training, credibility or motivation to effectively convince clients to adopt healthy practices. To help build their efficacy, we provided them with messages on mobile phones to present to clients. We present a study which compared three presentations of persuasive health messages by health workers using a phone-based lecture-style message, a phone-based dialogic message that elicits user responses, or no additional aids. We found that dialogic messages significantly improve the quality of counseling sessions and increase discussion between health workers and clients; however, we did not statistically measure an effect of either phone-based message on health behavioral outcomes. We analyze these results in light of the challenges we faced and compromises we made through the research process due to the interplay of social, cultural and environmental realities, and discuss how these factors affect ICTD projects at large.

I. INTRODUCTION

Globally, half a million women die each year due to complications in pregnancy and childbirth [33]. The greater tragedy is that most of these deaths are due to preventable causes that are nearly eradicated in the industrialized world. While access to information is often seen as the answer to prevention [21], deep-rooted values and beliefs often pose barriers to the acceptance of new health behaviors. As it has been seen that ICTs can effectively improve information access (i.e. [30], [11]), we further explore their potential to present information in persuasive ways.

We present a novel architecture for the design of persuasive health messages and an in-context study which investigates the persuasive power of these messages for improving maternal health practices in rural India. Specifically, we investigate the use of mobile phone-based dialogic messages, which engage rural women in conversations about their health practices by drawing from theories of persuasion. We use mobile phones as a platform conducive to speech-based, dialogic information exchange.

In our study, we asked rural health workers to present 52 clients with two persuasive messages on pregnancy-related practices. We compared the use of a lecture-style message, dialogue-based message, and a message delivered by the health worker without a phone. We observed the quality of the counseling sessions, as well as the engagement of the clients.

This material is based upon work supported by the National Science Foundation under Grant No. 0915705.

Ramachandran is with the University of California, Berkeley, U.S.A. Email: divya@cs.berkeley.edu.

Goswami is with Dhirubhai Ambani Institute of Information and Communication Technology, India, Email: vivek_goswami@daiict.ac.in.

Canny is a professor at the University of California, Berkeley, U.S.A. Email: jfc@cs.berkeley.edu.



Fig. 1. A health worker (right) presents a mobile phone-based persuasive message to her pregnant client (left).

After one week, we followed up with the clients to assess the persuasive power of the messages by measuring health behavioral outcomes. We found that the counseling session was significantly improved when health workers used the dialogic messages with ($p < 0.001$). The measures of client engagement and persuasive power across the three cases are not statistically significant.

We designed this study after months of qualitative field work, iterations of prototype development, careful design of content through consultations with stakeholders, and in-depth analysis of persuasion theories. Yet, the realities of the environment in which we ran the study constantly challenged the rigor of our research design. This paper presents a detailed account of the design process, and the tight coupling of social, cultural and environmental factors at various steps along the way. We analyze our results in light of these factors, and end with a discussion of the compromises we made in the face of these challenges, and how they relate to the field of ICTD at large.

II. RURAL HEALTH WORKERS IN INDIA

India accounts for the highest number of maternal deaths globally per year [33]. In an attempt to improve maternal and child health, the Indian government appoints a rural Accredited Social Health Activist (ASHA) in each village to convince pregnant and postnatal women to utilize free services for themselves and newborns, including subsidies for institutional deliveries, and free vitamins and immunizations [15]. ASHAs receive performance-based compensation, but no regular salary. Another program employs an Anganwadi Worker

(AWW) in each village, who runs a morning preschool, and ensures that children are immunized and fed one meal per day. In rural parts, the line between the responsibilities of ASHAs and AWWs is often blurred.

A. Challenges

In our previous work, we learned that rural health workers face a number of challenges [27]. They often do not receive their required training, or meet the minimum schooling requirement (some are illiterate). Monthly training meetings are ineffective. Health workers not always aware of their responsibilities and so do not carry out all their work. ASHAs rarely conduct regular house visits of pregnant women to provide counseling. Power dynamics in the village and household influence the acceptance of ASHAs and AWWs. Often, pregnant women have little control over their decisions, and cannot obey the advice of health workers when it conflicts with opinions of household authorities. With all these challenges at play, the motivation of these health workers is subpar.

B. Interventions

Previously, to address these challenges, we used mobile phones with short videos (illustrations with audio voiceovers) to help ASHAs during their house visits with pregnant women [27]. The videos helped ASHAs engage clients and their families in discussion. However, the effectiveness of the videos depended on each ASHA's ability to take advantage of the videos by pausing, discussing the points, and asking questions. Therefore, we were interested in further developing mobile media that more appropriately supports a structured, persuasive style of counseling.

III. RELATED WORK

Many research projects have looked at various aspects of designing ICTs to support health workers in developing regions [30], [12], [14], [8]. While these projects address various health worker tasks, none examine the specific use of persuasive messages to strengthen health worker efficacy during counseling.

Several technology projects have explored the use of technology to persuade and motivate users to change their behavior [31]; much of this work is in the health domain (i.e. [9]). Specifically in the ICTD space, persuasive technologies have been used to change reproductive health behaviors of rural women [22]. However, this work does not discuss the specific design of persuasive messages or utilize dialogue as we do here.

Our previous relevant work shows that users are more persuaded by messages that are presented in a question-and-answer style, than when presented all the information up-front [26]. We re-evaluate the relevance of this hypothesis in a field study with rural, illiterate women.

IV. PERSUASION

The science of persuasion through dialogue dates back to Aristotle's classical rhetoric [16]. Most relevant to our work

on designing persuasive messages are his writings on *logos*, or the persuasive power of a speech based on its ability to prove a truth, or apparent truth, through practical arguments. Rather than rely on logic, logos-based arguments appeal to the listener's practical reasoning, presenting the desired action as a direct implication of the listener's own salient beliefs. We draw from the art of rhetoric to design dialogic messages that specifically address rural women's arguments against a particular action.

Practitioners in the field of public health have long been examining theories of communication and persuasion to design and present health messages [17]. Below, we list several relevant approaches used in this space, and their underlying models.

Health messages should:

- appeal to the listener's self-efficacy, or perceived ability to perform an action by recommending simple and achievable actions [3],
- induce behavior change by addressing the underlying set of salient beliefs that cause a specific behavior [1],
- maximize involvement of and personal relevance to the listener to encourage more lasting attitude change, (according to the Elaboration Likelihood Model of persuasion, this happens through central processing of the message [24]), and
- use positive affective appeals to arouse more positive feelings and acceptance toward the recommended action.

V. PERSUASIVE MESSAGE ARCHITECTURE

In this section, we describe how we drew from the persuasive frameworks described above to directly address challenges faced by ASHAs through the careful design of culturally relevant persuasive messages.

A. Health Outcomes

We selected two pregnancy-related issues that are locally relevant, and that have short-term outcomes. Through interviews with ASHAs and pregnant women, we identified anemia as a prevalent yet preventable health issue. Over 80% of women are anemic, and ASHAs are provided with iron tablets to distribute for free to pregnant women [15], yet many women refuse to take them. We targeted the outcome of increased consumption of iron tablets.

The second outcome, also taken from the ASHA's core responsibilities, has been the focus of many previous public health interventions: birth-preparedness [19], [20]. Preparing for a delivery emergency includes arranging for transportation to the hospital, identifying a blood donor and a facility which can perform emergency caesarean section, setting aside money in case of an emergency, and selecting a skilled birth attendant or making arrangements for institutional delivery. For our short-term study, we targeted the outcome of increased emergency money savings.

We now describe how we created content with the goal of persuading pregnant women to adopt these two very relevant and impactful pregnancy-related behaviors.

B. Text-based Materials

Many projects have explored new methods of delivering existing health content using ICTs [30], [29]. These projects often utilize content from resources like Hesperian [5] (a non-profit publisher of health handbooks) publications to create new materials with text, pictures, audio and/or video. We have learned that even when starting from such an excellent source of content, the message itself should be restructured to specifically include persuasive elements that improve its impact when presented in non-textual formats.

C. Culturally Relevant Arguments

Through discussions with ASHAs and pregnant women, we understood that women do not take their iron tablets for a number of reasons, many of which are based on traditional beliefs (e.g., the baby will get too big to deliver normally). And in general, the attitude towards birth is that it is a normal process, and few women are aware of or do anything to prepare for emergencies. The arguments used by women against these actions are of two types: *myths* and *barriers*. Addressing these specific relevant arguments was critical for an effective persuasive message.

In our previous field work, we found that when pregnant women and ASHAs watched video messages based directly off of text, they could only recall concrete actions, and not specific details, especially when the messages contained multiple conditionals. We decided that every message should contain an explicit *action* described in simple steps to improve self-efficacy.

D. Message Elements

We designed a message architecture based on the persuasive frameworks described above as well as on our previous field experiences. Each message focuses on one particular health outcome, and contains three different elements:

1) *Myth-Correction-Action*: A widely-believed *myth* is introduced and immediately followed by a *correction* to that myth. This is followed by a recommended *action*.

2) *Barrier-Solution-Action*: A relevant *barrier* is addressed, followed by a *solution* for dealing with that barrier, followed by a recommended *action*.

3) *Task-Instruction-Reward*: *Instructions* to perform a very specific *task* are provided in order to make the recommended actions more concrete and easy to remember. This is followed by a reminder of the greater *reward* that will result from performing that task (and provides the positive affective appeal of the message).

A single message contains a sequence of these elements, each of which emphasizes the value of a particular action. This action is directly linked to the health outcome (in our case, taking iron pills and saving money for emergencies).

E. Lecture vs. Dialogic Style

Keeping the basic content of the elements constant, we designed two forms of persuasive messages. Building on our previous work [26] as well as the theories discussed earlier,

	Lecture	Example	Dialogic	Example
Myth	General Statement	<i>Many women believe that <myth>.</i>	Question about personal beliefs	<i>Do you believe that <myth>?</i>
Correction	Explanation	<i><myth> is not true; in fact, <correction>.</i>	Explanation with rhetorical question tags	<i><myth> is not true; in fact, <correction>, did you know that?</i>
Action	Instruction	<i>You should <action>.</i>	Request for personal commitment	<i>Will you <action>?</i>
Barrier	General Statement	<i>Many women face <barrier>.</i>	Question about personal experience	<i>Do you ever face <barrier>?</i>
Solution	Suggestion	<i>If you ever face <barrier>, you can <solution>.</i>	Instruction with rhetorical question tags	<i>If you ever face <barrier>, you can <solution>, okay?</i>
Action	General Instruction	<i>You should <action>.</i>	Request for personal commitment	<i>Will you <action>?</i>

Fig. 2. The persuasive messages are based on relevant myths and barriers, and presented in dialogic and lecture styles.

we hypothesized that audio-visual messages that require direct response from the user are more persuasive than longer lecture-style recitations of information (as is often used when moving from text to audio-based presentation). In order to enforce user responses in the dialogic version, we inserted *rhetorical question tags* after each piece of information, which elicited a “yes” or “no” response from the user. Our message architecture differentiates between lecture and dialogic style messages. Figure 2 shows how myths and barriers are presented in both styles.

F. Mobile Prototype for Presenting Messages

In previous work [27], we identified the mobile phone as an ideal platform for providing ASHAs with audio-visual materials for counseling pregnant clients because of their

- *Portability*, which supports the ad-hoc meetings and house visits during which counseling generally occurs,
- *Growing popularity*, not only as a communication device, but as a platform for supporting many other rural health worker tasks (i.e.,[12]),
- *Interactability*, which provides affordances for two-way communication and dialogic information presentation, and
- *Low cost*, relative to all other ICTs that have these features.

The prototype is written in Java 2 Micro Edition (J2ME), and runs on the Nokia 3110c mobile phone. The application supports the presentation of messages through audio (with optional still images) or video. It is designed to support the message architecture, by creating a structured object for storing information associated with each message element, and can be used in lecture or dialogic modes.

Information objects are parsed from an xml input file which lists associated media files (audio, image, video), and attributes

such as element type. A toggling pause-and-play button is displayed when messages are playing in both dialogic and lecture modes. All button presses are logged to a text file.

When played in dialogic mode, the user's response guides the flow of the application, so an additional response field containing the "next" information object to be played is stored (depending on whether the user has responded with a "yes" or "no"). The user response time is also logged. Based on previous work on health messages, we believe that tailoring the message according to the user's responses will more effectively engage them in the material [4], [11]. The application proceeds through a sequence of arguments from myth, to barriers, to final task, skipping ahead if either (1) the user responds positively to the arguments, or (2) if the user does not find a particular argument relevant. Figure 3 illustrates the flow.

In the next sections, we describe a field study of the prototype described.

VI. STUDY SITE: KALAHANDI, ORISSA

The degree to which health problems and poverty affect villages in Orissa varies widely depending on proximity to main roads, industries, active NGOs, and even individual leaders. We decided to work in the district of Kalahandi, which lies within the tribal belt of Orissa. Kalahandi has the unfortunate distinction of being the poorest district in Orissa, the poorest state in India [25]. We chose to work in the block (265 villages) of Thuamul Rampur, which borders the town of Bhawanipatna, the district headquarters, as this is a major project area of our partner NGO.

A. Maternal Health

The Orissa state government has placed special focus on this district, and therefore many ASHAs and AWWs have been appointed; however, the maternal and infant health indicators are still dismal. In Kalahandi, 1356 ASHAs are appointed and trained to, among other things, promote immunizations, institutional deliveries, and distribute iron supplements. Yet, in the year of 2009, 37% of all births took place at home (this rate was as high as 55% in the block which we selected). Only 69% of pregnant women received their tetanus toxoid injections, and only 76% of targeted women received iron tablets.

B. Social Hierarchy

Thuamul Rampur block is home to three different communities of people: scheduled tribe (ST), scheduled castes (SC) and other backward castes (OBC). Historically, SC and ST communities have been at the bottom of the Indian social hierarchy [28]. According to the Hindu caste system, the OBC refers to the lowest caste; SC communities are ranked below the caste system, and have been previously considered "untouchables." In villages in Orissa, tensions between upper castes and SC communities are still prevalent. While SC communities have suffered from socio-cultural oppression, ST communities have struggled economically. ST communities are tribal, and have lived by their traditional means for

centuries; they tend to inhabit hilly forest areas, are still mostly illiterate, and are socially isolated and uninfluenced by other communities. Thuamul Rampur's population is predominantly ST (56%); 25% of the rest are SC, and 19% are OBC.

VII. PROTOTYPE ITERATIONS

As we piloted our prototype, we discovered a number of necessary changes.

A. Branching

We originally intended an important feature of the dialogic version of the message to be its branching based on the response of the user. However, during our initial pilots, we realized that client responses were not always honest; they did not always admit to believing a myth or facing a barrier. For example, one participant insisted after every message element that none of them applied to her and that she took iron pills daily. However, when the ASHA asked her to show her the pills, the participant could not find them. One interpretation is that she was trying to present herself as socially acceptable, as seen by [7] specifically when responses were directed to a health worker with a mobile device. Other times, the response was influenced by the presence of the mother-in-law or husband of the client. Therefore, we decided that regardless of the user's response, all elements of the message should be played for all users. Therefore, although our prototype supports branching, we did not use this feature for our study.

B. Language and Prosody

Because our selected study site was mostly tribal, we felt initially that we should record all of the messages in the local tribal language, Kui, rather than the common local language, Oriya. However, we found that many of the ASHAs were not tribal, and therefore could not speak or understand Kui and only spoke Oriya. We recorded the messages in both languages (by the same speaker), and implemented a language toggle button so that both ASHAs and their tribal clients could understand the message.

To us, the recordings sounded rehearsed, and the voice lacked emotion. While we kept trying to push more natural prosody, our local contacts insisted on the simpler style. We came to realize that what they were suggesting was simply more culturally appropriate, and observed the impact of the messages when piloted. As one NGO staff remarked, "Tribals are simple people: they don't need emotion, they just need a clear message."

VIII. PERSUASION TASKS

We created two messages with still images and audio that targeted anemia prevention and birth preparedness. Each message presented one myth, three barriers and one task, based on outcomes of iron pill consumption and money-saving. In order to remember to take iron pills, each woman was given a poster to hang on her wall, and a marker. Every day, after taking a pill, the message instructed her to draw one feature of her baby's face (one eye, second eye, etc.) The associated

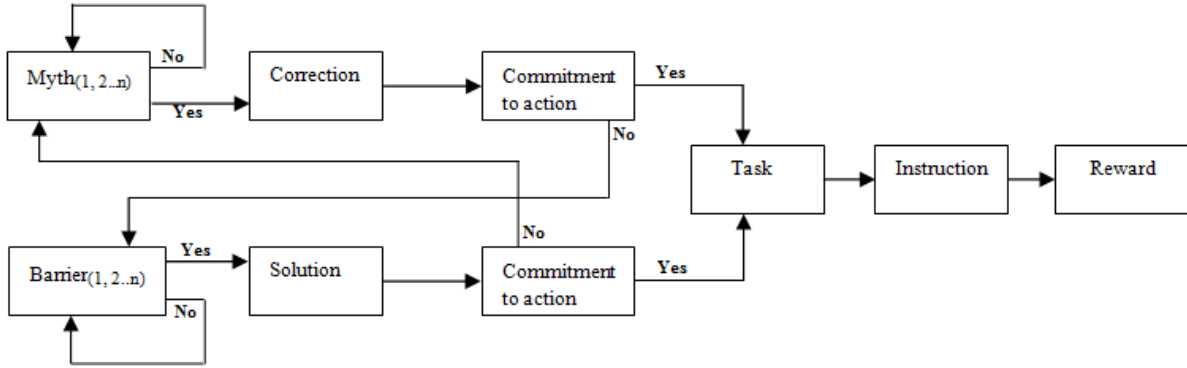


Fig. 3. A flow diagram showing the user response-based transitions between information objects (myths and barriers) used in dialogic mode.

reward was that after one week, she would see her baby’s face smiling at her, and know she had taken good care of it. For saving money, each woman received a clay money bank in which she was instructed to put one coin every day. In an emergency, the money bank could be broken to retrieve the money. And as a reward, if all went smoothly, she would have money to spend on new items for her baby.

IX. HYPOTHESES

We propose the following hypotheses for our study:

Hypothesis 1.i (H1)

The dialogic-style message will be more persuasive than the lecture-style message.

Hypothesis 1.ii (H1)

Both dialogic and lecture style messages will be more persuasive than health workers without the assistance of the phone.

Hypothesis 2 (H2)

The quality of counseling by the health worker will be higher in sessions using the dialogic-style message than in sessions using lecture-style.

Hypothesis 3 (H3)

The client will be more engaged in sessions using the dialogic-style message than in sessions using lecture-style.

The metrics for the hypotheses stated are seen in Figure 4.

X. ITERATIVE STUDY DESIGN

In this section, we discuss our study design, and changes we made due to field realities.

A. Participant Selection

Our target was to recruit 50 pregnant women through approximately 15 ASHAs. We would accompany the ASHA on a house visit to her client’s home, where the ASHA would counsel her client using the prototype. We initially planned to collect data at health centers to locate ASHAs and pregnant women, but had difficulty doing this as centers were poorly staffed. With the help of our partner NGO, we selected ten villages that were reasonably accessible by road, and went to each village in search of health workers (ASHAs, AWWs, or nurses) and data. This influenced the random selection process,

Hypothesis	Construct	Metric	Description	Method
H1	Persuasive Power	Iron pills taken	Count pills missing in packet/face features drawn	Direct measure
		Money saved	Amount of money saved in clay money bank and check weight	Self Report
H2	Quality of Counseling	Pause Length	User and app-initiated pauses indicate discussion time	Application Logs
		HW Activity	Frequency of explanations	Observation (scale of 1-5)
H3	Client Engagement	Response to phone	Frequency of responses to voice on phone	Observation (scale of 1-4)
		Response to HW	Frequency of responses to HW	Observation (scale of 1-4)
		Alertness	Client’s attention throughout session	Observation (scale of 1-3)

Fig. 4. Metrics defined for testing hypotheses.

as we were limited to villages where health workers and nurses were more active.

We recruited 52 participants for our study; 44 were from the ST community, 3 SC, and 5 OBC. One participant had studied until 9th grade, four had attended school until 3rd grade or less, and the remaining 46 had never gone to school. Nine participants knew how to write only their names, two could write more than their names, and the rest were illiterate. Participants were between two and nine months pregnant. All were planning to deliver at home; only one woman had previously delivered at a hospital.

B. Limited Access to Health Workers

We found that ASHAs were assigned to clusters of villages based on population. Therefore, in our ten pre-selected villages, only five ASHAs were appointed. The large distances between villages and lack of reasonable accessibility to many of them made it difficult for us to recruit more ASHAs. However, we did find that few villages had AWWs who were still active in maternal health work, and so we recruited two of them.

We recruited seven health workers total, 5 ASHAs and 2 AWWs. They ranged from age 23 to 36. Of the ASHAs, one had not gone to school, three had studied until only 5th grade,

and the other until 9th. The two AWWs were more educated, having studied until 8th and 10th grade. While most of the client base was of the scheduled tribe community, only two ASHAs were ST. Of the rest, two were SC and three were OBC.

C. Methodology

After health workers (ASHA and AWW) had been recruited, we scheduled a date to visit each. On that day, the primary researcher (female) asked the health worker to familiarize herself with both messages completely, and trained her to use both lecture and dialogic modes (i.e., how to pause, restart, and select “yes” or “no”). Then, the primary researcher accompanied each health worker to the homes of three to 15 clients each.

On some occasions, an additional male researcher and/or male translator accompanied as well, but they did not directly observe or interact with the participant or health worker during the consultation in order to minimize discomfort.

In order to minimize confusion for health workers, we decided they would switch between lecture (L), dialogic (D) and control (C) arms only twice. Each health worker was randomly assigned an ordering. For example, a health worker assigned “CLD” would counsel her first set of clients using no phone (C), second set with the lecture-style prototype (L), and last set with the dialogic-style prototype (D) Before each set, she was refreshed on usability. Each health worker was also randomly assigned a message ordering for her first client, and alternated thereafter, i.e. anemia prevention (A), then birth preparedness (B), or vice versa (BA).

The health worker decided the ordering of house visits according to her convenience (usually based on location). We decided on the number of C, L and D participants based on the total number of participants we expected to visit each day. However, this total was rarely accurate: sometimes participants were not home, sometimes new pregnant women were identified, and sometimes health workers stopped early. We prioritized balancing the number of C, L and D participants, which meant that health workers would switch between the three arms more than the intended two times.

There were a total of 22 clients in the C arm, 16 in the D arm, and 14 in the L arm. Two sessions were conducted with two participants together, due to unavoidable circumstances. We could not balance the AB ordering easily, because during control sessions health workers defaulted to AB despite instructions. Therefore, there were 35 in the AB group, and 16 in BA. Due to a logistical complication, one client was exposed only to A.

XI. RESULTS

We present the results from our study, beginning with the metrics defined in Table 4, and then discuss some qualitative findings.

A. Persuasive Power

We measured the persuasive power of the messages by following up with clients after seven days to gather data on the

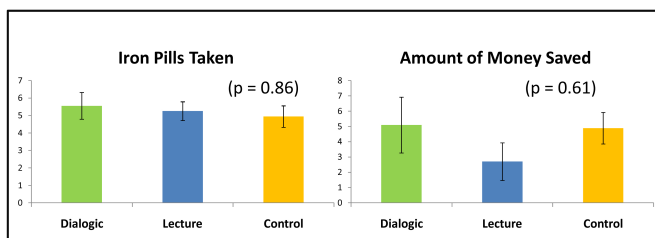


Fig. 5. Graph of persuasive power over three conditions, measured by the number of pills taken and amount of money saved.

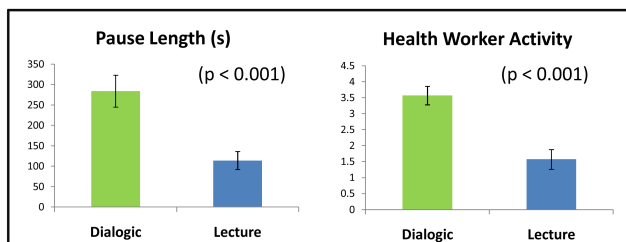


Fig. 6. Results of two metrics of counseling quality over lecture and dialogic conditions. See Figure 4 for description of metrics.

number of iron pills consumed and amount of money saved. We were able to follow up with only 42 of the 52 women; six were not home, three had given birth in the elapsed seven days, and one refused to speak with us. In addition, two others claimed their children had taken the iron pills to school that day, so we could not gather their iron pill data. The iron pill results stated below includes data from 40/52 women, and the money saved refers to 41/51.

Many women were confused about how to draw the face, and posters had been ripped by their children, so this was not a reliable measure for iron pill consumption. Therefore, we only counted the number of iron pills that were missing from their tablet strips. An ANOVA single factor test for the iron pills consumed across three arms yields $F(3, 2) = 0.179$ ($p = 0.84$), which is not a statistically significant result. We also analyzed the difference across the three arms for the amount of money saved by the participants. An ANOVA single factor test for the same yields $F(3, 2) = 0.504$ ($p = 0.61$), which is also not statistically significant. Figure 5 shows these results.

B. Quality of Counseling

We evaluated the quality of counseling between the D and L groups based on the two measures defined in Table 4. Using a parametric one-sided T-test, we found that the pause time during the counseling sessions ($p < .001$). The time during which the message was paused was spent in discussions about the message between the health worker, participant and other bystanders. The frequency of the health worker’s explanations was also greater in D over L, ($p < .001$). These results are shown in the Figure 6.

We observed much more discussion in the D group: health workers were constantly repeating and elaborating on what had been discussed in the message, and also eliciting responses

from their clients. In the L group, health workers would often wait for a good stopping point before pausing, and by then forget to discuss a number of points that had been mentioned. They often simply echoed the last few words of each sentence, rather than stopping and explaining further. In three L cases, the messages were never paused.

C. Client Engagement

We compared the engagement of the client in both the D and L groups. We did not find any significant difference between the groups in the clients' response to the phone, response to health worker or alertness (see Figure 7).

However, from our qualitative observations, we noticed that women often responded directly to the voice on the phone in D, but not in L. In two cases, they actually even folded their hands in a greeting gesture in response to a greeting from the voice. While some clients immediately responded to the phone from the start of the message, others were hesitant; however, in D, by the end of the message, they would respond without the health worker's prompting. In all but ten of the counseling sessions, other onlookers were present (between 1 and 6, not including the researchers, health worker or client), who also engaged in health discussions (Figure 8).

An unexpected finding was that clients who never listened to the radio were significantly more responsive to the phone directly, than those who listened to the radio more frequently. This result was statistically significant with ($p < 0.05$).

D. Health Worker Variability

The seven health workers themselves varied quite a bit in their work ethic, motivation, treatment of clients and treatment of us. Because we had such a small number of health workers, we tested the difference in persuasive power across health workers. For the anemia task, a single factor ANOVA yielded $F(7, 6) = 2.555$ ($p = 0.038$), a statistically significant result. The analysis for the money saving task, however, was not significant, yielding $F(7, 6) = 0.8358$ ($p = 0.551$). We further investigated various recorded characteristics of the health workers to understand which (if any) might have caused the difference. A single factor ANOVA analyzing the persuasive power of health workers by their community (ST, SC, OBC) yields $F(3, 2) = 5.187$ ($p = 0.01$), where ST health workers were significantly more persuasive than those of OBC or SC (SC was the least). We found no significance when comparing the health worker's education levels.

We also observed that clients were more open and friendly with health workers who were most similar to them (in terms of either community or education); in turn, those health workers approached their responsibility with more focus and sincerity. In contrast, more educated health workers bonded with us, and were more aware of our presence during counseling sessions, asking frequently about their performance.

E. Quality of Control Sessions

Though we did not specifically hypothesize on the quality of the control sessions being lower than those with the phone (as



Fig. 8. The study often attracted a number of onlookers.

the measures cannot be compared fairly), we did collect some observational data. The control sessions on average lasted ($\mu = 12.33$ | $\sigma = 4.01$) minutes, much less than the average lecture sessions of ($\mu = 23.47$ | $\sigma = 6.02$), and average dialogic of ($\mu = 33.24$ | $\sigma = 12.01$). We also kept track of the points covered by the health worker during the control sessions; out of the eight main points (four for each topic) emphasized by the recorded messages (including corrections to myths, solutions to barriers, and instructions for tasks), on average the health workers covered only ($\mu = 4.91$ | $\sigma = 1.1$) points without any prompts from us.

F. Preferences

All health workers stated that they preferred to conduct counseling sessions with the phone, specifically with the dialogic version, because it was easier to engage the clients. One health worker was much more comfortable with the phone, and expressed concern that she might forget some of the points if she did not have it. At least three health workers were noticeably more quiet during control sessions. In another control case, after a particularly confrontational client flatly refused to take iron tablets and would not even hang the poster in her house, the health worker commented that if the client had heard the message through the phone in her own language, she would have been more receptive.

XII. ANALYSIS

In this section, we take a closer look at some of our qualitative observations about the persuasion results to further analyze the results.

A. Iron Pills - A Closer Look

Despite the fact that all ASHAs had iron tablets to distribute to their clients, only one fifth of the participants we recruited had actually received them before our visit. The rest were given iron tablets by us. Therefore, if they believed in the myths or faced the barriers mentioned by the message, it was not likely through personal experience during their current pregnancy. In short, most clients were compliant: of the 40 participants with whom we followed up, 28 took more than 5 iron pills.

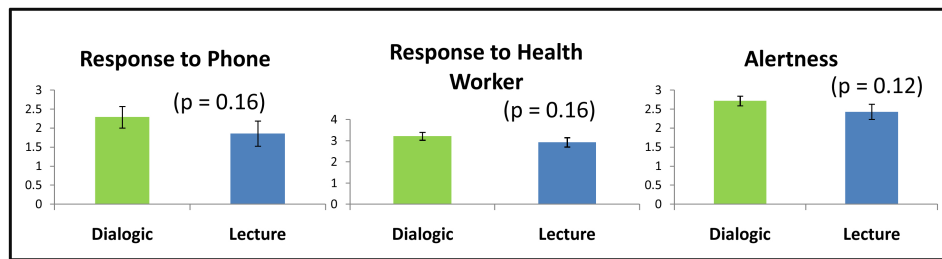


Fig. 7. Results of three metrics of engagement over lecture and dialogic conditions. See Figure 4 for description of metrics.

Group	Reaction During Session	Follow-up Results
C	Made her vomit. refused; argumentative; would not allow poster to be hung	Took none; sent us away
C	Receptive and interested to learn	Took none; said she lost them
C	Receptive and interested.	Took only 3; forgot rest
C	Listened, but was not very interested.	Took 2, did not like taste so stopped.
C	Was scared, as she didn't like the taste and it made her nauseous.	Took 2, then vomited due to taste. Got scared and stopped.
D	Made her vomit; playful but argumentative	Took 5 tablets, forgot rest
D	Believed baby would get big; continuously refused; playful but stubborn.	Took 7, one each day.
D	Thought baby would get too big, but stopped arguing when she heard the recorded message and became receptive.	Took only 3; forgot rest.
D	Repeatedly said she was scared and flatly refused; never explained why she was scared.	Took none; finally explained she was scared it would get stuck in her throat; did not know how to swallow tablets with water.
L	Very interested and willing to learn.	Took only 1, then vomited due to taste. Got scared and stopped.
L	Listened, but was slightly distracted.	Took 3, forgot rest.
L	Was not very interested, but did not argue.	Took 4, forgot rest.

Fig. 9. Reactions of selected clients towards iron pills.

While nearly all participants agreed that “other” women believed in the myths about iron pills and faced the barriers stated, only 6/40 admitted the same about themselves (see Figure 9). In addition, another six appeared to be receptive during the counseling session, but consumed four or less iron pills throughout the week. When examining only these 12 “outliers” and comparing the control arm to both the phone arms, it appears that the phone could have an effect ($p < 0.07$). A larger difference might have been detected had we singled out non-compliant clients only for the study; however, further investigation is necessary to make any conclusions.

B. Saving Money - A Closer Look

During the counseling sessions, 15/51 participants either laughed out loud or sarcastically asked “What money?” when they heard the birth preparedness message. In these cases, health workers would negotiate a commitment to save money “whenever they could find it.” All 15 of these participants were of the scheduled tribe caste. Four of them actually did save money.

Given the general reaction to the money-saving task, it was not surprising that a total of 20/51 participants did not save any money. The reason was always that they simply did not have any to save. The recorded message did address the barrier of not having enough money by explaining how even the smallest amount of money per day would be sufficient, and health workers elaborated on this. In most cases, the health workers used their judgment based on their knowledge of their clients’ economic status to decide how much to push on this issue. However, we noticed that the two most educated and well-off health workers responded with less sympathetic comments like “Come on, you can’t find one coin each day?”

C. Effects of Mobile Messages

We found that regardless of the presence of the phone during counseling, most women were persuaded to take tablets, and more than half to save money. The benefit of the phone is somewhat inconclusive. While the statistics show no apparent added benefit, the effect of the phone messages cannot be totally disregarded: all the health workers had used and heard the mobile messages before counseling their clients, and their persuasive ability might have been improved by the previous exposure.

An unintended benefit of the messages was that we uncovered (as did health workers) new barriers and myths regarding the health behaviors, i.e., some women did not know how to swallow tablets. When health workers finally identified this problem, they had no trouble demonstrating an appropriate solution. In this sense, the messages empowered the health workers with the ability to provide relevant advice. Uncovering myths and barriers previously had been very difficult for us as women were often embarrassed to share their concerns, but by the end of the message-aided conversations, women opened up. Thus, the messages have the potential to build self-efficacy of health workers by helping them identify problems to address.

XIII. RESEARCH AND REALITY: THE BIGGER PICTURE

Our results show that dialogic messages significantly improved health workers’ ability to provide in-depth, effective counseling. However, we were unable to measure the impact of this improved ability on their clients through the behavioral changes we defined. Throughout this paper, we have discussed changes, iterations and compromises that we made to our research goals in response to real, challenging factors in our

study environment. This is often a disadvantage in field studies which attempt to maximize realism, and consequently have limited control over extraneous factors [18]. In the following section, we analyze our results in light of these factors, and discuss general tradeoffs of prioritizing methodological rigor over accurately preserving the interactions of contextual realities.

A. Truly Rural

We faced a number of challenges because the site we selected for the study was rural. Apart from the cluster of villages which were relatively accessible by road, most villages required hours-long hikes over mountains.

Previous work refers to the tradeoffs of choosing truly rural, hard-to-access field sites [2], and recommends the advantages of a rural site be weighed against logistical disadvantages that add unnecessary burdens to the research. In our case, we selected Kalahandi as our site because, along with its rurality, came poor maternal health outcomes that could benefit most from our intervention. We compromised by selecting villages that for the most part minimized the additional need for long hikes. The tradeoff for this decision was that we could not recruit a larger number of health workers, but rather were restricted to the seven who served the more accessible villages; with this small number, the variability across health workers introduced an undesired, albeit interesting effect, as described next.

B. Cutting across Castes

Although our results are limited by the low number of health workers, the statistically significant findings with respect to persuasiveness and caste of the health workers are surprising. The ST health workers were likely most persuasive because the majority of the client base was ST. They were also more friendly with their clients. The least persuasive health workers were SC, with OBC falling in the middle. A possible explanation dates back to traditional divides between these castes. Anecdotally, we heard of more rifts between the SC and OBC communities, whereas OBC people in general were more sympathetic towards ST. However, SC communities, having been oppressed by the higher castes, have historically been seen to exploit ST communities in turn [28]. While this is still highly speculative, the findings more generally emphasize the importance of evaluating ICTD interventions within contexts that preserve extraneous factors and consider how they might be coupled with outcomes.

Had we decided to measure only the persuasive power of the messages on rural women, we could have eliminated the health worker entirely from the picture, and shown the messages to the women directly; instead, we deliberately decided to build on the existing model of health workers as agents of persuasive messages, consequently inheriting generations of traditional attitudes about caste. The interactions of individual characteristics of the technology “agents” with the acceptance of the intervention itself are not unlike previous results on the success of telecenters depending greatly on similar characteristics of the associated entrepreneur [23].

C. Unidentified Foreign Researchers

Reflexivity on influence of the researcher is emphasized in qualitative research [10], and of particular importance in ICTD where there is a wide gap between the researchers and the communities they research [6]. We found our personal interactions with health workers and clients had unexpected influence on both, possibly affecting persuasion.

Our study required that we accompany the health worker to each client’s home to ensure that she delivered the persuasive message (using D, L or C treatment), to mediate any usability issues, and to observe the counseling session. However, our presence also introduced other effects which may have boosted the persuasiveness of both the health worker and her message. The primary researcher was unfamiliar, and therefore appeared important. She was often seen as the true bearer of the message; some health workers even believed, and told their clients, that they were delivering the message on behalf of the researcher, because she did not know the local language. Other times, the voice on the phone was associated with the researcher, and viewed as a local-language translation of the researcher’s personal message.

With more educated health workers, the researcher’s presence introduced a Hawthorne Effect; they tried to impress the researcher by explaining each point in the message carefully. In addition, the researcher’s own sincerity sometimes motivated the health workers to be more sincere about their own jobs: once, when the researcher arrived at a village at the break of dawn to visit women before they headed to the fields, a health worker commented, “You woke up in the middle of the night to get here this early, of course I’ll make time to visit a few houses with you.” Another health worker used the researcher’s dedication to try and motivate clients, stating, “She has come from so far to deliver this message to you - it must be important then, right?”

D. Research Study, or Intervention?

Even as the research study was designed to preserve as much context as possible, it introduced a number of additional interventions. Because we were counting iron pills, we needed to provide pills to all the clients, raising the number of recipients from the norm we observed (20%) to 100%. This in itself was an intervention, and previous work has shown that messages are more impactful when the effort required to obtain the object in question is low [13]. The study also enforced that health workers visit clients in all their assigned villages: half of our participants were from outside villages which health workers rarely visited. We also brought additional props - posters and money banks. While these were all purchased locally, they were still new, and caused a stir. Many women often gathered to watch, whether or not the phone was being used, and engaged in discussions.

Therefore, even as we attempted to compare the effects of three interventions within a realistic, field context, we introduced a number of changes to it. It is nearly impossible to isolate the effects of the persuasive message amidst them. The question that arises, then, is whether that is necessary. The house visits and iron pill distribution that took place as a result

of the research study are in fact mandated by the government program; health workers had iron pills - they were just not consistently delivering them.

Had the persuasive messages on mobile phones been introduced as an intervention, rather than a research study, then perhaps they would have still introduced similar changes. For example, health workers would receive new usability training, and probably by new trainers. It would be only logical to take advantage of logging functionalities on the phone and track health worker activity, thus imposing an additional level of accountability. The sheer excitement of having the phone or something to share might also affect the health worker's sincerity.

Should we be motivated only by the goal of creating impact, then these are not confounds, but simply features of the intervention. ICTD interventions rarely come alone, and often their success depends on the other factors which are natural counterparts [32]. The impact of this research study, in that case, is that 34/52 women began taking iron pills, and 31/51 women began saving money for the birth of their child.

XIV. ACKNOWLEDGMENTS

We thank Dipti Vaghela for introducing us to Kalahandi, and for her inspiration and invaluable guidance and discussions throughout the course of this study. We thank the staff at Gram Vikas for their incredible field support, particularly Sri Parama. We thank Ilda Ladeira and Ed Cutrell for their help with the study design, and Tapan Parikh, Nithya Sambasivan, Sandra Spence and Sonesh Surana for their feedback and discussions on the paper. We thank our anonymous reviewers for their valuable suggestions and comments. And last but not least, we thank the hardworking ASHAs, AWWs and new mothers for their participation.

REFERENCES

- [1] I. Ajzen. From intentions to actions: A theory of planned behavior. In J. Kuhl and J. Beckmann, editors, *Action control: From cognition to behavior*. Springer-Verlag, 1985.
- [2] Y. Anokwa, T. Smyth, D. Ramachandran, J. Sherwani, Y. Schwartzman, R. Luk, M. Ho, N. Moraveji, and B. DeRenzi. Stories from the field: Reflections on HCI4D experiences. *Information Technology and International Development*, 5(4):101–115, 2009.
- [3] A. Bandura. Guide for constructing self-efficacy scales. In F. Pajares and T. Urdan, editors, *Self-efficacy beliefs of adolescents*, volume 5, pages 307–337, Greenwich, CT, 2006. Information Age Publishing.
- [4] J. Brug, I. Steenhuis, P. Van Assema, and H. De Vries. The impact of a computer-tailored nutrition intervention. *Preventive Medicine*, 25:236–242, 1996.
- [5] A. A. Burns, R. Lovich, J. Maxwell, and K. Shapiro. *Where women have no doctor*. Hesperian, 2006.
- [6] J. Burrell and K. Toyama. What constitutes good ICTD research? *Information Technology and International Development*, 5:82–94, 2009.
- [7] K. Cheng, F. Ernesto, and K. Truong. Participant and interviewer attitudes toward handheld computers in the context of HIV/AIDS programs in sub-Saharan Africa. In *Proc. CHI 2008*, 2008.
- [8] A. Chib. The Aceh Besar midwives with mobile phones program: Design and evaluation perspectives using the information and communication technologies for healthcare model. In *Mobile2.0: Beyond Voice? ICA Pre-conference*, 2009.
- [9] S. Consolvo, P. Klasnja, D. W. McDonald, and J. A. Landay. Goal-setting considerations for persuasive technologies that encourage physical activity. In *Proc. 4th Conference on Persuasive Technology*, New York, NY, USA, 2009. ACM.
- [10] W. Creswell, John and V. L. P. Clark. *Designing and Conducting Mixed Methods Research*. Sage Publications, 2007.
- [11] S. Davis. Internet-based tailored health communications: history and theoretical foundations. *Interface: The Journal of Education, Community and Values*, 7, 2007.
- [12] B. DeRenzi, N. Lesh, T. Parikh, C. Sims, M. Mitchell, W. Maokola, M. Chemba, Y. Hamisi, D. Schellenberg, and G. Borriello. e-inci: Improving pediatric health care in low-income countries. In *Proc. CHI 2008*. ACM Press, 2008.
- [13] E. Duflo, M. Kremer, and J. Robinson. Nudging farmers: to use fertilizer: Theory and experimental evidence from Kenya.
- [14] S. Grisedale, M. Graves, and A. Grunsteidl. Designing a graphical user interface for healthcare workers in rural India. In *Proc. CHI 1997*. ACM Press, 1997.
- [15] International Institute for Population Sciences (IIPS) and Macro International., Mumbai. *National Family Health Survey (NFHS-3), 2005-06: India: Volume 1*, 2007.
- [16] H. Lawson-Tancred, editor. *Aristotle: The Art of Rhetoric*. Penguin Group, 1991.
- [17] E. Maibach and R. L. Parrot, editors. *Designing Health Messages: Approaches from communication theory and public health practice*. Sage Publications, 1995.
- [18] J. E. McGrath. Methodology matters: doing research in the behavioral and social sciences. *Human-computer interaction: toward the year 2000*, pages 152–169, 1995.
- [19] R. A. McPherson, N. Khadka, J. M. Moore, and M. Sharma. Are birth-preparedness programmes effective? *Journal of Health, Population and Nutrition*, 24:479–488, 2006.
- [20] A. C. Moran, C. Sangli, R. Dineen, B. Rawlins, M. Yamogo, and B. Baya. Birth-preparedness for maternal health: Findings from Koupla district, Burkina Faso. *Journal of Health, Population and Nutrition*, 24:489–497, 2006.
- [21] N. Pakenham-Walsh, C. Priestly, and R. Smith. Meeting the information needs of health workers in developing countries. *British Medical Journal*, 314, 1997.
- [22] V. Parmar, D. Keyson, and C. deBont. Persuasive technology for shaping social beliefs of rural women in India: An approach based on the theory of planned behavior. In H. O.-K. et al., editor, *PERSUASIVE 2008, LNCS 5033*, pages 104–115, 2008.
- [23] B. Parthasarathy, K. Keniston, G.R. Kiran, R. Kumar, A. Punathambekar, G. Kumar, J. Srinivasan, and S. Benjamin. Information and communications technologies for development: A comparative analysis of impacts and costs from India. Technical report, Indian Institute of Information Technology, Bangalore, 2004.
- [24] R. Petty and J. Cacioppo. *Communication and persuasion: Central and peripheral routes to attitude change*. Springer, 1986.
- [25] Planning and Coordination Department, Government of Orissa, Bhubaneswar. *Human Development Report 2004*, 2004.
- [26] D. Ramachandran and J. Canny. The persuasive power of human-machine dialogue. In H. O.-K. et al., editor, *PERSUASIVE 2008, LNCS 5033*, pages 189–200, 2008.
- [27] D. Ramachandran, J. Canny, P. Das, and E. Cutrell. Mobile-izing health workers in rural India. In *Proc. CHI 2010*. ACM Press, 2010.
- [28] K. Sahoo. *Rural Development: Scheduled Castes and Scheduled Tribes*. Classical Publishing Company, 2005.
- [29] A. G. Sharma, M. Plauche, E. Barnard, and C. Kuun. HIV health information access using spoken dialogue systems: Touchstone vs. speech. In *Proc. ICTD 2009*, 2009.
- [30] J. Sherwani, N. Ali, S. Mirza, A. Fatma, Y. Memon, M. Karim, R. Tongia, and R. Rosenfeld. Healthline: Speech-based access to health information by low-literate users. In *Proc. ICTD 2007*, 2007.
- [31] K. Torning and H. Oinas-Kukkonen. Persuasive system design: state of the art and future directions. In *Proc. 4th Conference on Persuasive Technology*, New York, NY, USA, 2009. ACM.
- [32] M. Warschauer. *Technology and Social Inclusion: Rethinking the Digital Divide*. MIT Press, 2004.
- [33] World Health Organization, Geneva. *World Health Report: Make every mother and child count*, 2005.