Instructions for Dementia: a Comparison for Usability and Efficiency

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ABSTRACT
The amount of people suffering from dementia is rapidly increasing, assistive technology can help society manage this growth. Since design guidelines are scarce, this paper shows the evaluation and comparison of three different ways of providing instructions for people with dementia. These prototypes are aimed at aiding in carrying out daily tasks, in this case playing a CD, and were tested with seven participants.

Due to this relatively small number, significant differences cannot be proven. However, mainly for the more complicated tasks, the results hint at a difference in efficiency and usability between these different methods, showing a need for more elaborate research in this field.

Author Keywords
Dementia; Design Guidelines; Providing Instructions; Assistive Technology.

ACM Classification Keywords
H.5.2 User Interfaces: User-centered design.

INTRODUCTION
We are currently experiencing an aging society, a process which will continue to increase with effects that are already starting to become visible and will become more problematic over time. Along with aging, the number of people suffering from dementia will increase heavily, with 46.8 million in 2015 and expected duplications every 20 years [1]. Dementia exists in different shapes, each of which featuring symptoms related to loss of cognitive functioning. Among the more familiar memory loss, people with dementia often experience difficulty in completing familiar tasks at home and being able to retrace steps [2]. As a result, independence is decreased, negatively impacting the person with dementia and the informal caregiver(s) [3].

Due to an increasing ratio of caretakers to caregivers, using assistive technology is starting to become an interesting and possibly necessary partial substitute to traditional caregiving [4]. Technology can be used to address a wide range of problems for people suffering from dementia, such as disorientation, sleep disturbance, memory loss and completing daily activities. However, in order to implement these technologies in consumer products, an inviting and user friendly design is required. Design guidelines for such products in a dementia context are scarce, resulting in high potential yet ignored products as people with dementia were not included in the design process [5,6].

The goal
This research focusses on the task completing issue, using the GUIDEmentia concept as a basis [7]. The concept consists of a screen-based product that uses NFC to scan objects in a home environment. The product will then assist the user in completing a task related to this object by providing step-by-step instructions through video and audio.

The concept introduces a challenge in connecting the virtual with the physical world which, if done correctly, could boost independence for the person with dementia and unburden informal caregivers. In order to maintain a level of focus, electronical devices will be considered, rather than daily activities. By using a CD player, which can already be difficult in an early stage [8], instead of getting dressed for example, differences in interaction are kept to a minimum in order to achieve explicit results. With current technologies, plenty of possibilities for realization of this concept exist [9]. However, for people suffering from dementia, selection and human-centered development of these technologies is crucial as going from instructions to actions can be difficult [10]. In this paper, various methods of providing these instructions are presented and compared, both qualitatively and quantitatively, in order to answer the question:

How should we present instructions to help people with early- and mid-stage dementia learn to use unfamiliar electronic devices in a home environment?

METHODS

User
Seven people with dementia were selected for this research (Table 1). Each participant met the requirements of being diagnosed with a form of dementia. Since severity of dementia significantly influences test results, only subjects in an early- or mid-stage were selected, or stages two until five in Reisberg's dementia scale [11]. Each participant received an instruction providing prototype and an unfamiliar electronical device, in this case a CD player. Furthermore, none of the participants could operate the CD player without instructions.

Male : Female	3 : 4
Mean age (SD)	77.4 (±8.0)

Table 1. Age and Sex of the participants.

Design

All participants were presented with the same CD player and asked to play a CD on the device. This process was divided into five steps. The CD player required different types of interaction for the different steps, divided in three difficulty classifications. Physical actions, placing the CD in the slot and closing the CD lid, were defined as the most simple interaction. Pressing push buttons, since these actions are less directly related to the intended result, were classified as moderately difficult. A slide button was defined as a difficult interaction, next to the disadvantage of the push button, the required interaction was more complicated and precise.

The participants were divided in three groups, each with a different instruction providing prototype.

Audio-video (A)

Similar to the current GUIDEmentia concept [7], the first group (N=2) received instructions through video and spoken audio (Figure 1). Mainly on the internet, this method of providing instructions is commonly used. The video clearly shows where and how the action should take place, supported by the extra modality, audio.

Figure 1. Snapshot of the video instruction.

Audio-visual-marker (B)

Colored stickers were added to the buttons of the CD player for the second group (N=2) (Figure 2). Research shows that cueing using color improves visual distinction in environment and objects for elderly [12]. The audio, as well as the visual instructions referred to the color. Video was replaced with images to maintain focus on the stickers.

Figure 2. Snapshot of the instruction using markers.

Paper checklist (C)

Most instructions for using devices in a home environment are homemade, using written text placed near the device (Figure 3). This technique was used to compare technological solutions with the current most common method (N=3). For this study, the steps were printed in A4 size.

Figure 3. (Dutch) Digital version of the paper checklist.

The first two options utilize the GUIDEmentia prototype with small alterations (Figure 4), designed to be easy to understand and connect to objects in the physical world. The designs are partially based on research indicating improved usability with visual aid approaches [13]. These first two methods are shown on a small, 4 inch screen. After each step of the process, the video pauses, providing the participant with the option of either replaying the step or continuing to the next. The number of steps, five, was identical for each of the three options.

Figure 4. The prototype that was used for the first two groups.

Main differences

The three different methods were selected to compare a few different qualities and their effect on the process of receiving instructions.

Connection

A major aspect of instruction providing consists of cueing, referring to a certain action on a certain part of an object. In the paper version, this has to become clear from text only. The hypothesis is that the required action is difficult to understand in this case, especially for complex tasks. The second group can see on the display where and how this action should be performed, supported by audio. However, the video might refer to a button on the CD player that is difficult to distinguish from the ones around it. The idea behind the color coding group is to make this connection the most simple out of the three options.

Keeping track

Although none of the options actively sense which action is performed by the participant, the groups that use the GUIDEmentia prototype are prompted after each step. The display shows the sentence “Did you succeed?”. The display will then show two buttons, allowing the participant to replay the instruction or continue to the next. The intention is to make the participant of his or her progress.

Usability

The final considered aspect is ease of use. The GUIDEmentia prototype was designed to be as simple as possible, however it does require a small amount of touchscreen interaction from the participant. Since most elderly are unfamiliar with such technologies, the paper version is expected to be more accepted by the participants.

Approach

The comparison was performed through 30 minute usability sessions (Appendix A, Appendix B). In order to exclude the effects of short term learning capabilities and keep the sessions from becoming tiresome, each participant only used one of the interventions. After a brief explanation regarding the context of the research, the participants were asked to play CD using their designated prototype. The observer monitored the process, capturing the required time per step and observations regarding the interaction. Only when no intention to interact was observed from the participants, the instructions were repeated.

Next to the observation data aspects, the users were asked to participate in a short interview. During the interview basic information regarding age and living situation was acquired, as well as information regarding technology-related skills, such as use of computers, televisions and other equipment.

Furthermore, a User Experience Questionnaire (UEQ) [14] was performed during each session. Efficiency is not the only aspect of a successful solution, the results of the UEQ could be informative regarding technology acceptance for people with dementia. The UEQ questions were completed together with the observer as some of the questions required a more elaborate explanation.

RESULTS

The results have been divided into three sections, firstly notes from the observer and answer to his questions, secondly the filled in UEQ forms and finally the measured time. Regarding the quantitative results, due to the small amount of participants the error margins are rather large and large differences should be considered as trends, rather than significant results.

Observations

Paper versus screen

For two out of the four participants that used the GUIDEmentia prototype, the observer was required to restart the first instruction video. After having missed the initial instruction, the participants did not actively press the button to restart the video. After the restart, one of the participants did not require further assistance. For the other participant, the action was performed the second time, however the observer was once required to press the button to continue to the next instruction step.

The participants from group C did not require this type of guidance. These participants did show more doubt before performing actions. Two out of the three subjects asked the observer multiple times whether the action they were about to perform was the right one.

Tracing steps

Out of the four participants that used the digital way of receiving instructions, no one made mistakes such as pressing a wrong button or pressing a button twice. One of the participants using the paper instructions moved a slide button one step too far, which was considered as an error. Furthermore, one participant once read the same instruction again after just having performed it. Another participant started reading from the top after each step. Although neither resulted in errors, both could get into trouble in more complex situations.

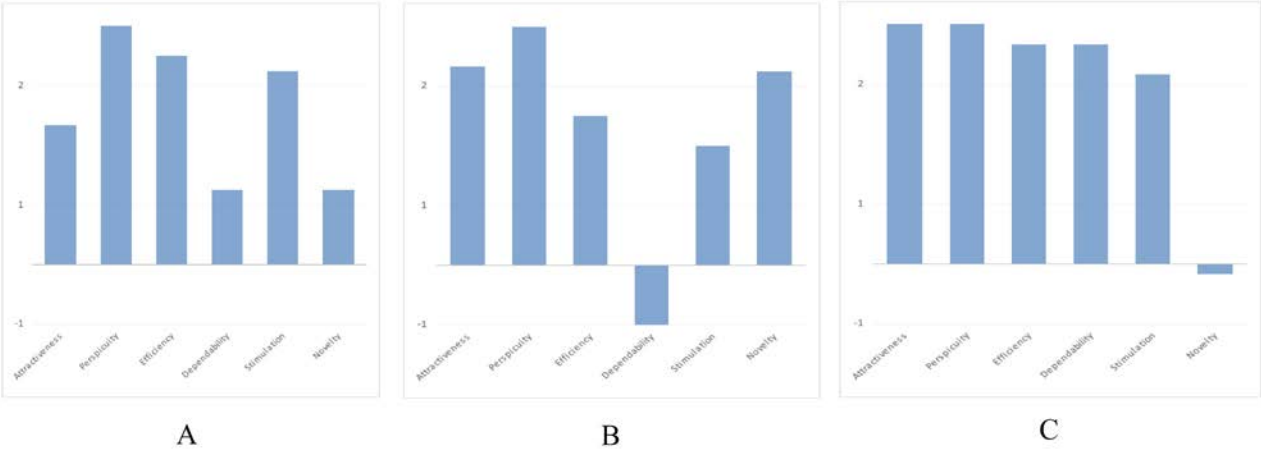

Figure 5. User Experience Questionnaire per group.

User Experience Questionnaire

As mentioned, the relatively small amount of participants affected the error margin of the results. However, from the visual representation of the answer (Figure 5), a trend can be seen. Groups A and B score lower in dependability, confirming the lack of acceptance for technology. Furthermore, the participants seemed to recognize the lack of novelty in intervention C.

Time

Comparing the total amount of time required to complete the process did not provide valuable results since the participants were in different stages of the disease, thus affecting cognitive abilities. Although group A was the fastest overall, this could have been due to cognitive state (Figure 6).

A clear visual trend appears when comparing the average time in percent for each of the steps (Figure 7). In the process of playing a CD, step four, moving a sliding switch, was assessed as the most complicated action. The participants from group C had trouble finding the correct button, as well as finding out what to do with it. For group B, this difference was less extreme, whereas in group A, the required time to perform the action is quite similar to the other steps.

Statistical analyses such as Mann Whitney U and Kruskal Wallis did not result in significant results due to the error margin in the relatively small group of participants. The difference in percentage for step four between the different interventions is χ^2 (2)=3.929 (p=.140).

DISCUSSION

The results show some difficulties with the use of the digital prototypes. In this case, the chance that these problems emerged from the fact that this was their first experience with such a product is highly likely. As mentioned before, learning capabilities should be able to solve this issue.

This research features certain limitations that affect the results. First of all, the number of participants is too low to achieve significant results in the quantitative data analysis part. Furthermore, it is not a complete, thus correct, representation of the target group in regards to the results from the observations. Although the group was quite diverse in gender, age and living situation, the magnitude of the differences in behavior and understanding implies that many more should be included in studies to end up with general design guidelines.

Secondly, during the sessions described in this report, people with dementia used the device for the first time and one time only. One might argue that this setup could be seen as a realistic scenario because people would forget how to use it in a short period of time. However, contrary to popular belief, learning abilities remain to a certain extent [15,16,17]. Therefore a more representative study with intentions similar to this one should include long-term effects, conducted and measured in context.

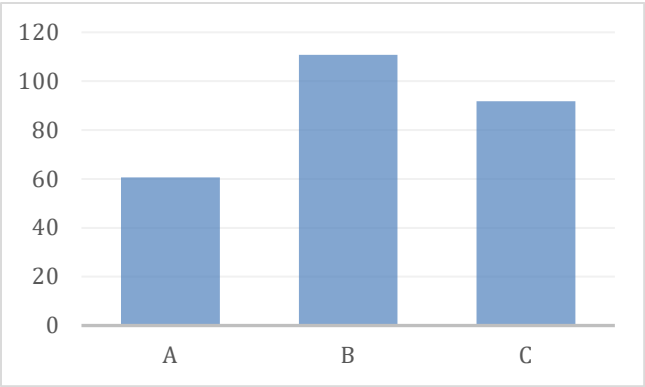

Figure 6. Average time per group.

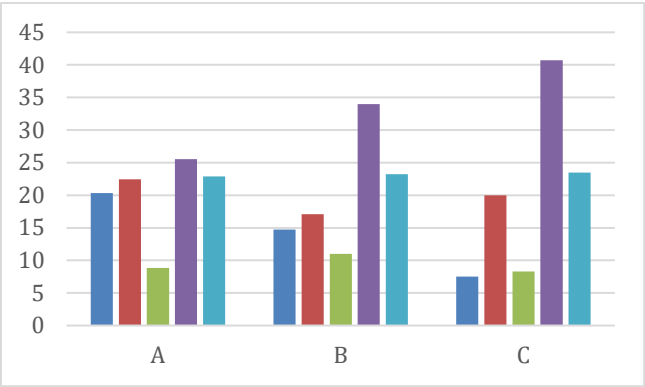

Figure 7. Time (%) per step.

Finally, although effort was put in finding a device with different types of interaction, the CD player does not represent all types of interaction possibilities. Next to other ways of providing input, such as turning a knob or pulling a lever, feedback and related information from the intended device should be considered. A more elaborate study could for example start by assessing the different types of interaction based on a framework, such as the Frogger framework [18].

CONCLUSION

The results indicate that using assistive technology to help with people with dementia carry out tasks is at least comparable and in many ways superior to alternatives such as written instructions. Certain qualities of having an actual person carry out the instructions, such as a visual representation and support through audio, are integrated in the concept. Using colored stickers for cueing adds to these benefits by enhancing the connection between the virtual instruction and the physical object it refers to.

These results are already visible when comparing data from a single use. The size of these differences would likely increase in longer term studies, taking into account the learning curve regarding use of the assistive technology [15,16,17]. In terms of user experience, acceptance of technology-based aiding devices should increase over time as well [19]. In combination with a large group of participants and a structured framework of interaction possibilities, the potential impact of efficient and user friendly technological solutions for people with dementia provides sufficient reason to continue with creating design guidelines for instruction providing assistive technology.

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APPENDIX A

Technische Universiteit Eindhoven, 11 mei 2017

Toestemmings Formulier

Voor het project 'Design for Dementia' van de Technische Universiteit Eindhoven, wordt onderzoek gedaan naar uw mening over de interactie met een product.

U bent uitgenodigd om deel te nemen aan een onderdeel van deze studie waarin onderzoek wordt gedaan naar richtlijnen rond het ontwerpen voor dementie. Tijdens deze studie ligt de focus vooral op hoe instructies het beste aangeboden kunnen worden. Tijdens deze sessie krijgt u instructies om een CD af te spelen. De observeerder zal bijhouden hoe lang u hier over doet en hier vervolgens vragen over stellen.

U bent niet verplicht de vragen van de student te beantwoorden. Indien u zich wilt terugtrekken van het onderzoek kunt u dit ten aller tijden aangeven aan de onderzoeker. Alle informatie zal als vertrouwelijk worden behandeld tenzij u aan geeft dat het publiekelijk mag worden gemaakt.

☐ Ik geef **wel** toestemming, mijn foto's openbaar te publiceren op internet of andere media, daarnaast mag mijn data worden gebruikt ten behoeve van het onderzoek. Mijn data zal anoniem worden verwerkt.

☐ Ik geef **geen** toestemming, mijn foto's openbaar te publiceren op internet of andere media, mijn data mag uitsluitend anoniem worden verwerkt ten behoeve van het onderzoek. Ik zal niet in enige foto te zien zijn.

Ik heb het 'toestemming formulier' begrepen, en neem vrijwillig deel aan dit interview. Ik begrijp dat mijn toestemming mijn wettelijke rechten niet beschadig ingeval van nalatigheid of andere wettelijke schuld van iedereen die betrokken is bij deze studie.

Datum: .....

Naam participant: .....

Handtekening participant: .....

Datum: .....

Naam student: .....

Handtekening student: .....

TIJD

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Interventie A / B / C

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…….....
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UEQ

*Geen foute antwoorden, uw mening

	1	2	3	4	5	6	7		
onplezierig	○	○	○	○	○	○	○	plezierig	1
onbegrijpelijk	○	○	○	○	○	○	○	begrijpelijk	2
creatief	○	○	○	○	○	○	○	fantasieloos	3
makkelijk te leren	○	○	○	○	○	○	○	moeilijk te leren	4
waardevol	○	○	○	○	○	○	○	waardeloos	5
vervelend	○	○	○	○	○	○	○	prikkelend	6
oninteressant	○	○	○	○	○	○	○	interessant	7
onvoorspelbaar	○	○	○	○	○	○	○	voorspelbaar	8
snel	○	○	○	○	○	○	○	langzaam	9
origineel	○	○	○	○	○	○	○	conventioneel	10
belemmerend	○	○	○	○	○	○	○	ondersteunend	11
goed	○	○	○	○	○	○	○	slecht	12
complex	○	○	○	○	○	○	○	eenvoudig	13
afstotend	○	○	○	○	○	○	○	begeerlijk	14
gebruikelijk	○	○	○	○	○	○	○	nieuw	15
onaangenaam	○	○	○	○	○	○	○	aangenaam	16
vertrouwd	○	○	○	○	○	○	○	niet vertrouwd	17
motiverend	○	○	○	○	○	○	○	demotiverend	18
volgens verwachtingen	○	○	○	○	○	○	○	niet volgens verwachtingen	19
inefficiënt	○	○	○	○	○	○	○	efficiënt	20
overzichtelijk	○	○	○	○	○	○	○	verwarrend	21
onpragmatisch	○	○	○	○	○	○	○	pragmatisch	22
ordelijk	○	○	○	○	○	○	○	rommelig	23
aantrekkelijk	○	○	○	○	○	○	○	onaantrekkelijk	24
sympathiek	○	○	○	○	○	○	○	onsympathiek	25
conservatief	○	○	○	○	○	○	○	innovatief	26

Wat is uw leefsituatie? (mantelzorger, leeftijd, zorgverleners)
…….....
…….....
…….....

Van welke technologie maakt u gebruik? Bedient u deze zelf? (TV, PC, smartphone)
…….....
…….....
…….....

Gebruikt u hulpmiddelen? (instructielijstjes, geheugenhulp, dementie specifieke AT/producten)
…….....
…….....
…….....

Wat vond u van het hulpmiddel? (was het anders niet gelukt, instructies te makkelijk of moeilijk, AT te makkelijk of moeilijk, UI)
…….....
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…….....

Methode-specifiek (Te druk? Voortgang bijhouden lastig? Connectie fysiek/virtueel lastig?)
…….....
…….....
…….....
…….....

APPENDIX B

Usability session versus in-context

At the start of this research, the decision was made to conduct an in-context comparison study. A data gathering prototype, registering time between actions and errors, would be left with the participant for a week, in order to visualize the effect of learning over time. In combination with observations from the informal caregiver and interviews at the beginning and end of the week, a realistic scenario could be created without an observer's influence.

Due to time issues related to the amount of participants and available prototypes, the advantages and disadvantages of such a study were compared with those of a usability study, which would consist of short sessions. During these sessions, measuring a learning effect would not be possible and an observer would be present, possibly influencing the test, but allowing for direct observations. The latter option was selected.