Evaluating Interaction-Triggered Emotions in People with Dementia

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Abstract

Current User Experience (UX) tools are not applicable for evaluating the UX of people with moderate to severe dementia as communicating about self-reflection is beyond their abilities. Observational Quality of Live (QoL) methods are frequently used in the dementia context, but not designed for formative evaluations. In this paper we present Proxemo, a prototypical approach combining the strengths of methods from both domains. By enabling evaluators to accurately document emotions of people with dementia Proxemo overcomes the problem of UX tools requiring self-report and the vague timeframes of QoL methods. In a preliminary study experienced evaluators from the domains of UX and dementia interacted with the prototype intuitively and were keen on applying it in an evaluation. In future work we will optimize Proxemo for rating emotions of multiple users.

Author Keywords

Dementia; Reminiscence; User Experience; UX; Evaluation; Methods; Wearable;

ACM Classification Keywords

H.5.2. Information interfaces and presentation (e.g., HCI): User interfaces – Evaluation/methodology, User-centered design, Prototyping, Haptic I/O;

Five concepts for interactive reminiscing

In an adapted contextual design process we worked out five concepts with our project partners: interactive Walls, avatars, an interactive table, the set of drawers in Figure 1 and a multimedia stock solution that serves as a basis for caregivers to prepare reminiscence sessions.

Figure 1: Tangible prototype of the interactive set of drawers. The interface consists of four drawers with embedded displays showing different topics. Inside each drawer are tangible objects related to the picture on the outside.

Introduction

Dementia causes interference with activities of daily living through the loss of memories [22; 23], including autobiographic memory and subsequently, self-identity [28]. One way to counteract this development or alleviate the decline of Quality of Life non-pharmacologically is training the brain by actively invoking memories of the past. So-called *reminiscence activities* are widely known in dementia care and applied in many care facilities on a daily basis. Under this term, all kind of interventions are pooled which help people with dementia to actively reminisce. The array of possible activities is broad and, following the person-centered care by Kitwood (e.g. [18]), depends on individual experience and the preferences of the person with dementia. Examples of activities include crafting sessions [24], visiting art exhibitions [1], creating life-story books with youth volunteers [5] or elaborate reminiscence programs for baseball fans [34]. During extensive observations in two facilities [13] we found that reminiscence sessions in the care facilities' daily routines consist of less extraordinary and costly events. With the focus being on encouraging people with dementia to reminisce about autobiographic events, also a well-targeted question on a picture in the newspaper can serve as the trigger to invoke memories.

Reminiscing through technology

Even though showing around printed photographs of former times or turning on radio music from the 50s are reminiscence activities often used by caregivers, also multiple approaches employing interactive systems have been made in the last two decades. The most popular is presumably the CIRCA project [2]. It established a touch screen computer with media

content to enrich face-to-face communication between caregivers and people with dementia in reminiscence sessions. And there are some more examples in literature (see [21] for a review).

The InterMem project

In the interdisciplinary project *Interactive Memories* (InterMem) we explore how reminiscing in people with dementia can be enriched through technology. Our approach is a user centered iterative design process. Through an adapted *contextual design* process [12; 13] we developed 5 concepts for interactive reminiscing that will be reported elsewhere in more detail. One of them is the tangible set of interactive drawers for people with moderate to severe dementia shown in Figure 1. But how could these be evaluated? How can we determine whether our approaches were successful? It turned out that the literature provided no satisfactory answers. In the following we show why existing methods are not applicable to tangible interfaces in dementia context and present a possible solution.

Evaluation Methods Used in Dementia Care

Lazar, Thompson and Demiris [21] list 44 articles in their systematic review on the application of information and communication technology for reminiscence interventions. They looked into the kind of technology used and the purpose it served. But an important topic not covered in said review is, how the listed technology probes were designed and evaluated. So as a first step we reviewed the papers included in Lazar, Thompson and Demiris [21]. Of those studies we found 23 studies where an evaluation is described. We extracted information on how data was collected during the evaluation and which criteria were applied (see Table 1). The standard usability criteria *effectivity,*

Criteria	Used by
participation	7
triggered reminiscence	7
engagement	6
enjoyment	6
choosing	6
interest	5
satisfaction	5
effectiveness	4
having a choice	4
psych. stability	4
usability	4
maintenance	3
positive reaction	3
quality of life	3
learning effect	3
efficiency	2
activity	2
media used	1
physiology	1
social aspects	1

Table 1: Frequency of evaluation criteria reported by studies referenced in the review by Lazar et al. [21].

efficiency [15] reported in studies do not apply here as they are not relevant to the domain of reminiscing. Also the amount of participation or reminisced items are criteria for showing efficiency or training effects. Reminiscence activity is about triggering emotions and enhancing self-identity, behavior and attitude on the long sight [35]. As we wish to iteratively optimize the set of drawers we seek a tool for formative evaluation that allows to systematically map dementia care patients' emotions to the interactions that evoked them.

Requirements for formative evaluation in dementia care
Based on literature and the contextual design process (described in more detail in [13]) we derived following requirements for the evaluation of a tangible prototype with people with moderate to severe dementia in the context of a care facility:

R1 Avoid overexerting people with dementia by keeping cognitive load to a minimum.
R2 Plan for residents with disabilities in speech.
R3 Embed evaluation into the daily routine.
R4 Due to restrictions in communication [6] and self-reflection, do not use self-report methods. Even people in an early stage of dementia are not able to handle an interface leaving them three options [25].

For optimizing the prototype we need to identify which interactions are good and which have to be adapted. This need led to the additional requirements:

R5 Map reactions to specific interactions.
R6 Instant documentation of emotions since some reactions are only interpretable in the context.

Quality of Life
Apart from psychological stability (see Table 1), *Quality of Life* (QoL) is a criteria frequently used for evaluating long-term effects of reminiscence interventions. A review by Algar, Woods and Windle [1] mentions 20 different QoL measures of which nine observational tools are closer analyzed and compared. Among the variety of QoL tools, scales using self-report are not interesting for us (R4). As our users have moderate to severe dementia that is amongst others defined by aphasic syndromes [6] proxies have to rate their QoL.

One of the most complex QoL tools that requires trained expert evaluators is the *Dementia Care Mapping* (DCM) [17]. It consists of 23 behavior categories (e.g. articulation, handicraft) and quantifiers (+5 very positive to -5 very negative) for mood and engagement shown by the observed person. Combined the weighted behaviors are used as representative labels describing observation periods of five-minutes. Observations are thought to cover five to eight people at once.

DCM also served as inspiration for the creation of simpler tools incorporating fewer items, for example the *Positive Response Schedule for Severe Dementia* (PRS) by Perrin [23]. She broke down the "behavioural *composites*" from the DCM to "behavioural *components* […] such as a smile, a nod, a gesture, an engaging of eye contact" (p. 185) [23]. For observation periods of 20 seconds observers code dichotomous values for ten micro-behaviour categories. This tightens the time frame but still does not allow to map emotions directly to the interactions triggering them (R5).

Emotions are recognizable by people in other humans through facial expression [9]. Translating them into a

UX-Tool	Reason for exclusion
AttrakDiff	Too complex
DES	Too complex
Emocards	Wrong domain
FACS	Video analysis
FaceReader	Parkinson
Laddering	Too stressful
LEMtool	visual interface
PANAS	Too complex
PrEmo2	product design
SAM	Too complex
Valence Method	Too stressful (see Laddering)

Table 2: A selection of User Experience tools that can be used to assess single interactions with respect to evoked emotions (ordered alphabetically). In the right column reasons are stated that made the tool unsuitable for either tangible interfaces or being applied on behalf of a person with dementia.

verbal scale means cognitive effort and may influence the response [14; 33]. Thus a valid alternative for logging emotions is given by pictorial scales. In the context of Dementia the *Observed Emotion Rating Scale* (OERS) [20] provides descriptions next to emoticons representing the emotions pleasure, anger, anxiety/fear, sadness and general alertness. It is considered a QoL measure [1; 20] and also shares the issues of other QoL methods pointed out above. 16 seconds out of a ten minute observation are the smallest unit of any of the five emotions reportable. Therefore its fixed timeframe is too vague (R5).

What QoL methods do not cover
In summary, observational QoL methods capture different facets of behaviour by labelling observations during fixed, predefined timeslots. Here we come to the core problem of using QoL measures for evaluating user experience. They help us to make decisions on a high level. They help to answer the question, whether the intervention led to an improvement or not. For example, whether the entire interactive system raised a resident's mood. However, the methods' output cannot indicate, which of the single interactions worked and which did not. In an iterative design approach, this would be significant information for the designer.

Evaluating interactions in user experience
The growing field of user experience (UX) offers a huge range of methods for measuring product related emotions (see Table 2Table 1 and http://www.allaboutux.org for a more detailed list). How often a person smiled on average while using a prototype is useful information. More important to us is, which piece of content, animation or interaction triggered the smile (R5, R6). Even though most UX

methods were developed for self-report we consider them in the following in particular with regard to their suitability for being applied by observers (R4). That excludes tools like PANAS [31], DES [16] or AttrakDiff [11] as they are too complex to appropriately be filled in by proxies. The Valence Method [4] allows to link feelings directly to the moment when they occur. But the method's core part includes Laddering [26], a questioning technique much too stressful for people with dementia (R1). An approach to measure emotions directly from the face muscles activity is made by FACS [10] but requires video analysis thus violating R6. It is additionally problematic to interpret facial activity when users may suffer from Parkinson's Disease [27]. To our knowledge further context like body posture or breathing is not yet included in applications like the Noldus FaceReader (http://www.noldus.com).

Pictorials
The Self Assessment Manikin (SAM) [3] is a pictorial method for self-reporting an affective state. Using three dimensions it is too complex for quick documentation by proxy (R6). Simpler are Emocards [8], requiring the user to pick one of eight cards representing an emotion whenever prompted. Similar is PrEmo2 [19], developed for emotional responses to a product's design. The LEMtool [14] takes linking emotions to triggers even one step further. As Emocards and PrEmo2, it consists of a cartoon character expressing a set emotions. When embedded into a website, the LEMtool allows the user to attach an icon representing an emotion to a selected area on the screen. The possibility of tagging an emotion where it occurs would cover R5 if the LEMtool was not bound to a visual interface. The concept of using pictorial methods is nevertheless relevant to us. Desmet et al. [7] list an overview of pictorial methods
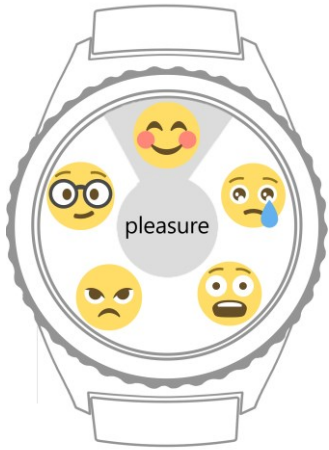
Figure 2: This image shows a smartwatch wireframe of the application Proxemo. Emoticons represent the five OERS [20] categories (clockwise): pleasure, sadness, anxiety/fear, anger, and general alertness.

Emoji art provided free by http://emojione.com, CC-BY 4.0.

and point out their usefulness in situations where respondents have too limited time to verbally express their emotions. With the keywords "limited time" we are at the core of dementia care again.

Strengths of existing methods

Summarizing the applicability of above listed methods for formative evaluations in the context of dementia, we conclude that none perfectly matches the requirements of our project. Many of them have strengths worth mentioning:

- The Valence Method allows to tag moments during usage, whenever feelings occur.
- Pictorial tools in general are more intuitive than verbal scales and thus require less effort in training and application.
- The OERS holds a set of emotions already established in the context of dementia.
- Due to applying OERS and other QoL tools, some expert evaluators are trained in identifying emotions in people with dementia.

Combining the best of UX and QoL
Revisiting the strengths and weaknesses it appears necessary to create new methods or adapt existing ones to cope with the shortcomings and unite the strengths of both domains. In the following we propose *Proxemo* - a first approach enabling a PROXy to report EMOtions.

Proxemo

Proxemo is thought to be used by evaluators, e.g. researchers or caregivers, as proxies when evaluating the emotional responses of people with dementia to an

intervention. It enables the evaluator to log the type and exact time of an emotional reaction. When synchronized with a captured video, the events can easily be linked to specific interactions. A combination with gaze data from eye tracking would even allow linking logged events to areas of interest, being focused at during that time by the participant.

The technical requirements for the tool are low. It must be able to set precise timestamps, when an emotional reaction is logged and write those to a file readable by video analysing software. Furthermore, it should be unobtrusive so that evaluators are not kept from writing or interacting with residents. Last, the user shall be enabled to log emotional events whenever they occur. An intuitive pictorial interface for example on a touch screen would satisfy the latter requirement.As the application should attract least possible attention by the persons being observed whilst still fulfilling above stated requirements we decided on a smartwatch for our first prototype. A smartwatch supports the possibility to be used by evaluators for spontaneously logging an observed emotion while they may perform activities requiring both hands a second before and after the use.

Prototyping and preliminary results
Two prototyping session resulted first in paper prototypes and later in low fidelity wireframes as shown in Figure 2. Finally we implemented a dynamic prototype of Proxemo using the rapid prototyping software Axure (http://www.axure.com). We performed cognitive walkthroughs [32] with two experienced UX evaluators and two experts on evaluations in the dementia care context. They explored the prototype online during video conferences with shared screens.

Figure 3: This image shows the Proxemo wireframe after an emotion was logged. There are two ways to interact with Proxemo:
a) Rotate the bezel clockwise or counterclockwise (as indicated by arrow) to select emoticons, then confirm the selection via a tap into the inner circle to log the corresponding emotion. So the names of the OERS categories can be read before they are logged (novel users).
b) Directly tab on an emoticon to log the corresponding emotion. This way no verbal feedback prior to logging an emotion is given but a single tap is all interaction required (advanced users).

Emoji art provided free by http://emojione.com, CC-BY 4.0.

The UX evaluators wished for the pictorials to be interchangeable so Proxemo can be used in various contexts. They also raised the question how the emotions of multiple users can be rated when for example three residents interacted with the drawer at the same time. UX evaluators had to scroll once through all emoticons (see Figure 3.a) to learn the corresponding OERS categories. Without having been briefed on which scale we implemented the dementia experts recognized immediately that the emoticons represented the OERS categories. They liked the interface and were keen on actually using it in context. For future versions they could also imagine a function to log the duration of an emotional state.

Discussion

There are well established methods for measuring Quality of Life in the dementia context. There are also elaborate User Experience methods for self-reporting emotions during product usage and beyond. At the interface of both domains, however has not been much worked on. Participatory design approaches involving people with mild to moderate dementia were made [29; 30]. But tools to support iterative testing in user centered design processes are not yet adapted for people with moderate to severe dementia as target group. With a growth of this user group in mind and the positive effects of interventions with technology reported so far (e.g. [2]) this is a research topic that is growing in importance.

A limitation in terms of generalizability of the research presented here lies in our focus on evaluating tangible interfaces. We developed an interactive set of drawers that is large enough so interactions can easily be captured by a camera and linked to emotions by

proxies. This may be more difficult when people with dementia use prototypes that are smaller or mirrored like tablet PCs. Another limitation is that compared to the DCM, Proxemo currently only allows for one observed person to be rated. In the second design iteration we will include a possibility to rate multiple people observed at the same time.

Finally, this paper shows just an example of an evaluation need occurring in the field. Further research will be necessary. Our next steps include implementing Proxemo and testing it with experienced evaluators in dementia care facilities.

Conclusion

The contribution of this paper is to point out the lack of user experience tools applicable to the dementia context. We reviewed literature and presented existing methods from both, the domain of dementia and user experience testing. Combining strengths from both domains we created Proxemo, a smartwatch application enabling evaluators to accurately log emotions of people with moderate to severe dementia. Proxemo overcomes the problem of UX tools requiring self-report and the vague timeframes of QoL methods.

Acknowledgements

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