



Full length article

Designing a personal music assistant that enhances the social, cognitive, and affective experiences of people with dementia



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ABSTRACT

Research shows that music with a strong personal meaning can enhance the social, cognitive, and affective experiences of both people with dementia (PwD) and their social environment. We applied a human-centred design method, called situated Cognitive Engineering, to develop the conceptual design and design rationale of the Music ePartner. The design rationale specifies the general knowledge-base (ontology), context (use cases), and expected effects (claims) of the ePartner support. Three functionalities were developed through rapid prototyping: (1) annotated play lists, (2) a music and picture album, and (3) a picture slide show. Accompanied by a close relative, five PwD participated in a formative evaluation of the prototype at their regular day care centres. All participants interacted with all three functionalities of the prototype as they would in their natural setting. The researchers observed participants' responses to the prototype using observational scoring forms, and interviewed participants about their experiences using semi-structured interviews. Results showed that the music stimulated PwD to tell life stories related to the songs. Furthermore, music evoked positive individual and group experiences. Specific constraints, additional user needs, and interaction requirements for the Music ePartner resulted in a refinement of both the requirements baseline and the design rationale.

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1. Introduction

In modern societies with ageing populations, the need to support and improve the lives of *people with dementia* (PwD) becomes ever more urgent. According to the World Health Organization (WHO), there are currently 47.5 million people worldwide who are affected by dementia (Scheltens, 2015; World Health Organization (WHO), 2015). And every year, another 7.7 million new cases emerge.

Dementia has an overwhelming impact both on the people suffering from the syndrome, and on their family and friends (Alzheimer's Association, 2015; Beard, Knauss, & Moyer, 2009; van Gennip, Pasman, Oosterveld-Vlug, Willems & Onwuteaka-Philipsen, 2014; Verhey, 2015). As of yet, there exists no treatment to cure dementia (World Health Organization (WHO), 2015). Most treatments therefore aim to improve the quality of life for PwD and their kin. As the benefits of available medicinal treatments often do not outweigh their negative side-effects, most researchers

agree that person-centred care and psychosocial interventions are preferred over medicinal treatment (Banerjee et al., 2009).

Psychosocial interventions are non-medicinal treatments that aim to support and improve the quality of life for PwD and their informal caregivers, while also moderating the negative implications caused by the syndrome (Banerjee et al., 2009; Dröes et al., 2006; Koopmans, Olde Rikkert, & Zuidema, 2015; Lawrence, Fossey, Ballard, Moniz-Cook, & Murray, 2012; Riley, Alm, & Newell, 2009). For this type of treatments, it is important to find – for each individual PwD – a suitable care plan that is fitting for the person and his/her situation, i.e. *person-centred care*. Additionally, person-centred care focuses on preservation of the patient's personhood and his/her social connectedness with the social environment (Beard et al., 2009; Buron, 2008). Placing an emphasis on understanding the 'person behind the dementia' has been shown to result in better care due to improved awareness of the patient's personal needs among his/her relatives and professional caregivers (Cooney et al., 2014).

An effective type of intervention that touches upon all these aspects (e.g. tailored care, taking the social environment into account, focus on personhood, emphasis on social connectedness) is

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the use of music to stimulate physical activity, evoke positive moods and emotions, support social interaction, and stimulate self-disclosure (Cooney et al., 2014; Haight, Gibson, & Michel, 2006; McDermott, Orrell, & Ridder, 2014; Sarkamo et al., 2014; Sixsmith & Gibson, 2007; Subramaniam & Woods, 2012; Sung, Chang, & Lee, 2010; Ueda, Suzukamo, Sato, & Izumi, 2013; Vasionyte & Madison, 2013). Music can be used as a trigger for recalling autobiographical memories, as it evokes an emotional response that, in turn, facilitates the recall of autobiographical memories with a similar emotional meaning, especially older memories dating from years back (Krumhansl, 2002; Schulkind & Woldorf, 2005). Cuddy, Sikka, & Vanstone (2015) make an even stronger claim by stating that “the musical lexicon has been spared in [Alzheimer’s Disease] and [...] through the musical lexicon, access to lifetime events can be evoked, even if such access cannot be attained through a verbal route”.

In short, the use of music can substantially contribute to the practice of dementia care. Yet an important obstacle for implementing music-related interventions in the dementia care practice is the lack of a platform especially designed for use by PwD and their social environment in their natural environment. An important challenge in the design of such a platform is that it should provide appropriate support for each of the stakeholders (i.e. PwD, relatives, and health care professionals) based on their personal roles and needs.

As part of the ReJAM project,¹ we aim to develop *the Music ePartner*, a music platform that:

- supports a suite of music-related activities for PwD and their social environment
- can be used in a variety of contexts and settings
- fits the daily routines of the dementia care practice
- is easy to use for PwD, formal caregivers, and informal caregivers

To design the Music ePartner, we conducted the first design and evaluation cycle of a series of studies aimed at the iterative refinement of the Music ePartner. This paper presents the results of this first cycle. Section 2 describes the deployed design method and the resulting design rationale of the Music ePartner. Section 3 describes the prototype of the Music ePartner that was developed for this first research cycle. Section 4 describes a formative evaluation of the prototype that aimed to obtain information about the needs, abilities, and limitations of the target groups, and to refine the requirements of the Music ePartner. Section 5 discusses the results obtained in the evaluation. And lastly, Section 6 describes the refinement of the design based on the evaluation study and the implications for future research.

2. The music ePartner – design

The first design cycle of the Music ePartner project aimed to gather knowledge about the three target user groups, their needs and limitations, and the dementia care practice in which the Music ePartner will be used. To offer the target users some idea of what the Music ePartner might look like and what functionality the ePartner might contain, we developed three naive functionalities for the Music ePartner, e.g. the collection of songs favoured by the PwD, enriching collections of songs with semantic annotations such as memories and pictures associated with the songs, and playing the songs, with the possibility to also look at associated pictures.

2.1. Research objectives

The research objectives of the first design cycle were to obtain insight in:

- a) the specific roles and needs of different stakeholders (i.e. people with dementia, relatives, and professional caregivers) with respect to music and music-based reminiscence;
- b) how technology can support people with dementia and their social environment in collecting, annotating, and accessing music with a strong personal meaning;
- c) the effects of using such technology in a natural setting, for both the people with dementia and their social environment.

2.2. Design method

For this research, we employed the situated Cognitive Engineering (sCE) method (Neerinx, 2011; Neerinx & Lindenberg, 2008). The sCE method has been developed specifically to support the design of intelligent human-computer interaction. The sCE method describes an incremental design process, the goal of which is the iterative specification and refinement of a design rationale: an explicit argumentation underpinning each of the design decisions (also see Fig. 1). A design rationale is founded in empirical research (conducted in evaluations), situated in a task domain, and supported by theories from human factors.

The design rationale is described in functional requirements, which are supported or deflected by hypothetical claims. Requirements describe what the application should be able to do. Claims describe what (primarily user) effects are expected to be found, both positive (+) and negative (–), in an application that is compliant with a specific requirement. The claims are used as guidance for the evaluation of the requirements; they translate into testable hypotheses.

To test the claims, prototypes are developed that are compliant with the requirements so they can be evaluated in – either formative or summative – user-based studies. The outcomes of evaluations contribute to the design rationale: they either confirm or negate the tested claims, thereby adding to the argument to either keep the requirement or replace it by something else. Through this process, a design is constructed, that is underpinned both theoretically and empirically.

A design can be evaluated in different ways, e.g.:

1. Analytical verification aims to verify that a prototype is compliant with the design rationale.
 - (a) Knowledge verification aims to verify the system’s knowledge representation.
 - (b) Behaviour verification aims to verify the system’s behaviour.
2. Empirical validation aims to validate that the design accomplishes the objectives of the design.
 - (a) UX validation aims to diagnose the usability, acceptability, and desirability of the design.
 - (b) Effect validation aims to test whether positive/negative claims about the system’s effects can be validated.

This paper describes our initial design rationale, its behaviour verification, UX validation, (partial) effect validation, and the refinements made to the design rationale based on the outcomes of the evaluations.

2.3. Design rationale

The initial design rationale was founded in a literature review

¹ <http://rejam.nl>.

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