Validating Mobile Phone Design Guidelines: Focusing on the Elderly in a Developing Country

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ABSTRACT
Designing a usable mobile phone interface is a non-trivial task, especially when it is intended for use by a special needs group. The group we focus on here is composed of *the elderly in developing countries*. To inform specialised design, researchers produce and refine sets of tailored guidelines. In this case there is surprisingly little empirical evidence attesting to the value or efficacy of such guidelines. Corroborating evidence, in the form of endorsements of designs that have resulted from their implementation, would constitute such evidence. The aim of this paper is to evaluate existing mobile interface design guidelines for the elderly in developing countries by means of implementation. Guided by the design science research methodology, published guidelines were used to design and implement a mobile phone interface tailored to the needs of elderly South Africans. The resulting prototype was evaluated with two groups of South African elderly mobile phone users. Besides validating and refining the guidelines, the challenges experienced in implementing guidelines were noted together with some conclusions about the viability and usefulness of the specific guidelines, as well as mobile interface design guidelines in general. The unique contribution of this paper lies in the reflection on crossing the research-action divide by also considering the challenges of the developers in implementing the guidelines.

CCS Concepts
Human-centred computing → Human Computer Interaction → HCI Design and evaluation methods → User studies

Keywords
Guidelines, aging, mobile telephony, interaction design, HCI4D.

1. INTRODUCTION
This paper focuses on the mobile phone needs of elderly South Africans, for three reasons. Firstly, the elderly are a globally growing user group [45]. Secondly, they are poorly served by current mobile phones and thirdly, mobile communications constitute the primary form of access in the developing world [37, 47].

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Mobile phone interface design has come a long way, but age-sensitive design does not seem to have kept pace, as evidenced by the meagre functionality offered by many so-called "Senior Phones". We were unable to locate any mobile phones designed specifically for older consumers in developing countries. Furthermore, since the mobile phone is the primary access method in the developing world [47], the mobile-only paradigm has vital implications for mobile interaction design [17]. These factors were a compelling motivation for the research reported in this paper.

When designing interfaces specifically for developing world users, a wide range of additional challenges, beyond the technical, have to be considered [6, 9, 27]. It is thus advisable to guide mobile phone designers working in this context. One way is to provide tailored guidelines [1]. Abascal & Colette [2] argue that guidelines are especially good at ensuring that design is inclusive and ensures that the design does not make a negative social impact on end users. A number of interface design guidelines for elderly mobile phone users have been produced [47, 49], but there is scant evidence of their successful application. Industrial producers of mobile phones are likely to be sceptical of guidelines that have not been proven efficacious. What is needed is a trial, an evaluation of a phone that has been produced by following a set of published guidelines. This, then, is the purpose of this research.

In a literature review of research approaches to mobile use in the developing world, Donner [12] advocates for research on increased integration between Information and Communication Technology for Development (ICT4D) and non-ICTD studies. That validates the rationale for this paper's research objective, which lies at the intersection of human-computer interaction and development informatics.

In the next section we review the literature with a focus on mobile phone interaction needs of the elderly in developing countries. We consider existing guidelines that encode good practice and justify our choice of the set of guidelines we chose to test. We then report on our experiences of developing and evaluating a mobile interface, called the Gran-a-Phone, based on the advice offered by the guidelines. We reflect on the efficacy of the specific set of guidelines we implemented, and the viability of guidelines in general, in a field as fast moving as mobile phone telephony.

2. RELATED LITERATURE
2.1 User Needs
The older generation experiences particular challenges in using mobile phones [19, 35, 43].The over 65s are not homogenous nor are the physical and cognitive constraints they experience static. Design for older users compels acknowledgement of the reality of progressive and increasing disability [15] but also of varying

capability across the age range. We now discuss the literature in three areas that informed the study, namely the developing country context, designing for the elderly in general, and mobile interaction design.

2.2 The Developing Country Context

In developing countries the design goal should be to build systems that empower end users as inclusively as possible [9, 33]. Context-specific techniques should be considered in order to inform successful design as the success and acceptance of an ICT product is dependent on how it appeals to the needs and context of the target users [10]. Context-related challenges in the developing world include illiteracy, low computer literacy, language barriers, social and cultural differences and economic constraints [17, 23, 26] where the magnitude and impact of these factors is exacerbated by the developing world constraints [17]. For example, the concept of sustainability seldom appears in design for developed countries but in the developing world sustainability needs to be built into thinking from the beginning. This includes financial, environmental, technological, social and cultural, political and institutional sustainability [9, 33].

2.3 Current Senior Mobile Phones

Abdulrazak, Malik, Arab and Reid [3] contend that current smartphones for the older user are limited in number, lack personalization or suffer from informational and navigational complexity. Yet older South Africans have notably matured in their usage of mobile technology, both in terms of frequency and functionality, since 2009 [48], with usage now encompassing a wide range of functionality including social interaction, entertainment and mental stimulation [34]. It seems that the mobile phone industry has yet to realise this.

A search for "Senior Phone" delivers a number of options, including the TTFone, Denver GSP, MaxCom, Doro, Fonerange, Emporia Euphoria, kisa, Jitterbug, Snapfon and Just5 CP10S. All support voice communication and SOS functionality (except Jitterbug). Most provide SMS functionality (except kisa). Many provide extras like a torch, radio or calendar. Some are hearing-aid compatible and almost all have attempted to accommodate poor vision, dexterity and hearing. However, the one shared characteristic is that all are essentially feature phones. As the rest of the world moves towards Smartphones, and the rich functionality they provide, the industry seems to assume that Seniors will be content with feature phones, with their limited functionality, that many of the rest of us discarded years ago.

A notable exception is the Fujitsu Stylistic, an Android touch screen phone that was first advertised in 2013. As with other industry-released phones, the results of empirical tests are generally not available and the phone itself does not yet seem to be available outside France. Another promising Senior Smartphone is the Phoneage [3]. This phone's design was, unfortunately, not explicitly mapped to a given set of design guidelines and this limits the usefulness of the design in terms of validating guidelines.

2.4 Guidelines

Guidelines are particularly useful way to support inexperienced designers [2] since they encapsulate good practice in an easy-to-use format. A variety of guidelines on designing interfaces for the elderly have been published [4, 25, 32, 37, 39, 41].Guidelines to inform the design of age-sensitive mobile phone interaction have also appeared in the literature[14, 20, 30, 38].Sometimes guidelines appear in the discussion section of a paper that reports on the evaluation of a particular interface [8], which means that the usual searches for publications do not always uncover these contributions. Other guidelines to inform the design of age-sensitive mobile phone interaction have emerged in recognition of the growing worldwide "gray market". One set of guidelines was proposed by [28]. Their "universal mobile design" solution guidelines were developed in South Korea, a developed country. They categorise their recommendations into three groups: physical, cognitive and cultural & psychological factors. Díaz-Bossini & Moreno [11] derived guidelines to inform design for elderly users in the mobile phone context, and use these to evaluate three Smartphone apps. Neither of these sets of guidelines was used to design a new mobile phone interface, unfortunately.

Techniques and methods that are used for designing interfaces in *developed world* contexts rely upon certain assumptions about how users and developers can interact and present ideas that are not necessarily valid in developing world settings [9, 49].

Devezas, Mashapa, Giesteira and van Greunen [10] developed generic Human Computer Interaction (HCI) guidelines tailored to a developing country context. However, these are neither mobile-specific nor are they tailored to the needs of older users. An attempt to encode good practice in this area is encapsulated within the guidelines proposed by Van Dyk, Gelderblom, Renaud and van Biljon [48]. They built on existing design guidelines for the elderly, and then integrated mobile interaction design guidelines from Jones and Marsden [27] and Hoober and Berkman [25] to produce a comprehensive set of guidelines to inform mobile phone design for the elderly.

The most appropriate set found was the *Extended Senior Mobile Phone Adoption Checklist* (ESMAC) [48]. It guides mobile phone development for elderly users, but, most importantly does so in a developing world context.

Any set of guidelines has to be tested and the resulting product evaluated to validate them and prove their worth. We chose to validate ESMAC guidelines since they were produced in South Africa, using South Africans as participants in their studies. We followed the guidelines to design a prototype we called the *Gran-a-phone*.

3. METHODOLOGY

The development of an artefact while producing a knowledge contribution (such as validating existing guidelines) fits the design science paradigm as advocated by Hevner *et al*. [22] and extended by Hevner & Drecksler [13]. The Gran-a-phone prototype was evaluated in terms of the user experience of elderly evaluators. The ISO FDIS 9241-210 definition of user experience is "*A person's perceptions and responses that result from the use and/or anticipated use of a product, system or service*." was applied.

Hereby user experience is viewed as an extension of the concept of usability in the area of HCI. Considering the context and characteristics of the elderly mobile phone user we adapted the user experience evaluation process to mitigate evaluating related anxiety (as described in section 4). We tested the efficacy of the ESMAC guidelines [48] by following their recommendations in designing a mobile phone interface for older South Africans called the *Gran-a-Phone*.

The rest of this section details the prototype design as informed by the guidelines. This comprises the hardware choice, a reflection on applying guidelines including some of the problems encountered and finally an explanation on the application of the filtered guidelines.

3.1 Hardware Choice

The mobile phone industry is moving towards phones without keypads. Using a touch screen frees the user from the constraints of a physical keypad that cannot accommodate the varying and evolving needs of a heterogeneous user base. It means that achieving the desired high contrast screen and larger font size is trivial, and supported by the operating system. They have been proven viable for use by older participants, despite physical and cognitive impairments [18, 24]. We thus elected to use touch screen hardware (Samsung Galaxy) with an Android Operating system.

3.2 Applying Guidelines

A set of fairly abstract guidelines will produce many different instantiations. This is to be expected since guidelines do not provide complete design solutions. However, if guidelines are to help designers avoid major errors then their usefulness needs to be proven. Hence we produced one possible implementation based on the guidelines – other instantiations will no doubt have a different appearance but ought to be implemented based on the same principles as encoded in the guidelines. The ESMAC checklist-based guidelines [48] categorises advice into three essential groups of characteristics: (1) *physical*, (2) *complexity* and (3) *features*. In working through the guidelines (see Appendix A) to inform our design we encountered a number of problems.

1. We were confounded by the sheer number of guidelines in the set (54) and found that we had to choose which to apply, and which to omit.
2. The features category conflated phone features (hardware and interaction design) with functionality (send SMS), which made it hard to fix on a core set of functionality to include in our prototype.
3. Some guidelines were dependent on the phone platform choice. For example, guidelines 5,6,7,13 and 14 refer to hard keyboards so we could omit them given our hardware choice. Moreover, guideline number 2 instructs us to use a touch screen, which renders the above-mentioned guidelines superfluous.
4. Some of the guidelines seemed outdated, especially in the modern smartphone era. For example, guidelines 9-11, 17-35, 39-40, 45 50, 53 & 54 are related to the hardware or the operating system of a phone, and thus do not have to be designed into the interface.
5. Guideline 42 is implemented by the mobile service provider, and is not interface- or phone-dependent.
6. Some guidelines seemed subjective. For example, what does “essential” mean in guideline 52?
7. For some design decisions there were no guidelines. For example, which icons are appropriate for this demographic? What functionality should be offered by the interface?
8. Some were obscure. It is not clear what number 46 refers to. We also have reservations about 49, which might be considered overly invasive by our demographic.
9. There is repetition: 36 and 52 seem to make the same point. As do 16 and 47.

3.3 Applying the Filtered Guidelines

3.3.1 Physical Guidelines: 1, 3, 4, 8, 15, 16

Guideline summary: keys should be large [8] and provide feedback when pressed. It should be easy to answer calls and summon assistance and the buttons should not easily be accidentally pressed.

Using large icons was trivial, as was the provision of large buttons to answer calls and summon assistance. The soft keypad might well present the older users with something of a challenge in other ways. For example, accidental touch screen activations are a major issue [19]. Harada, Sato, Takagi, and Asakawa [19] recommend feedback through audio and visual channels to mitigate this problem. To prevent accidental activation, we implemented a traditional hard press mechanism for all commands, which mirrors their well-established interaction with more traditional devices where buttons had to be pressed down with moderate force, and not merely tapped. This also ensures that dexterity problems, which could cause them to brush and accidentally tap a button, do not activate functions. We also implemented click-based sound feedback to register the receipt of the command by the interface.

3.3.2 Complexity Guidelines 36, 37, 38, 41

Guideline Summary: one to one mapping between keys and functions, clear meaning, simple menu structure and only essential functionality.

A flat menu structure provides a “Home” button in every screen to ease navigation, as recommended by Chaudry *et al*. [8]. The icons are large. We sought in vain for a guideline related to icons. Following the advice of Holzinger [24], we tried to choose metaphors that would resonate with our older focus group so as to maximize their sense of familiarity. We thus made use of metaphor in choosing icons – ambulance for emergency help, rubbish bin to delete messages, old (known) phone icon for calling, questionmark for help. The choice of metaphors is challenging, as first pointed out by Kuhn [29] and recently confirmed by Abdulrazak *et al*. [3].

3.3.3 Feature Guidelines

These were minimal and somewhat out-dated when the interface was being designed for a modern smartphone as hardware of choice. We thus turned to the research published by [45] to identify core functionality we should include. The authors propose a motivational needs-driven usage space model for encoding functionality offered by mobile phones. The model proposes mapping phone functionality to user needs as an appropriate way to identify useful features. Based on the functions the literature reported elderly phone users emphasizing, we produced a usage space model for older mobile phone users (see Table 1).

Table 1: Literature support for age-sensitive usage spaces

Objects	Usage Space	Research Literature
Core	Safety	[1, 39]
	Security	[39, 40]
	Relationships	[16, 34]
	Organisation	[40, 46]
Additional	Entertainment	[34]

We included SMS and Calls (Safety, Security & Relationships), an emergency call button (Safety & Security), a contact list (Relationships & Organization) and a calendar (Organization). This constitutes hygiene functionality (core usage spaces) with entertainment as the only functionality within the additional space. Technology use is dynamic and, as such, these categories constituted a point of departure, not a static classification.

3.4 Prototype Interface

The resulting prototype interface is shown in Figure 1.

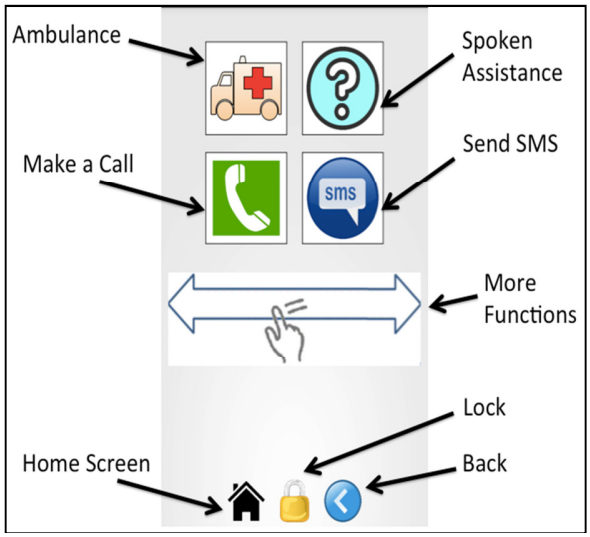


Figure 1: The Gran-a-Phone Home Screen

- Upon selecting *Ambulance* the customizable emergency number will be dialled automatically.
- Upon selecting *Spoken Assistance* an audio clip is played that provides context sensitive instructions.
- Upon selecting *Make a Call* the user can type in a number or select from the listed contacts.

Switching from one screen to the next is achieved by swiping the arrow. The hand is provided to make this clear. The rest of the function names are self-evident and present core usage space functionality. Figure 2 demonstrates the lock screen and calling screens.

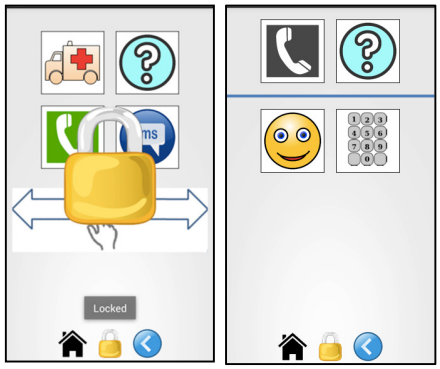


Figure 2: The Gran-a-Phone Lock & Calling Screens

3.5 Comparison

We now compare Gran-a-Phone to other Senior phones. We used amazon.com to identify features, and searched the Web for descriptions of the phone features. We compare Gran-a-Phone to senior phones that had more than 20 reviews on Amazon.com on 10 August 2016.

Table 2: Comparing Gran-a-Phone to other Senior Phones

	Jitterbug[1]	Snapfon[2]	Just5 CP10S[3]	Gran-a-Phone
# Reviews	61	983	48	
5 *	47%	48%	33%	
Sample of Liked Features	Simplicity Response Agent; Big buttons; Volume	Display; Big Buttons; Audio Feedback; Ease of Use	Volume; SOS Feature;	
1 *	20%	13%	31%	
Sample of Disliked Features	Hard to Flip Open; Cheap Looking; Hard to Use	Unreliable; Poor SMS interface; Volume; Backlight Glare	Size too small; Unsuit-able for visually impaired	
Interac-tion	Buttons	Buttons	Buttons	Touch Screen
Keypad Feedback		Speaking		Click
Large Buttons	•	•	•	Large Icons
Backlight	•		•	N/A
Spoken Assis-tance	Response Agent	24/7 Response (sub-script ion)		Recorded Audio Assist-ance
Powerful Speaker	•	•	•	•
Hearing Aid Compatib le	•	•		
Vibrate	•		•	•
SMS	•	•		•
Camera	•			•
SOS		•	•	•
Lock	Close Phone	External Switch	Soft	Soft

[1] https://www.jitterbugdirect.com/
[2] https://www.snapfon.com/
[3] https://www.just5.com/worldwide/en/cp10s/cp10s-bestinspace/

4. PROTOTYPE EVALUATION

Usability testing usually means that an evaluator from the target user group is asked to use the device or interface to carry out a set of tasks [44]. The designer is on hand to observe the process and to record any difficulties experienced during task execution. This feeds back into the design and development process. From the designer's perspective, the approach of testing early and often can counter confirmation bias [36] by revealing flaws and inconsistencies[44].

When a product is being developed for older users this approach warrants reconsideration [31]. Such users often experience difficulties during the course of their everyday lives as a consequence of age-related infirmities. Carrying out a usability task might stress them more than it would a younger person. Moreover, this demographic is more likely to blame themselves for any difficulties they experience with an interface [44]. Finally, it is challenging, time-consuming and possibly stressful for an older person to master any new system that they don't even need. The usual testing process is not mutually beneficial for the designers and the testers. Hence we decided to use a more consultative approach for our evaluation.

In accordance with our desire not to stress our participants unduly we followed the recommendation of consulting our participants in a group situation [5]. This gave them the support of their contemporaries in a situation where they could easily have felt intimidated on their own [7, 28]. This approach did not require them to master any new systems and was one of our primary aims. This process gave them the opportunity to critique the interface design and thereby provide valuable insights to the designers without unduly stressing them.

Following the recommendations of Silva and Nunes [42] we first demonstrated the functionality of the interface and then asked our participants to verbalize their impressions and thoughts. We then encouraged them to "play around" with the device themselves hoping that this process would elicit initial impressions, and harvest inputs to feed into subsequent iterations of the design process

4.1 Carrying out the Evaluation

The data was captured both in group sessions and individually for other participants in the rural areas of South Africa. The group sessions were conducted at the *** Retirement Centre in the Gauteng Province of South Africa. The individual interviews were conducted in the Limpopo province near Polokwane in the participants' homes.

Ethical clearance was obtained from the Manager of the *** Retirement Centre, the College of Science, Technology and Engineering, Ethics and Research Committee at the University of South Africa and also from the individual participants. Permission for recording the interaction was obtained by means of signed informed consent forms.

The group evaluation event was advertised by putting up posters at the Retirement Centre a week before the event and also verbally by the researchers at the communal meeting on the day. The main evaluation took place after the meeting when participants were divided into groups of 4 to 5 for the evaluation sessions. The same procedure was followed for the focus group (20 individuals with English as first language) and the individual interviews (13 individuals with Setswana as first language) and structured as follows.

The researcher explained the purpose of the evaluation and requested participants to complete the informed consent form. Where necessary the two researchers present assisted the participants to get the consent forms completed before the evaluation could begin.

1. The participants provided biographic information, details about their current mobile phone usage and some opinions about their current mobile phone.
2. Participants were then introduced to the initial design of the phone prototype. They were given a brief demonstration of the interaction style and functionality. They were also given the opportunity to try things themselves but since this was not a formal usability evaluation no set tasks were proposed. We were eliciting initial opinions, insights and impressions.
3. We then asked participants for their impressions of the prototype interface design.

The interviews were recorded. Some problems were encountered during the focus group interviews:

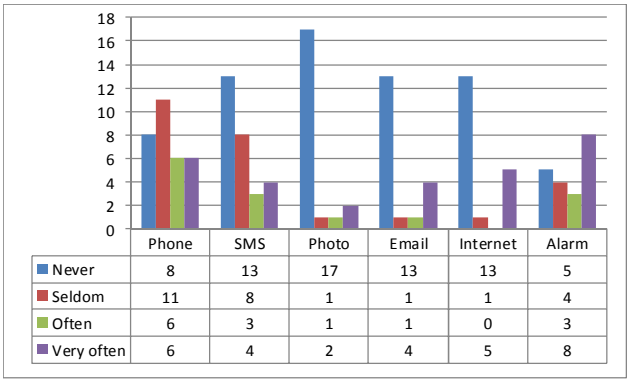
- *Conveying the purpose* of the research was a problem. Despite the fact that posters explaining the non-for profit research were put up a week before the time, two residents of the retirement centre brought their old phones to be exchanged and another had expectations about purchasing the prototype. They accepted the situation when it was clarified and they gladly participated in the evaluation.
- *Importance of order and predictability*. During one discussion we had just settled ourselves when another participant unexpectedly joined the group. This increased the number of participants above the initial number proposed. One of the existing participants complained loudly about this "intrusion". This prompted the new addition to leave and this upset the complainant even more. Order and predictability is clearly very important to this demographic. They are easily put out when the unexpected occurs.
- The *physical impairments* of hearing and seeing complicated group interaction since participants initially had difficulty hearing what the experimenters were saying or seeing the mobile screen. The demonstration was thus repeated for many individuals. Luckily, the other members of the focus group did not seem put out by the need for repetition – they seemed to enjoy having the opportunity to hear us explain things again: it seemed to clarify things for them.

As noted, the individual interviews followed the same procedure but then with only one researcher and one participant at a time.

Our difficulties during this evaluation mirrored those reported by Silva and Nunes [42] but also, as these authors point out, we discovered that the exercise delivered dual benefits. The researchers gained a much better understanding of their target user group. Moreover, the participants also benefitted in that they were able to share their experiences of mobile technology. Whereas usability testing with this demographic risks stressing and upsetting them, we did not get the impression that they were at all stressed by our focus groups. They participated enthusiastically and seemed to enjoy the social interaction and the opportunity to give their opinions. The audio recording transcription was analysed to interpret responses to the questions on what they liked, what they disliked, and what they would change.

5. RESULTS AND DISCUSSION

The 33 participants included 10 men and 23 women. The age groups were as follows: 6 between 65 and 74; 7 between 75 and 80 and seven over 80 years of age. Besides the one Blackberry and four Samsung phones, the rest of the participants owned Nokia feature phones. Two did not know what make of phone they owned. The frequency of used functions is depicted in Figure 3. It can be seen that the respondents used their mobile phones mainly for phoning and texting.



	Phone	SMS	Photo	Email	Internet	Alarm
Never	8	13	17	13	13	5
Seldom	11	8	1	1	1	4
Often	6	3	1	1	0	3
Very often	6	4	2	4	5	8

Figure 3: Usage of Phone Functions

When asked to verbalise their feelings about their current phones, and then about the prototype phone interface, the responses could be classified into four main categories: *very positive, positive*, *negative* and *other* as depicted in Table 3. The majority of the participants (3+17) reported feeling positive about their current phones, with 10 reporting negative feelings about their phones and 3 being indifferent. The Gran-a-Phone was perceived more favourably than their current phone but that cannot be deemed significant due to the confirmation bias and acquiescence tendencies. A useful insight is the fact that participants did not want a big or heavy phone: the Samsung Galaxy S3 used for this evaluation was considered too bulky. Given the drive to create bigger interaction elements (buttons, text and displayed text) the only option seems to be to reduce the number of design elements on the interface. Interestingly, the negative feelings about participants' current phones related to cognitive difficulties whereas with respect to the Gran-a-Phone prototype the perceived difficulties related to the physical size of the device.

Table 3: User Perceptions

Current Phone			Gran-a-Phone	
#	**Terms**		**#**	**Terms**
3	great, excellent	Very positive	8	excellent, lovely, fantastic, fun, happy
17	good, useful	Positive	20	good, easy, interesting, better, helpful
10	frustrated, nervous, network problems, losing airtime	Negative	3	too big, need training, for youth
3	necessity	**Other**	2	Stress free, available?

One participant considered the Samsung a high-end device and felt that possession of the phone would make the owner a target for a mugging. He argued that an older person who owned such a phone might be afraid to use it in public. This, of course, has nothing to do with the phone's interface but it is an interesting observation related to the context of use. The participants' likes, dislikes and recommendations from the audio recording of the interviews are summarised in Table 4

Table 4: Audio response summary

Question	**Response**
Liked	Icons, age compatible, touch screen, could see what happened (visual feedback)
Disliked	Size (too big and too heavy), trouble with swiping,
Recommended Changing	Provide greetings like: "Good morning, God bless you" Long battery life: do not want to charge every day App sound: (Samsung Galaxy S3) at top volume was not adequate Cradle for charging Functionality to watch TV
Quote	'I only need to phone in and out' (make and receive calls)

5.1 Reflection

During our evaluation process it became clear that the end product was deficient in ways that the guidelines did not predict or prevent. Three possibly interacting explanations merit consideration.

The *first* is that the guidelines themselves were at fault. The *second* is that we did not apply the guidelines correctly. The *third* is that the field itself, mobile telephony, has particular characteristics that make guidelines unworkable.

With respect to the choice of the guidelines, we chose peer-reviewed guidelines that had emerged from multiple studies with elderly users over a number of years. Moreover we chose guidelines that had been produced in South Africa, our chosen developing country. Finally, they had been published in peer reviewed venues.

Yet in applying the guidelines we encountered many challenges, as explained above. We conducted a filtering process, and we could well have filtered out the wrong ones, or retained those that we ought to have removed. The fact that we had to conduct a filtering process at all suggests that the guidelines themselves were suboptimal or inadequate. The deficiencies in the final product could well have been a result of the interaction between a poor choice of guidelines and poor application thereof. Let us briefly consider how the interface might have differed if we had applied Kim *et al.*'s [28] guidelines.

Physical Factors: the recommendations suggest using a bigger screen and the use of large buttons. They emphasise the need for extra volume and additional feedback when buttons are pressed. Their final recommendation in this category presents a conundrum – they recommend a small phone, but this jars with the previous recommendations for larger buttons and screen size.

Cognitive Factors: Kim *et al.* [28] recommend limited functionality, but do not provide much guidance for choice thereof. They also mention the need for users to be reminded of their context at all times. They discourage the use of a layered menu structure and recommend requiring as few steps as possible to carry out functions. They suggest the use of the person's home language in order to reduce confusion. They also recommend the use of textual labels rather than icons.

Cultural & Psychological Factors: these recommendations do not apply to the phone itself, but rather to encouraging its use in a particular environment and context.

The Gran-a-Phone implements all these guidelines except the icon avoidance. In our evaluation we did not detect aversion to icons, although, as we mentioned before, the icon we chose for the contacts was a poor choice. Our participants all liked and immediately understood the other icons.

It seems that Kim *et al.*'s [28] guidelines would have resulted in a similar interface design to the one we arrived at. Also having followed a rigorous guideline selection process as described in section 2.4 we ruled out poor guideline selection as a reason for the non-optimal application design. Poor execution (implementation of the guidelines) is undoubtedly a factor to consider and here multiple implementations would have been helpful in elevating these findings to a higher evidence level. However, there is another possibility: that developing a viable set of guidelines for this context might well be infeasible.

There is a possibility that the field of mobile telephony is a particularly poor application area in terms of guideline development and use. The challenge might lie in packaging design guidance in a format which is useful in such a dynamic fast-changing environment, while still informing design in a way that is helpful and meaningful. This field is one where technology changes at unprecedented rate, which means that the inevitable lag involved in producing and publishing design-related research is overtaken by a changing technology, rendering the guidelines impractical before they can be used.

This explanation, while not negating the other possibilities, needs to be given serious consideration because of its implications. The literature provides many examples of mobile interaction design guidelines for the elderly but we could find only one example of guideline implementation. Based on the difficulties experienced with implementing the guidelines our main insight is that guidelines should not be published before they have been implemented, validated and refined. Requiring rigorous implementation as a necessary pre-condition to publication of such guidelines will contribute to a better understanding between researchers and developers in terms of the guideline-artefact divide and thereby contribute to a deeper appreciation of the research-action divide.

6. CONCLUSION

We have reported on a study that tested the viability of mobile phone interface design guidelines, developed specifically to meet the needs of the elderly in a developing world context. Our findings confirm the importance of such a validation process, since some significant deficiencies in the guidelines emerged during the application of the guidelines. The study raises questions about the validity and usefulness of the practice of creating guidelines without evaluating those through implementation.

We believe a discourse on the responsibility of researchers to also evaluate guidelines thorough implementation is critical to the relevance of guideline-related research. Another approach to optimising interaction design is to consider switching to design patterns instead of guidelines. This approach is significantly different from the guideline approach. Patterns emerge from successful designs, from designers encoding *existing good practice* into a disciplined pattern format. These might have more ecological validity than guidelines.

7. ACKNOWLEDGMENTS

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Appendix A

Extended Senior Mobile Phone Adoption Checklist (ESMAC) Guideline [48]		
1. Physical characteristics		
Type	Identifier	Details
Keys	1	Large size keys.
	2	Touch screen (can provide larger keys but less tactile feedback
	3	Key buttons should provide for clear tactile feedback when pressed.
	4	Key buttons should provide for audible feedback when pressed. (Key tones should also be adjustable via the phone settings).
	5	Backlit keypad is preferred especially for use in low-light conditions.
	6	Keypad inscriptions should use a suitable large font with high contrast colours.
	7	Raised buttons
	8	The phone should have a big "Answer" button and a big "End Call" button
	9	A keypad lock/unlock switch on the side of the phone is preferable to the normal two key press function.
	10	Separate keyboards for text and numbers.
	11	Easy key-lock function (physical and via software).
	12	Stylus for key-press and stylus clasp provided.
	13	Soft (rubber) buttons.
	14	Wide spacing between the keys.
	15	Keypad buttons are not too sensitive (prevent accidental key presses).
	16	Large emergency button in a prominent place (programmable function).
Display	17	Option to make the (power saving) display backlight timeout function extra long before it dims or switches the backlight off.
	18	Display should be larger than normal
	19	Screen font should be large.
	20	Screen font should be high-contrast.
	21	Display should have adjustable brightness and contrast.
	22	Display should have different colour schemes.
	23	Provide magnification and zoom options for enlarging the screen characters.
	24	The phone surface should be easy to grip
	25	Overall size of the phone should not be too small
	26	The phone must not be too heavy.
	27	Rubberized corners may protect the phone during a fall.
	28	The case design of the phone should be hearing aid compatible
Case	29	The case should have phone neck-loop compatibility.
	30	Phone must have easily visible and identifiable speaker and microphone positions..
	31	Phone must have an obvious top and bottom.
Extras	32	It should have a flashlight LED external on the phone body that is easily controlled via a single button.
	33	The phone volume should have additional amplification with an extra-loud loudspeaker. It should have a speakerphone facility, and a headphone jack
	34	Longer battery life.
Battery	35	It should be easy to recharge via a cradle rather than a plug.
2. Complexity		
Keys	36	Each key should preferably control only one function (not always possible on a limited size device), but at the same time, the number of key buttons should be minimized. Avoid button overload (dedicated function buttons).
	37	Recognizable function names on buttons to facilitate recognition rather than recall.
Menu	38	Simplified menu structures to minimize nesting of functionality.
	39	Clear indication of battery charge remaining.
Indicators	40	Clear indication of a missed call and message received
	41	Easy to understand terminology and markings.
Tasks	42	An easy way to load talk (air) time.
3. Features		
Calls and SMS	43	Essential functions such as receiving and making a call, text messaging (SMS).
	44	Pre-programmed emergency speed dialling.
	45	Flashing and vibrating alert for incoming calls.
	46	Remote management of the phonebook (such as via SMS).
Caretaking	47	A big programmable, emergency button in a prominent place is desirable.
	48	Alarm and reminder functions (such as for wake-up and medication).
	49	Remote monitoring (i.e. constant one-way communication).
Communi-cate	50	Support additional languages in addition to English.
	51	Voice output of displayed information could also be useful, as is voice input (easily trained and effective voice recognition), used for example in voice dialling.
Features	52	Reduce the number of non-essential phone functions.
	53	Add a camera.
	54	Add internet access.