Affective Computing on Elderly Physical and Cognitive Training within Live Social Networks

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Abstract. Emotions play a key role in the user experience, in serious games developed for education, training, assessment, therapy or rehabilitation. Moreover, social network features were recently coined in as key elements for computer based cognitive and physical interventions. In this paper, it is argued that Affective Computing principles may be exploited to increases the motivation of senior users for such computer based interventions. A case study with quantitative results is drawn from the European Commission funded Long Lasting Memories project. Emphasis is placed on how affection, system usability and acceptance might be related to social interaction. Results provide a first evidence that there is indeed a link between how well the intervention and the system is liked when users are placed in groups thereby forming live social networks. It is imperative that such findings could be taken under consideration upon new exergaming designs incorporating social networking capacities over the web.

Keywords: Affective Computing, Social Network, Physical, Cognitive, Intervention.

1 Introduction

Considered as a significant emerging area with enormous research potential and a wide spectrum of prospective applications, Affective Computing (AC) was introduced by Picard in mid-nineties. The term of Affective Computing, i.e., "computing that relates to, arises from, or deliberately influences emotions", was first introduced at Pickard's publication of the Affective Computing book [1]. Acting as the bridge between emotions and computers through the use of theoretical descriptions of human affective states, AC investigates methods in order to establish a complete and reliable layer to support this bridge [2].

One of the fields that AC finds fertile ground is at applications assisting elderly people. Recent literature reveals an increasing number of projects and research targeting to elderly people. This increasing curve stems from the fact that the percentage of elderly living alone also increases gradually. Few of these projects pay attention at the recognition and fewer at influencing elderly people's emotional state. Recent systems

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use the technologies of affective computing and fuzzy interpolation to support the judgment of emotion state for elderly living alone [3]. Biosensors, digital cameras, speech treatment (perception/recognition of emotions) and on the other hand robots, avatars, music (expression of emotions) compose the orchestra of affective computing regarding elderly people [4].

On the contrary, the current trends on influencing elderly people's emotional state describe social networks that have been designed especially for elderly people. Such social platforms constituents include communication with relatives and friends and collaboration or competition to achieve goals in form of games. More generally, social networks with these characteristics invest on influencing the seniors' emotional state in order to promote the prosperity on daily life resulting at shielding health and wellness from emotional affection. Additionally, influencing of elderly people's emotional state must be a field of investigation, since there is a direct correlation to elderly health. Comparatively, emotions play a key role in the user experience, for example in serious games developed for education, training, assessment, therapy or rehabilitation [5]. Receiving increasing attention, the importance of emotion in the development of more engaging games [6] has recently been recognized by the gaming community. Nowadays, several games targeting at adopting the gameplay to the user's state (adjust difficulty level etc.) [6].

As it can be argued, in case of serious games targeting to therapy and training, AC increases the motivation to conform to therapy schedule and as a consequence better health results with successful training. On the other hand, findings in the literature denote the lack of motivation, stemming from affective computing, at physical and cognitive training. Nevertheless, collaborative serious games and or games promoting the competition may enrich the level of motivation.

Therefore, the main objective of the current piece of work is to highlight the importance of affective components' integration into a human-computer interaction system with the aim to enhance the usability perception of end-users, such as seniors [7]. In the context of the Long Lasting Memories (LLM) project funded by the European Commission, the approach of combining physical and cognitive training within an independent living platform was adopted [8]. The focus of this paper is to demonstrate how attention is paid to the relationship between affection produced by the game play and intervention groups (during trials) forming social networks.

2   Materials and Methods

2.1   Long Lasting Memories Trials

The Long Lasting Memories evaluates and validates the intervention by trials that take place during the project duration. The sample is consisted of elderly individuals, either healthy or Alzheimer's patients [9], and, alongside the literature, on Mild Cognitive Impairment (MCI) and dementia patients [10] with a Mini Mental State Examination score (MMSE) ≥ 25 and a Montreal Cognitive Assessment (MoCA) score ≥ 23; an Instrumental Activities of Daily Living (IADL) score ≤ 16, and aged 60 or older [7] (inclusion criteria). Consent from a cardiologist confirming the physical ability of the participant to exercise was also required. The trials were executed at 5

iterations each of them having duration 8 weeks. The seniors were presented at the trial site five days per week and the threshold for a successful intervention was 24 intervention days. The trials sites were different from iteration to iteration according to seniors needs during recruitment. The group of seniors performing the intervention at the same geo-location at the same time was variable from 1 to 12 users per group.

2.2   Physical Training

FitForAll (FFA) is an exergaming platform, for supporting seniors' physical training [10]. Seniors' interaction with the platform is realized through innovative low-cost game peripherals, such as Nintendo Wii™ Remote and Balance Board. Following user-centered game design principles, FFA aims at the alleviation of existing deficits of the Third Age. Moreover, taking into account the significant role affection (stress, disappointment) plays for seniors, when they come across new technology and computers, FFA is strongly built upon accessibility and user acceptance guidelines, by emphasizing on the users' impairments and limitations. Passive AC components of the platform, along with active AC components [7] allow users to maintain their self-esteem communicating with the system and its dynamic content respectively.

3   Results

3.1   Physical Training

FFA has been validated regarding its usability and mainly for its affective impact on seniors, in terms of a questionnaire, including items from: the Exercise Induced Feeling Inventory [11-12], the Physical Activity Enjoyment Scale [13], all validated and reliable measures of emotional states produced by exercise [14]. Ten items declaring 5 positive and 5 negative affective states were included and a Likert scale (from 1=not at all to 7=very much) was used to reply [7].

Table 1. Summary of results of 14 participants in the usability survey. A p value < 0.05 indicates significant difference between the mean and the neutral mean for each section (aRange = the possible minimum and maximum score for each section, [b]SD= standard deviation, [c]Neutral Mean= the value that would be anticipated if all the answers indicated a rating that was equally positive or negative. [d,e,f] significant at the 0.05 level)

Section	Range[a] (min-max score)	Mean (SD)[b]	Neutral Mean[c]	p value
Affective	10 – 70	57.43 (5.64)	30.00	$p < .00001$[d]
Usability	5 – 34	28.21 (3.29)	17.00	$p < .00001$[e]
Satisfaction	7 – 35	28.43 (3.72)	14.00	$p < .00001$[f]

As it is evident, the difference between participants' ratings in each section and the Neutral Mean for that section were highly significant [10].

3.2   Live Social Network

During the Long Lasting Memories (LLM) trials the intervention was organized in groups of elderly. The capacity of the groups was not constant and was depending to the time of the day, the geographical location, capacity of LLM systems (PC) and the senior likes. Thus, the trials results in small social groups from 1 to 12 users. During the LLM trials all subjects were conformed into 46 groups at 5 iterations (phased pilots).

Table 2. The number of groups according to group attendance

Seniors per Group	1	2	3	4	5	6	7	8	9	10	11	12
Number of Groups	2	8	5	5	2	5	6	6	3	-	2	2

In line with Table 2, Fig 1 shows drop out percentages during the Long Lasting memories trials. A drop out is considered when a subject was not able to fulfill the threshold in terms intervention days. There was no group with ten (10) seniors and therefore, the value for it is considered as 0%.
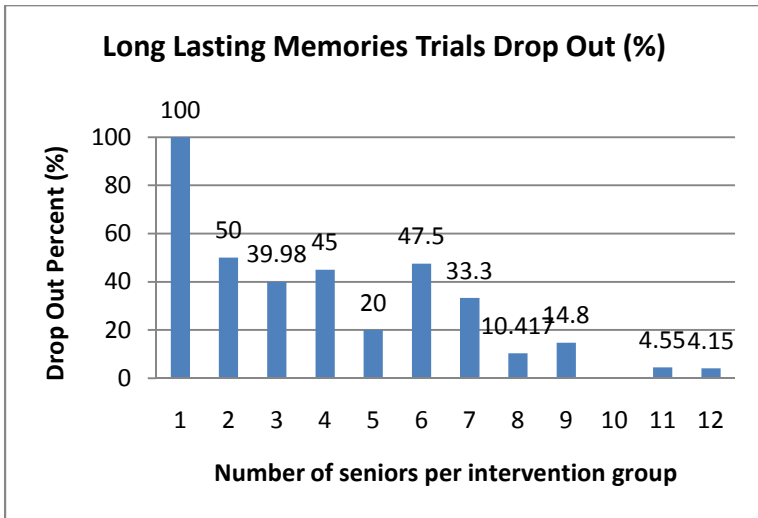

Fig. 1. Drop out during the LLM compared to the number of participants per group

4   Discussion

Many of the AC notions applied in the various elderly applications so far have been on what is called passive AC. Results obtained so far, indicate that there is strong evidence that the entertainment/joy received through the interaction within a social

group affects the affective state of the user; these in turn play a crucial role in the acceptability of a human-computer interactive system like that used in FFA. Extensive analysis of the statistical interaction between the affective survey results (snapshot presented in Table 1) and the dropout curves (snapshot in Figure 1) are under way. Such results will definitely confirm the exact relationship between affect perceived through system interaction, joy received from social interaction, and system acceptance (defined as non-drop-out system usage).

Therefore, future research on the physical training platform shall focus on enriching current passive AC elements with more active AC. In addition, FFA affective concept motivates elderly people to continue an intensive (5 days a week) cognitive and physical therapy in form of training. Furthermore, the AC aspects of the physical training system are enriched by the "social network" aspect of the intervention groups (e.g. competition-like goals and rewards (virtual daily tasks, e.g. collection of apples of a tree), social context during training (e.g. seniors providing advice to an another on how to win the game). Designed to promote the collaboration and/or competition, FitForAll finds fertile ground in case of "large" social network (more than 7 seniors per group).

On the other hand, it is revealed that the emotional state of the seniors play vital role in motivating and encouraging them to continue and intensive intervention based on serious games. Considering that more seniors per group means more competition and thus more positive emotional state, Fig. 1 depicts that an active emotional state motivates and encourages elderly people to continue with their intervention.

Consequently, the preliminary findings, regarding the correlation between real social networks and affective computing in case of serious games, must be analyzed so as to produce guidelines for incorporating virtual social networks capabilities and features in the training and therapy computing systems. Consequently, elderly people that perform a serious game intervention at home residential setting will take advantage of this as if they were performing in day care centers intervention programs. Finally, a continuously research on the discussed field will introduce a preliminary work of affective social computing systems.

Further future work will mainly cover the development of a social cloud platform which will provide a virtual environment for supporting physical training and enhancing social relations among seniors. A client of this platform will provide access in already existing social networking cloud services/applications. The data will be refreshed in real time so as a Senior could play his serious game in FFA and simultaneously communicate or be aware about his/her friends – users via social network services without geographical limits.

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