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Designing mindful intuitive interaction for people with dementia in everyday social contexts

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Abstract

This paper presents a methodological framework for developing intuitive interactive devices that can facilitate mindful emotion recognition and management for people living with dementia. Depression and other emotional issues are common in people with early stage dementia due to the anxiety of being diagnosed with dementia.

The aim of these devices is to facilitate the mindful control of the wearer over their own emotions to instill feelings of mindful self-empowerment. In order to realize such devices, it is necessary to develop a model of interpretation for relating physiological stimuli to emotions and to enable their creative translation. This article establishes a mindful co-creation framework for developing such an interpretive model to underpin the development of the envisaged devices.

Mindful design, intuitive interaction, wearable technology, Perceptual interfaces, co-design, dementia)

Emotions provide humans with a powerful means of negotiating the physical and social world, including the dynamic transactions of social relationships. Difficulties in recognising or managing emotions in one or more individuals can quickly lead to ineffective communication, conflict or relationship strain and breakdown.

Dementia is characterized by progressive memory and cognitive degeneration (Alcove 2013: 13). It is widely recognised that depression and other emotional issues are common in people with early stage dementia due to the anxiety of being diagnosed with dementia (Alzheimer Europe 2014) and that many have reduced social engagement.

In order to encourage and enable people with dementia to engage in activities that are in line with their interests and experiences, research into how to improve their quality of life is essential (Alcove 2013: 23; Alzheimer's Society 2013; Alzheimer's Australia 2008, Victorian State Government 2014).

Design can offer such novel ways, empowering people who experience these conditions in everyday life. Indeed, there are already a number of different design projects in this area (e.g. Nesta 2015). The paper presented here is part of work to be taking forward in the new European project called "Designing for People with Dementia: designing for mindful self-empowerment and social engagement", which is concerned with developing design solutions to help empower people with dementia, especially with regard to social engagement.

The focus of this paper is on how design can be used to address difficulties in recognising or managing emotions in the context of everyday social interactions to enable self-empowerment and social engagement for people with dementia. More specifically, the aim is to develop wearable designs that can facilitate the mindful control of the wearer over their own emotions, based on intuitive interaction to instill feelings of self-empowerment.

In order to realize such designs, it is necessary to develop a model of interpretation for relating physiological stimuli to emotions and to enable their creative translation. This paper develops a three-stage methodological co-creation framework as a pre-requisite for this interpretive model for the envisaged interactive wearable objects. The paper first reviews and synthesizes the three areas: dementia and emotions, mindful design, wearable design to provide a foundation and explain how the envisaged designs might work conceptually. The paper then discussed the framework parameters, and finally moves on to establishing the co-creation methodology that integrates the concept and parameters.

A review of current design approaches to emotion regulation in relation to dementia

This section reviews the different contexts of the research and draws them together to establish the conceptual premise for developing the proposed methodological approach.

Dementia, emotions and social interaction

People with dementia are regularly affected by behavioural and psychological symptoms of dementia (Alcove 2013, Gautier et al 2010, Manthorpe and Moniz-Cook 2008). In addition, they often face various difficulties of engaging in social context, e.g. through difficulties in planning, organizing, thinking strategically, paying attention to and remembering details,

managing time and space, and through a decreased ability to learn new skills, take initiatives and get motivated (Baddeley, Kopelman, and Wilson 2002).

In social context, this can cause difficulties in recognizing, relating to, and empathising with other people because individuals are struggling with their identity and with coming to terms with their circumstances. These difficulties often lead to social and emotional insecurity, which can e.g. result in aggressive behaviour or in withdrawal, posing a challenge for interacting socially and resulting in reduced social engagement. For example, insecurity due to memory loss can lead to aggression, or the fear of forgetting faces and not recognizing family or friends can lead to withdrawal.

Social contact, however, is central to stimulating mental faculties and emotional balance, and maintaining quality of life (Mendes de Leon et al 2003). The need for social engagement is recognised by the UN Convention on the Rights of Persons with Disabilities, with the right to the protection of integrity, living independently and being included in the community (European Union, 2014: Articles 17&19). In addition, the Synthesis Report on 'European Joint Action on Dementia' (Alcove 2013: 23) recommends that psycho-social interventions should be a priority to address behavioural and psychological issue, because they are safer than antipsychotics and can delay institutionalisation (European Commission 2014b: 11).

Design approaches to social engagement in dementia

There are an increasing number of design approaches to supporting people with dementia buy now. The various approaches follow different premises and hence address different aspects of dementia, such as stimulating memory (e.g. REMPAD, ReMind Me) or sensory response (Vibe-ing, Tactile Dialogues e-pillow, Snoezelen); promoting eating (e.g. 'ODE' fragrance system) or personal safety (e.g. personal alarm 'Buddy', 'Safe House' sensor system); or supporting care givers in various ways (Design Council 2012, 2013; Fashioning Technology 2013; Innovate Dementia 2015; Kinney et al 2004; Weert et al 2005, Yang et al 2013). These projects generally are concerned with the bodily wellbeing or the stimulation of memory.

There are a small number of projects which are specifically looking at facilitating social engagement for people with dementia. These include the 'dementia dog project', the 'dementia café project', and the 'dementia living project' (Nesta 2015, thejournal.ie 2014) The dementia dog project supports people with dementia with a guide dog (similar to a blind dog) who can help them remind of certain task as well as help them in orienting themselves on the streets. The dementia cafés, some including music-based entertainment, offer people the opportunity to come together for casual social interaction in a safe and understanding environment. The Dutch project 'dementia living' goes one step further: it houses students for free in the care homes in return for a set number of hours to be spent with or helping the people in the home.

While the above approaches are focused on facilitating the context for social engagement, our design approach focuses on supporting people with dementia within social engagement. The aim is to help people overcome fears of (failing in) social engagement, e.g. due to negative emotions arising from insecurities, or forgetting faces and not recognizing family or friends. The idea is to offer interventions early on so that the designs can be used to train with to encourage self-confidence and prolong independent social engagement.

An introduction to the mindful design approach

In order to achieve the proposed aim, we introduce the concept of mindfulness into design. Mindfulness is here understood as awareness or alertness of the present moment, and as flexibility that allows actively drawing novel distinctions through openness (Langer 1997: 111). Mindfulness can aid with the regulation of emotions, attitudes and behaviours, because it encourages reframing our actions and their causes, helping to adjust them to new situations and challenges (Langer and Moldoveanu 2000). Niedderer (2007, 2014) has introduced this idea into design to demonstrate how design can be used as a trigger to facilitate mindful action by raising awareness in everyday situations through embedding relevant triggers and choices within design (Niedderer 2007, 2013, 2014).

Mindfulness is increasingly used for therapy in the context of dementia care, both for people with dementia and their carers, and results have indicated reductions of stress and depression in both groups (McBee 2012, Monin and Schulz 2009, Oken et al 2011, Whitebird et al 2012). In distinction to these approaches, we are looking at the use of mindfulness in everyday social contexts. Cognitive mindful approaches have already been applied successfully in therapeutic and in everyday contexts (Ie, Nguyen and Langer 2014: 149-51; Djikic 2014; Manicavasgar et al 2011).

Building on these, mindful design offers the ability to activate and direct mindful awareness and reflection towards social engagement within everyday contexts through choices embedded in the design, which may integrate the supportive use of mindfulness practices, such as breathing exercises, where appropriate. Recent studies on computer-supported mindfulness found that appropriate design interventions can significantly surpass the effectivity of traditional mindful-ness training (Chittaro & Vianella 2013). Digital technologies have also been recognised more generally for their ‘potential to help face the challenges linked to dementia and neurodegenerative disorders’ (European Commission 2014: 5).

Our approach extends existing mindful design approaches, which use a mindfulness framework solely within a therapeutic context, and solely with regard to mental health unrelated to dementia (e.g. Thieme et al. 2013; Iida and Suzuki 2010). These remain linked to a therapeutic context in hospital settings where mindfulness is used based on meditation (Thieme et al. 2013), rather than on contextual awareness which is suitable to everyday contexts (e.g. Langer 2011).

The conceptual premise: designing mindful intuitive interaction

Drawing from the above discussion, this design approach seeks to offer a novel approach to managing psycho-social symptoms in the context of dementia by way of mediating personal emotional or cognitive barriers to social interactions through a mindfulness based approach. The aim is to realize this approach through the development of wearable objects (devices) for people with dementia that integrate mindful design concepts with/through the use of digital technologies. Their purpose is to help the wearer to compensate for an issue they encounter as a result of their dementia. The issues encountered can vary widely dependent on the nature of a person's dementia and how it affects them. They may vary from problems with emotion regulation or depression to a lack of ability to recognize the persons they are interacting with. The aim of the proposed design approach is to help create design that can engender mindful awareness to shift the perceived locus of control of the wearer from external to internal, thus helping the wearer develop a feeling of empowerment and control of their own emotions.

For the purposes of this paper, we are focusing on the scenario where difficulties in emotion recognition and management impede social interaction (Lough et al 2006). In response, we envisage the development of a wearable artifact(s), that are able to detect the emotional state of the wearer, and potentially of the person they encounter, to give the wearer appropriate feedback to help them navigate their social interactions. For example, the device might sense the wearer's anger, alerting the wearer to their emotional state before they realize it and enabling them to rationalize and act upon it. In order to be able to do this technically, the device will need to be able to measure physiological data and convert them into visual-sensory representations of the wearer's emotional state in order to raise mindful awareness of the wearer's emotions for themselves, and potentially others, in an everyday context.

The benefit of such direct feedback will be in the intuitive interaction, which it affords. Intuitive interaction refers here to the interaction of the user with the device *without* an intermediary interface and interpretation, such as currently customary digital displays or smart phone apps such as that by Chittaro & Vianella (2013). Instead unmediated intuitive interaction encompasses seamless interpretation with and through the intelligent artifact itself which is personalised to suit the emotional needs of the user. A simple example of unmediated feedback is the wristband by Iida and Suzuki (2010) which lights up upon touching another person. Simply, put our approach will integrate a mindful approach with an unmediated intuitive interaction approach. Such unmediated intuitive interaction will be beneficial in the context of working with people with dementia, because people with dementia are able to respond to sensory stimuli more easily and for longer than they are to cognitive stimuli (Hubbard et al 2002). This understanding of unmediated intuitive interaction complements and extends current definitions of intuitive interaction as based on prior (semantic) experience with the functional features of objects (Blackler, Popovic and 2010: 31).

The realization of the proposed mindful design concept is based a 3-tiered approach:

- The first stage is to create awareness of self through the sensory feedback of the device, which will enable the wearer to be aware of and manage better their own emotions.
- The second stage aims to create awareness of other through the visual-sensory feedback to enable the wearer to become aware of and understand better the emotions of the person they are interacting with.
- The third stage is the creation of awareness of self and other, enabled through intelligent learning and interaction between the devices.

In the following, this paper establishes a methodological framework, which underpins this three-tired approach. The methodological framework addresses two issues: Firstly, it discusses the parameters for the interpretive model for relating physiological stimuli to emotions underpinning the devices, including an overview and discussion of the physiological responses that are most appropriate to measure emotional arousal.

Secondly, it discusses co-creation strategies to enable the organic development of the three-tiered approach. This includes a discussion of the translation or interpretation of scientific/physiological data regarding emotions through participatory research to take account of their socially constructed nature and to identify what sensory stimuli usefully relate to different states of awareness and emotions. It also includes a discussion of participants' involvement needs for developing individualised designs that suit participants ergonomically, emotional and physiologically, as well as ethical implications.

Unpacking the framework parameters: relating physiological stimulus, technical data and emotions

This section discusses the technological underpinnings, which need to be considered for the development of the design methodology. They concern the parameters for measuring and interpreting physiological stimuli in order to relate them to an individual person's emotions, which are key to the realization of the concept.

Emotions, and how they are manifest in physiological stimuli and behavioural expressions

Research has clearly identified a link between stress and physiological arousal (e.g. Kirchbaum et al 1993, Connor-Smith et al 2000, Chida and Hamer, 2008). However, although some research exists, (e.g. Feldman et al 1999), a direct link between emotional arousal and physiological responses is less well documented. Nevertheless, it is reasonable to predict that emotional arousal of a sufficient intensity will generate a similar stress response and measurable changes in the activity of the autonomic nervous system, which governs physiological arousal and prepares the body for ' fight or flight'. Automatic responses to stress will be similar in a majority of people (e.g. increased heart and respiration

rates, increased muscle tension, momentary freezing of movement). Drawing on these insights, a wearable device could be designed to monitor these physiological changes, which are outside of conscious control and occur rapidly, in order to enable the wearer to recognise and act upon their own state of emotions through conscious responses.

Conscious control of responses to emotions will vary as they are mediated by higher brain centres and learned coping strategies. However, in the same individual, their pattern of learned response to a particular emotion is likely to be similar in different contexts. For example, some people will regulate anger emotions by exerting more control, while others will become less inhibited. These conscious mechanisms of regulation will result in physiological changes that are reasonably predictable in each individual. Therefore an intuitive device could be programmed to monitor these individualised responses.

A second approach could provide even more accurate feedback if the wearable devices were designed to be sufficiently acceptable to the participant group, e.g. in the form of jewellery. Psychological research has identified six emotions from facial expressions that are recognised irrespective of cultural and social differences. These ‘ universal emotions;’ are disgust, sadness, fear, anger, surprise and happiness (Black and Yacoob 1995). The muscular changes that underpin the sometimes subtle cues for these facial expressions have been identified (see for example Laukka et al 2013, Elfenbein et al 2002, Ekman 2009, Kendler et al 2008).

Drawing on this knowledge, fear and anger will provide the most useful feedback information for the purposes of this project. Fortuitously, they are to be the most easily recognizable, and could be incorporated in design, e.g. through muscle sensors, which could be attached with adhesive to the skin over the key musculature. As muscle tension increase, the bio-feedback could be used to trigger a small signal to the wearer to alert them. For example, a small audio signal could be used, which could also be loud enough, if desired, to provide feedback to the listener/receiver in the communication transaction, enabling the first and potentially the second step of the concept.

Different routes to interpreting physiological indicators for intuitive interaction

Having described above potential approaches to measuring emotions through physiological stimuli, one of the challenges as yet, which this research is addressing, is to relate the physiological stimuli mentioned to the specific emotions. Physiological stimuli such as muscle tension, heart and respiration rates, temperature, sweat and movement can be measured relatively easily through the appropriate physiological sensors. The difficulty is to interpret and relate physiological stimuli unambiguously.

Our hypothesis, based on the insight of the above discussion of physiological stimuli and emotions, is that a combination of different stimuli needs to be measured, along with sensed data that contextualises the physical situation of the wearer, for example, time, place, ambient temperature as well as other individuals in close proximity, as discussed in Schmidt

et al (1999) and in Christopoulou (2008). Their interpretation and relationship to specific emotions will be dependent on different readings and combinations of these. Therefore, there are a number of elements required to drive this work and test the hypothesis:

Firstly, there is the need for the use of relevant sensors to gain both the physiological inputs and the contextualisation information in an unobtrusive manner. This information must then be used with a smart, self-learning system to enable the appropriate and personalised interpretation of the data. The development of a suitable algorithm must undergo two distinct phases. Initial basic interpretive algorithms can be developed under laboratory conditions, drawing generic conclusions from received stimuli and contextualised data. These generic algorithms can then be used as a baseline for iterative adaptive work with individual wearers, to tune the response of the system to user-specific sets of circumstances. The final prototypes will have the ability to learn the users' habits over time and develop responses that accommodate the inevitable exceptions to the rules. In this way, the devices are envisaged to facilitate personalisation through intelligent learning.

The second phase of algorithm development has to be undertaken in close connection with relevant participants as each individual will have slightly different responses. In the first instance, this will be based on self-experimentation of the researchers, during the feasibility study, which is currently in progress. This is based on the understanding that in principle the same basic reactions exists in all individuals, whether healthy or affected by dementia and depression (or indeed other mental health issues). Once a baseline has been established, this work then has to be further developed and evaluated by work with relevant participants.

A further consideration is the acceptability of such devices for the intended audience. The sensor(s) will need to be placed in specific locations on the body dependent on what physiological stimuli they are to measure, which requires considering a variety of ways and places in which the sensors can be positioned and shaped to create attractive wearable objects. Therefore, it is useful consider what objects are normally worn in close contact to the body, but which are also attractive. These are of course clothing and jewellery. Existing approaches have made use of this, especially in form of smart watches. However, the designs of such devices can be extended much further and need to be customized to the taste of the particular audience. We therefore are intending to develop the aesthetic appearance of the devices, alongside the technological requirements, which could e.g. take the form of decorative ear-cuff, headband or facial decoration. These device will need to be shaped according to the preferences of the individual wearer throughout the co-design process.

At present, we are at the stage of the feasibility study, which seeks to demonstrate the possibility of relating physiological stimuli/sensor data and emotions and the combination of this with previous work on contextual information (Sloane and Dennett 2008). Since the details are covered by a non-disclosure agreement, at present, we are not able to report on the technical details. However, what we can report on is the methodological approach established for the co-design methodology, discussed in the next section.

Developing a co-creation framework for designing mindful wearable artefacts for intuitive interaction

This section develops the co-design methodology for the proposed work that integrates the conceptual premise (3 tiered approach) and the physiological-technical requirements with the user engagement of the investigation. For this purpose, this section briefly introduces current approaches to co-design strategies. It adapts relevant strategies to support the proposed mindful design approach in the context of this research, and to enable developing the personalised interpretations with and for each participant based on their emotions, physiological response and personal preferences.

Joining mindfulness and co-design strategies for a mindful co-design approach

Above, we have introduced the three-tiered mindful approach that is designed to enable the user to gain awareness of their own emotions as well as others' to help with managing emotions and increasing self-empowerment. We have also explained how emotion recognition through physiological sensors is dependent on their interpretation. For both steps, the user – i.e. the person who is to benefit from and to be supported through the design – has to be at the center of the design. This is both to ensure the design is suitable and acceptable to the user and addresses their specific needs. Therefore a methodology is needed that puts the user at the center of the design process. For this reason, we have chosen to turn to participatory co-design methods.

The co-design process is very flexible and can be used in many areas of design application to develop design ideas to fit users' needs and it is therefore well-suited to develop designs for participants who have particular individualised needs. Co-design, as it is referred to for this paper, brings together designers and users of design in the design process to enable them to exchange and develop their vision on what the future should be like. Participatory co-design methods (e.g. Sanders and Westerlund 2011, Sanders and Stappers 2008, and Greenbaum 2013) have been developed on the one hand to enable users actively to participate in the designers' world and to shape and develop relevant design ideas with their input and feedback. On the other, they offer benefits to designers such as richer insights into users' needs, access to users' knowledge and experience, as well as an early validation of use requirements, and developing products or services that fit the users' world (Steen, Manschot & de Koning, 2011). This will ensure that product ideas have the support and acceptance of, and are tailored to participants to be most effective.

The co-design process is well-suited as a methodology for implementing a mindful design approach because they share one significant characteristic, which is that they involve the participant in the decision making process. Decision making in itself is important because it encourages taking responsibility, which in turn can help improve well-being and feelings of self-empowerment. Langer (2010:xx) provides a pertinent example of the impact of decision making on elderly participants: She recounts one of her early experiments into mindfulness

in a retirement home. She gave two groups of participants pot plants in their room. The participants of the first group were told that they had responsibility for watering and looking after the plant. The second group was told that their carers would look after the plants. After three years, she found a significant difference in the health and mortality rate of both groups, with health in the first being far better and mortality rates lower than in the second.

While Niedderer has mainly introduced mindfulness into design with regard to the outcomes of the design process and how it can be embodied in the design object, in the context of the current research, we expand the idea of mindful design into the process of co-design to establish a mindful co-design process. Indeed, as indicated above, one could argue that mindfulness is already inherent in the co-design process, in that it requires both the designer and the user(s) to take responsibility for each other and that it facilitates conscious decision making. However, if mindfulness remains an implicit quality in the co-design process, a large part of the opportunity to design for choice and for enabling the user may be overlooked. In turn, if mindfulness is consciously recognised and integrated into the process, it can also be directed towards the design outcome and have a twofold effect.

Adapting mindful co-creation strategies to develop the interpretive framework

With the symbiosis of mindful design and co-design into a single mindful co-design approach, we are now in a position to construct the three-tiered methodology to support the conceptual approach (figure 1). The mindful co-design approach provides the 'back-ground' that underpins the three-tiered methodology. The three tiers of the methodology are built around the three conceptual stages: the mindful awareness of self, of other, and the interplay between them. Each of the stages comprises two parts: the work with the participants to identify situations and issues to be addressed, and the technical inquiry and response to the identified problems. Together, designers and participants move iteratively through these two parts in each stage, and successively through the three stages to develop the design solutions.

The three stages are further explained in the following:

The aim of the first stage ('Tier 1') of the methodology is to create awareness of self through the sensory feedback of the devices to be designed. This will enable the wearer to become aware of their own emotions, and consciously to respond to them. As a result, it is expected that they will be better able to manage their own emotions, and if necessary a carer can be alerted to provide support. As part of the design, it is envisaged that users may also learn certain mindfulness techniques, such as certain simple breathing exercises. The design will offer the opportunity of a reminder to such therapeutic exercises, which can further help to integrate the effects of therapy into everyday context. The designs will help root cognitive processes in practical exercises and prompt them through multisensory cues, and which can help people with dementia to recall the cognitive process rooted within them.

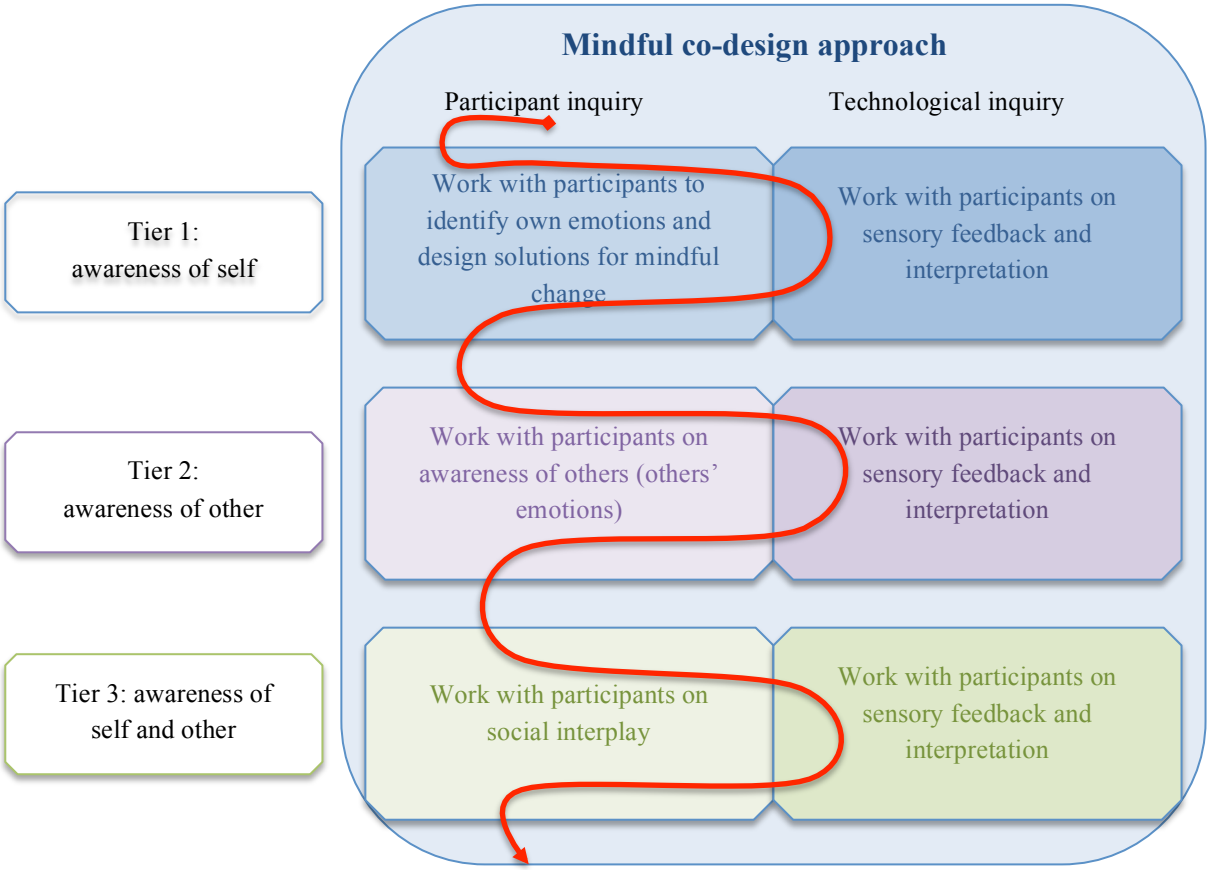

Figure 1: 3-tiered mindful co-design approach

To achieve the aims of 'Tier 1', the co-design process itself will involve the close collaboration of the participant(s) with the designers, ICT and care specialists. The first part ('participant inquiry') of 'Tier 1' will use mindfulness techniques within the co-design process to help participants uncover and discuss the emotional and social issues and needs they encounter, and how they may be addressed. The second part (technology phase) of 'Tier 1' will be concerned with the measuring of relevant physiological stimuli and their relation (or 'translation') to the emotional responses identified in the first part. This will require the adaptation of the basic algorithm to the specific physiology and perceptions of the individual participant. Further, there will be a need to provide an outer appearance in form of jewellery or clothing that is acceptable to the participant, which will be developed in an iterative process with each participant.

The second stage ('Tier 2'), in which the co-design process will be repeated, seeks to extend mindful awareness to mindful awareness of other through visual-sensory feedback to enable the wearer to become aware of and understand better the emotions of the person they are interacting with. At this stage two participants will be involved who can interact with and learn from each other during the design process and in response to the development of the responses of the artefacts, which they wear. The latter is an important part, since perceptions

of colour, light, sound or iconography, which may be used as a feedback mechanism to raise the wearers own awareness as well as that of his or her opposite, may vary between participants.

The third stage will be another iteration of the co-design process. It will go one step further still, with the creation of awareness of self and other, enabled through intelligent learning and interaction between the devices that both participants wear to enable intuitive interaction between both participants to create both awareness and confidence within their (social) interaction. At this stage, fine adjustment of the systems response in response to the wearers' perceptions will be the main concern.

Conclusion

The methodological development presented in this paper is feeding into a larger European project "Designing for People with Dementia". The aim of the project is to develop design interventions that help people with dementia to engage more confidently in everyday social interaction.

As a first step to realizing this aim, in this paper, we have outlined a novel design methodological approach for use in the context of people with dementia. We have introduced the concept of mindfulness into the co-design process to create a mindful co-design methodology to provide an approach for developing mindful design interventions that can help people deal with the emotional affects of being diagnosed with dementia and its impact on people's social engagement. The mindful co-design process importantly recognizes the significance of responsibility and decision-making process.

To this end, the paper has discussed the human aspect, including the relationship of dementia, and its impact on people's emotional and social engagement. We have reviewed current projects seeking to assist people with dementia, mainly through facilitating social engagement, and we have introduced the concept of mindful design to extend existing approaches and to put forward a 3-tiered conceptual approach for the design development. The paper has then reviewed the technical challenges posed by the elicited human-technological aspect of the project through tracing the relationships between emotions, physiological stimuli and the possibility of creating design interventions based on intelligent interactive technologies.

Based on the insights from these discussions, the paper has put forward a 3-tiered mindful-co-design approach. Integrating both mindful and co-design approaches, the proposed approach provides the grounding for joint decision making and responsibility of designers and participants within the design process. This will allow developing design solutions that provide the participant and end-user with the support they feel is needed to help themselves to take control of their emotional and social engagement.

Our approach thus extends existing design approaches to dementia through investigating and bringing together: the focus on psychosocial intervention in everyday social contexts; the use of mindfulness as a framework and design interventions; the use of co-designing with people with dementia and stakeholders; and embedding the design approach within a strong dementia care context for targeted development and evaluation of the design interventions. This approach will enable us to develop design interventions in response to actual psychosocial needs, to remove barriers and enable people to engage positively in social interaction.

One aspect that has not been discussed in this paper, but requires at least a mention is the ethical aspect of the proposed design process and interventions: Besides ethical health related requirements, which any study with vulnerable has to observe, there are two issues concerning this study that deserve highlighting. The first is that the co-design process, the participant is being given as much voice as possible within the design process to ensure that any design addresses the person's needs as perceived by themselves and that it is adapted to their way of use and their taste. Secondly, as long as there is no cure for dementia (in particular Alzheimers Desease), any interventions can only be remedial. To offer most effect, the proposed design interventions are envisaged to be as much as possible preventative in that they will be designed to offer multisensory learning that support cognitive processes so that they are maintained for as long as possible.

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