
Tactile Dialogues: Personalization of Vibrotactile Behavior to Trigger Interpersonal Communication

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Abstract

This article describes tests that have been conducted with Tactile Dialogues, a textile pillow that can react to touch with vibrotactile stimuli and haptic sensations. Tactile Dialogues is designed to stimulate movement and interpersonal contact for patients in the late stages of dementia, their family members and their caregivers. The most recent prototype of the pillow has been tested during 15 separate visits of family members or caregivers with patients. The aim of these tests is to find out whether personalization of the vibrotactile stimuli is appreciated over a mirroring vibrotactile behavior. We propose a three-scale measurement to help family members and caregivers examine the responses of the patient: muscular relaxation, physical movement and interpersonal contact. Through the semi-structured interviews we identified that family members and caregivers do appreciate the opportunity to personalize the vibrotactile behavior and that the pillow mainly functions as a way to establish communication with the patient.

Author Keywords

Smart textiles; dementia; vibrotactile communication; haptic communication; personalization.

ACM Classification Keywords

H.5.2 [User interfaces]: User centered design



Figure 1 Caregiver and Patient using Tactile Dialogues.

Introduction

Dementia is a common name to describe the different conditions that affect the wellbeing of the human brain and intervene with a patient's ability to read, talk, write and move. The disease, usually associated with old age, affects most of patients' ability to be independent and is a side effect of other diseases of the brain, such as Alzheimer's. The most recurrent symptoms of dementia include memory loss, mood changes, and problems in communications and reasoning [1,8].

Dementia is currently the main cause for elderly entry to residential care, creating more demand for quality facilities [8]. These factors not only weight in the investment on healthcare but also reflect on the conditions of care to dementia patients. In order to allow an active and more independent old age personalized care is necessary but often neglected [8]. Family members can play an important role in this. However when the phase of dementia becomes more severe, visits are becoming more rare, leaving more pressure on professional caregivers. In order to develop more personalized solutions connections between different stakeholders such as service providers, care givers, physiotherapists and family members are required.

Within the Smart Textile Services CRISP project [2] a group of stakeholders is working on "Tactile Dialogues", a smart textile pillow sensible to touch. Smart textiles involve the integration of technology (sensors, computers, actuators) in the textile itself [7]. Tactile Dialogues incorporates vibration motors in different areas that may be activated in different sequences, speed and areas. The product's main goal is to enable a dialogue between a patient with moderate-severe

dementia and their family-member, spouse or care giver, by a joint interacting with the product. This provides an activity to overcome the awkward feeling that is often connected to the increasingly alienated relationship. The device provides different vibrotactile stimuli patterns and haptic sensations that combined encourage the patients to move and develop conversations in a more alternative yet bodily way.

In the field of tangible interaction haptic feedback has been used before to elicit inter-personal communication. For example vibrotactile communication was used to develop new language between remote partners [4]. Other authors have showed the value of using vibrotactile feedback in cognitively high-demanding situations, such as in traffic [3]. Vibrotactile feedback offers stimuli which link more directly to bodily capabilities and is therefore an interesting modality for people with dementia.

The interactive possibilities of Tactile Dialogues allow designing personalization of the vibrotactile behavior. This is an aspect worth exploring as this can enable the product to be tailored to particular individual's use characteristics or preferences. In past studies tailoring activities to the capabilities of dementia patients and training families in activity use, resulted in clinically relevant benefits for patients and caregivers, postponed the need for home placement and reduced objective caregiver burden [6]. The current pilot study was set out to examine whether personalization of Tactile Dialogues would lead to a better experience for the patient and family member or caregiver and if so, how personalization should take place.

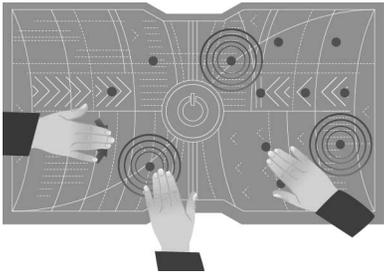


Figure 2 Personalized vibrotactile behavior design for patient 3: 'Search the vibration' game.

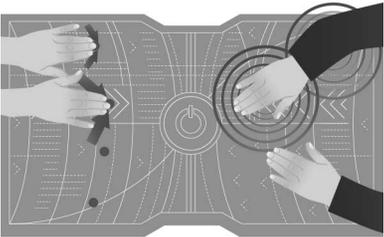


Figure 3 Personalized vibrotactile behavior design for patient 2: Under arm stimulation.

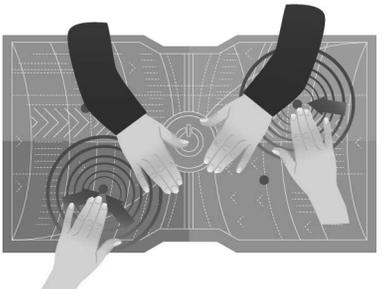


Figure 4 Personalized vibrotactile behavior design for patient 4: Increasing the area of stimulation.

Evaluation of Tactile Dialogues

Tactile Dialogues is designed for patients in the last two stages of dementia, when communication and awareness from part of the patient are extremely limited. The goal of the experiment is to evaluate whether a personalized vibrotactile behavior has a measurable effect in the amount of muscular relaxation, physical movement and interpersonal contact compared to a standard vibrotactile behavior design. The standard vibrotactile behavior was the *mirroring* behavior: touch on one end of the pillow is mirrored with vibrations on the other end. The current study for a personalized vibrotactile behavior with the pillow is conducted during 15 (5x3) sessions. We chose to include three sessions for each pair distributed over different days, as patients with dementia often display a high variety in their awareness of the environment and other symptoms of their condition over different days. After an information evening about Tactile Dialogues three groups of family members and two caregivers signed up to participate for three consecutive sessions with a patient.

The first pair, a patient (female, age 73) interacted with the pillow together with her daughters (age 48 and age 47). The second pair, the patient (male, age 79) interacted with the pillow with his three daughters (age 51, 48, 45). The third pair, female patient (age 74) interacted with the pillow with her husband (age 77). Except for one session all sessions took place in the presence of a caregiver from the care institution. The fourth and Fifth pair of patients (respectively male, age 78; female age 87) interacted in one session with a family member and caregiver and in follow-up sessions only with a caregiver. The first three pairs gave permission to videotape the sessions.

Session 1

Session one consisted of three phases. First, a short introduction was given about Tactile Dialogues and the *mirroring* vibration pattern. Second, the pair explored the product for approximately 15 minutes. The session ended with a semi-structured interview about the experience with Tactile Dialogues and suggestions for tailoring the vibration pattern to the patient. The first session had two goals: 1) make the pair feel comfortable with using the pillow and 2) explore how the vibration patterns can be tailored to the individual needs of the patient, by discussing ideas of the family members, caregiver and the designers. The co-design of the personalization of Tactile Dialogues took different forms depending on the input of the involved family members and caregivers. Some of them gave concrete suggestions while others were more open to suggestions from the design team. An example of a visualization of a behavior that was created can be found in figure 5. It shows a pattern in which the frequency of the vibration is connected to the amount of pressure that is measured by the input sensor. Other interaction behaviors that were programmed for the different patients can be found in figures 2, 3 and 4. The visualizations were used to communicate the vibration behaviors to the caregivers and family members during the second session.

Session 2

In the second session the pair again used Tactile Dialogues for approximately 15 minutes. The vibration pattern was now personalized and usually consisted of two or three specific behaviors that either the family member or the caregiver could perform. The goal of this session was to make the pair accustomed to using Tactile Dialogues with the personalized settings.

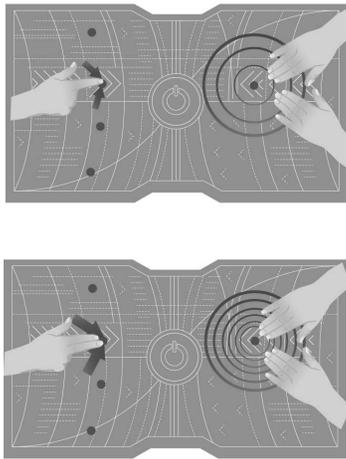


Figure 5 Personalized vibrotactile behavior design for patients 2 and 3 Pressure-Vibration frequency relation.

Session 3

In session 3 the pair explored both the *mirroring* and the tailored behaviors. Beforehand a time limit was discussed with the family members and caregivers, to ensure that patients would have enough energy left for exploring the other vibration program after exploring one of them first. This resulted in sessions varying from 5 to 9 minutes per program. In a following semi-structured interview we asked the family members and caregivers about their experience with the product and interaction with the patient over the three sessions. Furthermore, differences in the vibration patterns and their consequences for the pairs were discussed. Furthermore, we asked the family members and caregivers who allowed videotaping to watch the video of the third session and describe and interpret the response of the patient for every minute. We asked them to give a rating on a five point scale for the amount of muscular relaxation, physical movement and interpersonal contact during each minute of the video. Movement and contact were chosen as main outcomes because they were suggested as goals during the design of Tactile Dialogues. Relaxation was added based on observations in session 1 and 2.

Results

The results provide qualitative insights from the semi-structured interviews in session 1 and 3, as well as results from the first attempt to quantify the evaluation of (different settings of) Tactile Dialogues.

During the interview family members and caregivers reported increased relaxation in three out of five patients, increased movement in three out of five patients and increased contact between the patient and co-user, although in very different ways, in four out of

five patients. For one patient both the family member and the caregiver reported not to notice any changes in the patient, compared to usual interactions without the pillow. Three groups of family members reported to appreciate the opportunity to actually do a physical activity together with their loved one, instead of just talking or stroking the patient during their usual encounters. None of the family members or caregivers had the feeling that the patients were aware of the mirroring vibration pattern and its opportunities.

In the following sessions we noticed differences between the patients compared to earlier sessions, already without the use of the pillow. For example, patient 5 had trouble waking up in session 2, leading to little interaction with the pillow. Patient 1 was much less aware of her environment during session 2 and 3, while patient 2 was more awake and more aware of his environment in session 3, compared to earlier sessions. After the third session all co-users reported to see value in interacting with Tactile Dialogues, although it was clear that due to the different 'days' that dementia patients experience, the pillow did not cause the same highlights in movement or contact during every session.

None of the family members or caregivers reported a difference in the response of the patient between the *mirroring* and the tailored vibration patterns in the interview. However, all family members felt more comfortable with the tailored pattern and the option to adjust vibration patterns. A daughter of patient 2 described her view on personalizing location and type of vibration as follows: "I personally liked the second one [the personalized pattern] more. It provided more options, e.g. because of the vibration on the area on

| Categorized responses of the patients; reported by family members & caregiver, 3 rd session | |
|--|--|
| Movement | - Stroking the pillow - Tapping the pillow - Turning body to the co-user |
| Facial expression | - Raising eyebrows - Smiling / laughing |
| Relaxation | - Muscle relaxation - Sighing |
| Contact | - Eye contact - Grabbing hands - (attempt to) Talk |
| Awareness | - Aware of environment |

Table 1. Responses of the patients as reported by family members and caregivers while watching the videos of the third session.

| Patient 1 | Mirroring FM CG | Tailored FM CG |
|------------|----------------------|---------------------|
| Movement | 1.6 2.6 | 2.0 2.2 |
| Contact | 1.6 2.4 | 2.0 2.2 |
| Relaxation | 1.4 2.4 | 2.0 2.0 |

Table 2. Average ratings on a 5-point scale for movement, contact and relaxation of patient 1 by the family member(s) (FM) and the caregiver (CG).

| Patient 2 | Mirroring FM CG | Tailored FM CG |
|------------|----------------------|---------------------|
| Movement | 3.0 2.4 | 4.0 3.0 |
| Contact | 3.8 3.0 | 4.6 2.8 |
| Relaxation | 2.6 2.5 | 3.8 3.4 |

Table 3. Average ratings on a 5-point scale for movement, contact and relaxation of patient 2 by the family member(s) (FM) and the caregiver (CG).

| Patient 3 | Mirroring FM CG | Tailored FM CG |
|------------|----------------------|---------------------|
| Movement | 3.0 3.7 | 3.0 3.8 |
| Contact | 3.0 5.0 | 3.0 4.7 |
| Relaxation | 3.0 4.3 | 3.0 4.7 |

Table 4. Average ratings on a 5-point scale for movement, contact and relaxation of patient 3 by the family member(s) (FM) and the caregiver (CG).

the side of the pillow. That is an area that also counts for him [her father], not only his hands, but a larger area. Also the vibration with the short pulsation allows more variation” (translated from Dutch). Both family members and caregivers felt comfortable enough to be able to try out different vibration patterns with the patient, if a future interface would enable them to do this. Several suggestions on the options that a future interface should provide were given, the most important being able to vary the intensity of the vibration (as the strong change was better received in patients); select the area of vibration (because every patient has movement limitations and for this uses the pillow in different positions) and select from up to 4 different vibrating patterns, to mix with location and intensity.

Video analysis

The three groups of family members who gave permission rated the interactions. The ratings are examined only for separate patients and not as a group, because the responses between patients highly varied, a common finding in the condition of dementia [1]. The scales are used as an exploratory quantitative measure of response in the patient and evaluated for differences between family member and caregiver as well as for differences between the vibration programs. The family members recognized a number of responses in the patient (see table 1). Averages from the ratings for the amount of movement, contact and relaxation on every minute of the video are displayed in tables 2, 3 and 4. An analysis of these ratings demonstrated significant correlations between ratings on movement and relaxation for each patient for both the family members and the caregivers (significant ($p < 0.05$) correlations ranging from .474 to .919). An explanation

for this can be found in the contractures that patients with dementia in the late stages often experience. In such cases moving their fingers, hands or arms is at the same time relaxation of the contracture. Furthermore, for two out of three patients no significant correlations were found between the ratings of family members and caregivers, indicating that they have a different perspective on the behavior of the patients. This sometimes caused a more in depth conversation about the patient by the family member and caregiver, an outcome that was appreciated by both of them.

Conclusions

This pilot study aimed to explore and evaluate the personalization of Tactile Dialogues for patients with severe dementia. Every vibration pattern triggered different responses depending on the patient’s mood in the day of the test, their current stage of dementia and the experience of the family members in talking with the dementia patients. The pillow’s goal and result also varied depending on the patient’s current needs, in muscular relaxation, contact or movement. These changes in symptoms, needs and goals made it hard to compare the response of the patients to different vibration patterns (*mirroring* and *personalized*) over time. However, it is clear that Tactile Dialogues does induce a response in the patients. The results obtained further show that caregivers and family members experience the interaction with Tactile Dialogues and the response of the patients in a different way. It is thus clear that future research and design should benefit from both perspectives.

The pillow as seen in the current experiment proved to be a channel that family members and caregivers use as a way to establish communication with the patient.



Figure 6 Potential future interface for the personalization of Tactile Dialogues.

The pillow acts initially as a conversation starter and gives the space and inspiration to family member of how to encourage and persuade the patient with dementia to speak and move more. Thus it seems that the value of personalizing the pillow is much more present for the co-user, than the patient itself. Future research could dive deeper in the value for the co-user. As researched by Kramer and Gibson [5] and in the observations of these tests, better results were indeed obtained when the caregiver or family member combined the vibrations patterns with verbal cues and eye contact, something that seemed to be more present when feeling comfortable. Therefore the use of Tactile Dialogues and the personalization of the vibration patterns supported a need of elderly with dementia of constant encouragement and ever changing patterns in stimulation through voice and touch by their family and caregivers.

The current study suggests a future need for family members and caregivers to be able to personalize Tactile Dialogues. A future design must allow caregivers/family members a simple and easy design template as a starting point, as opposed to a blank canvas. Several suggestions are given that can be taken into account for this design. These elements combined give caregivers and family members the opportunity to explore and experience which type of therapy or interactive activity to conduct depending on the patients' mood and physical needs.

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