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Author(s):	Antonio Ascolese (IMA), Dimitra Tatiana Anastasiadou (UOC)
Contributor(s):	Francisco Lupiáñez Villanueva (UOC), Vito Nitti, Luca Trapasso (IMA)
Reviewer(s):	Jennie Hancox (DMU)

*Dissemination Level:

PU=Public

PP=Restricted to other program participants
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RE=Restricted to a group specified by the
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**Nature of Deliverables:

R=Report

P=Prototype

D=Demonstrator

O=Other

Abstract

Deliverable 5.4 ‘Social games’ provides a description of all the social elements used in the gamified environment (presented in D5.2) to motivate users and improve their social interactions (both virtual and real).

In particular, the social section designed and developed in the DOREMI application is presented with all its functionalities.

The main aim of D5.4 is to outline the integrated prototype of the whole application, and describe in detail the process, functionalities and clinical aspects of the Social Area. Technical aspects are also presented to show how the DOREMI application communicates with the game server and with the KIOLA server.

D5.3, 5.4 and 5.5 can be seen as three ‘twin documents’, intentionally following the same structure. These three documents describe in detail the content of the DOREMI application, the integrated working prototype containing the Exercise Area (D5.3), the Social Area (D5.4) and the Cognitive area (D5.5).

Keywords

Social games, gamified environment, socialisation, well-being, motivation

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1. ABBREVIATIONS

API - Application Programming Interface

JSON - JavaScript Object Notation

REST - REpresentational State Transfer

2. EXECUTIVE SUMMARY

The purpose of WP5 within the DOREMI project was to design and develop the gamified active ageing virtual environment. The virtual environment represents the main access point for the DOREMI end users. Using the DOREMI application on their tablet, users can engage with the virtual environment where different activities, related to the life protocols fine-tuned in WP2, are presented (as in D5.2). The game environment, considering both the clinical requirements and the user motivation and engagement, contains three different areas, specific for each clinical protocol: the Cognitive Area (presented in D5.5), the Exercise area (presented in D5.3) and the Social Area (presented in D5.4). As these three areas are already integrated in a unique app, as in the final version that will be used by the DOREMI end users, an integrated prototype is presented. This working and usable prototype presents the game environment with the whole functionalities studied, designed and developed thanks to the user-centered design (D5.2). From this virtual gamified environment it is possible to access the three areas where the clinical protocols are presented.

The unique prototype (the same for D5.3, D5.4 and D5.5) goes with three different 'twin documents' that help to explain how the prototype works and how it was designed and developed. For all these reasons it was decided to maintain the same structures for the three documents, to cover the same explanation needs. The structure of the three deliverables is:

Section 4 presents one (or more, if necessary) wireframe(s) of the specific area presented in the document. A wireframe is a design document. It is prepared based on: the product guidelines, information collected from users during previous phases of the project, new ideas tested during the DOREMI project, and information on specific issues that arose during the design of the application. These wireframes present the connections between the different functions or sub-sections of the different areas. For this reason, a lot of pictures are presented here. Pictures can represent the application in previous versions, but the main aim is to present the functionalities and the way the application works.

Section 5 presents the clinical aspects of the specific area. All the functions and the elements of the Cognitive Area, the Exercise Area and the Social Area, are designed and developed starting from the clinical protocols fine-tuned and presented in WP2 and every decision was taken in agreement with the clinical partner of the project. Clinical aspects were always considered the most important ones in all the phases of design and development.

Finally, section 6 tries to summarise all the technical decisions of the specific section. In particular, all the aspects involved in the communication process with the Game Server and the KIOLA system are described. This section is divided into two sub-sections; the first one is the common description, which is the same for each of the three deliverables, while the second one is a description of the specific content of each deliverable.

3. INTRODUCTION

In the frame of the DOREMI project, the main objective of WP5 ‘Development of social and gamified environment’ was to design and develop a prototype of a gamified environment to engage users and motivate them to complete the proposed daily activities according to the ‘Active Ageing’ lifestyle protocols prepared in WP2. This environment will be the access point for users to different sets of cognitive games, social networking, exergames, and gamified activities. D5.1 has already described the gamification strategy that has been implemented in the gamified environment (D5.2).

In this context, D5.4 addresses the objective to present a prototype of the Social Area. The Social Area is the section of the DOREMI application where the clinical protocol for socialisation is presented to the users. This section, as with the other two clinical main sections, was designed and developed following a user-centered design process (see D5.1 and D5.2). This approach was utilized to ensure that the DOREMI application is usable and has value to the target group. At the same time, both the design and the development activities were based on the clinical deliverables (D2.1, D2.2 and D2.3) and the lifestyle protocols suggested by clinical partners of the consortium. Finally, all the international guidelines regarding the development of applications for this specific target group were taken into account (as presented in D5.1).

The three clinical sections are, at M24, already integrated in the gamified environment and for this reason they are presented as a unique prototype, as it will be in the final version for end users. The three sections are strictly interdependent and are also dependent on the whole functioning of the gamified environment.

4. UPDATE OF GAME-BASED ACTIVE AGEING ENVIRONMENT

D5.2 (Game-based active ageing environment), according to the DOREMI Document of Work, was delivered in M14, when activities regarding the design and development of the gamified environment should have been closed. Nevertheless, as also explained in D5.2, according to the methodological approach that was chosen to design the game-based environment (User Centered Design) and according to the key role of the environment in WP5, the task couldn't be considered definitively closed in M14. For this reason, D5.2 presents the gamified prototype in a temporary version. After M14 user centered design activities went on, collecting feedback with users, at the same time of the feedback collection about the main areas of the application, in UK and in Italy, with different and updated versions of the prototype. For this methodological reason, the design of the game environment continued in parallel with T5.3, T5.4 and T5.5, until M24. Furthermore, to obtain a well-integrated and working application (both from a look&feel and a usability perspective), it was necessary to design and develop the environment at the same time of the three main areas of the application.

The final version of the game-based active ageing environment is presented and ready for a trial in the prototype delivered for D5.3, D5.4 and D5.5. However, in this document a brief walk-through of this final version is shown.



Figure 1 - The main page of the DOREMI game-based active ageing environment.

As designed for the first mock up, in the gamified environment each user has to walk the dog around a path, based upon aggregate scores from all 'clinical' areas and 'real' activities. Each path represents a European city. For each of these cities, there are five different milestones, used to engage the users and motivate them to continue their activities (based on the life style protocols). These milestones represent four different important monuments, famous in that city. The last milestone is represented by the sign of the next city that users can visit (London in Figure 1). Completing all the suggested activities (cognitive games, physical exercises, social interactions and nutritional diary), users can reach a milestone every day. Of course they can also need more time to reach milestones.

On the path, users can see only the next milestone (Sacre Coeur in Figure 1) in a black and white picture; all the milestones already reached (Eiffel Tower in Figure 1) in coloured pictures. All the unlocked achievements are collected and can be seen in a dedicate area, the 'Achievement section'.

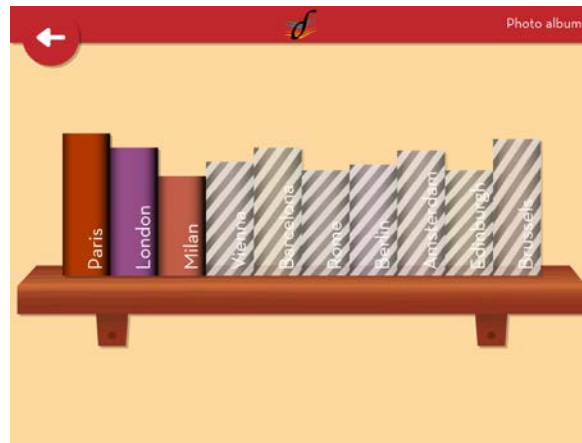


Figure 2 - The Achievement section.

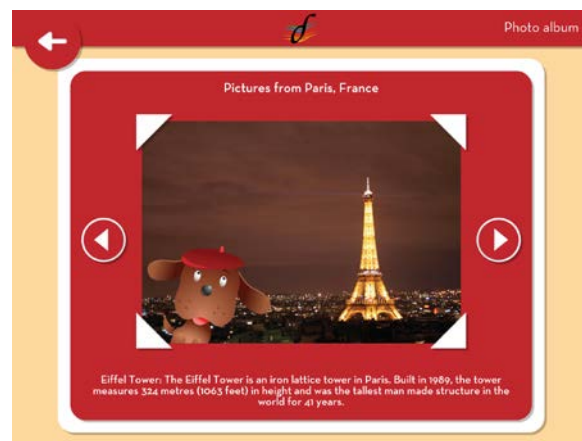


Figure 3 - An example of achievement: A picture from Paris in the photo album.

In the achievement section, a photo album for each of the cities that can be ‘virtually visited’ through the DOREMI application is shown, distinguishing the already unlocked ones (Paris, London and Milan in Figure 2) and the locked ones. Touching each of the unlocked photo album users can open the book and see all the collected achievements (Figure 3), with a brief description of the monument.

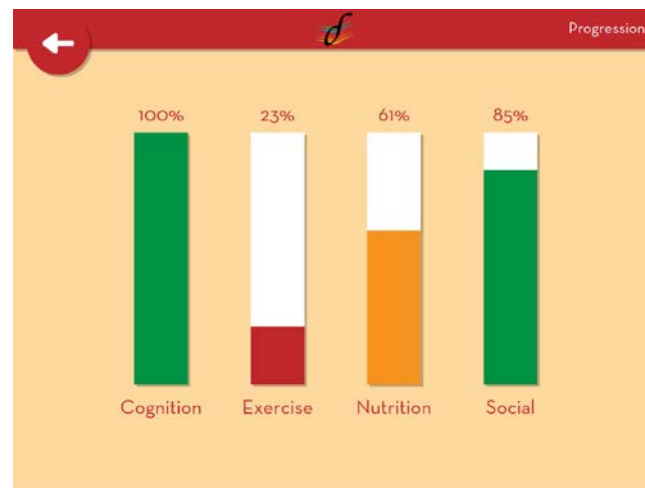


Figure 4 - The progression area

Furthermore, in the ‘progress area’ (Figure 4), users can see how close they are to reaching the next level and traveling to a new city. The bars represent their progress in cognition, exercise, nutrition and social activities. When all four bars reach 100% they will progress to the next level and be able to explore the next city. Each time they achieve a new level the bars will reset to 0%. In this way users can easily understand which kind of activity they need to train more or, in other words, which kind of health behaviours they should increase.

After each day, all the data collected by the DOREMI application and all the other sensors used in the project are sent to the DOREMI server, where the reasoner merge everything and through specific calculation (implemented within WP4 activities) gives back to the application data that are used to move the dog along the path and update the progress area.

5. DESCRIPTION OF THE SOCIAL AREA

In this section the wireframes of the Social Area are presented. A wireframe is a design document, prepared before the development of the application and, for this reason, not always correspondent to the final version of the prototype. These wireframes present the connections between the different function or sub-sections of the different areas. The main aim of this representation of the Social Area is to present all the functionalities and the way everything works in the application.

Users can access the Social Area through the dedicated button in the gamified environment (see Figure 1). The whole Social Area is shown in the biggest picture with arrows (Figure 5). The same is for the whole 'Well Done' system and 'challenge' system (Figure 13). Other images (Figure 6,7,8,9,10,11,12) represent a more detailed view of the Social Area, where numbers indicate connections between different pages. Finally, the other pictures (Figure 14,15,16,17,18,19,20) represent the detailed connection between the pages and functions of the Challenge, the Shared and the Well Done systems.

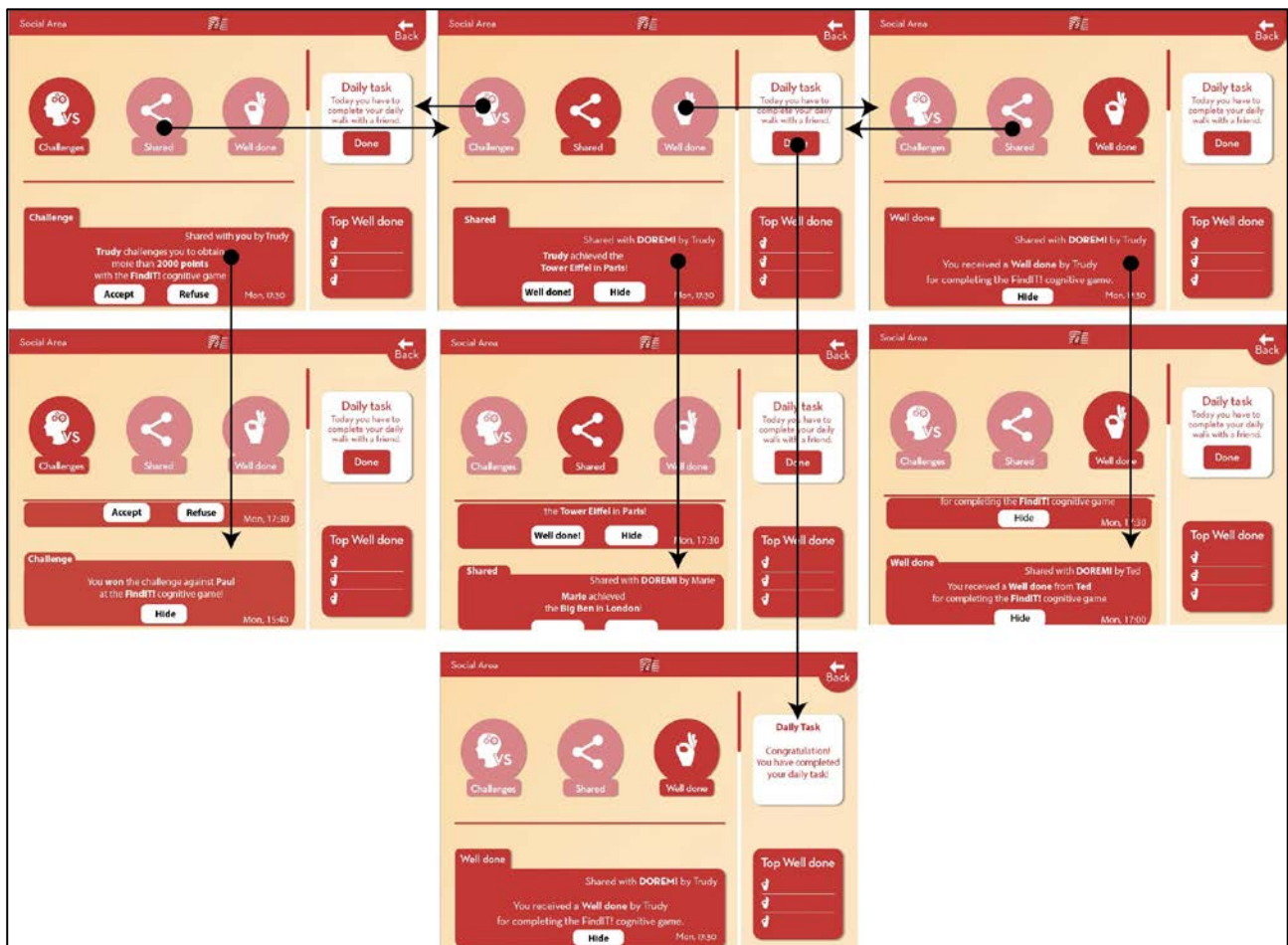


Figure 5 - The complete wireframe of the Social Area.

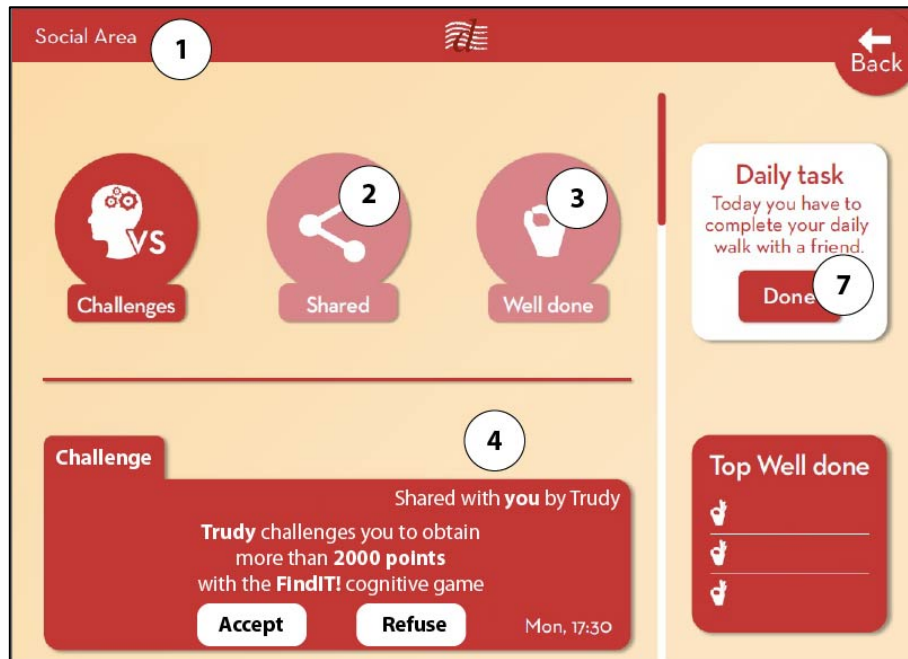


Figure 6 - Main screen of the social area (challenges section).

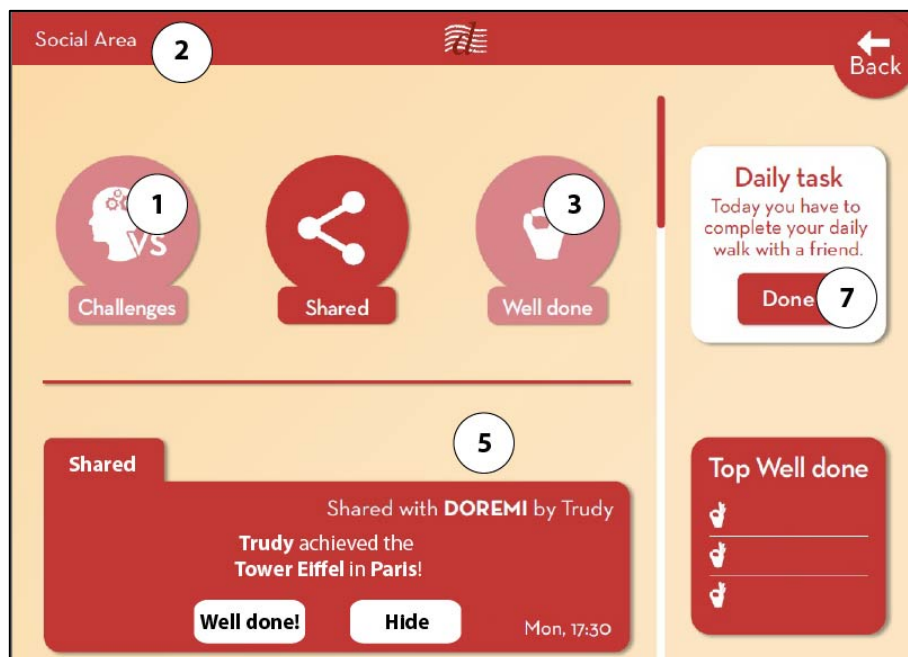


Figure 7 - Main screen of the social area (shared section).

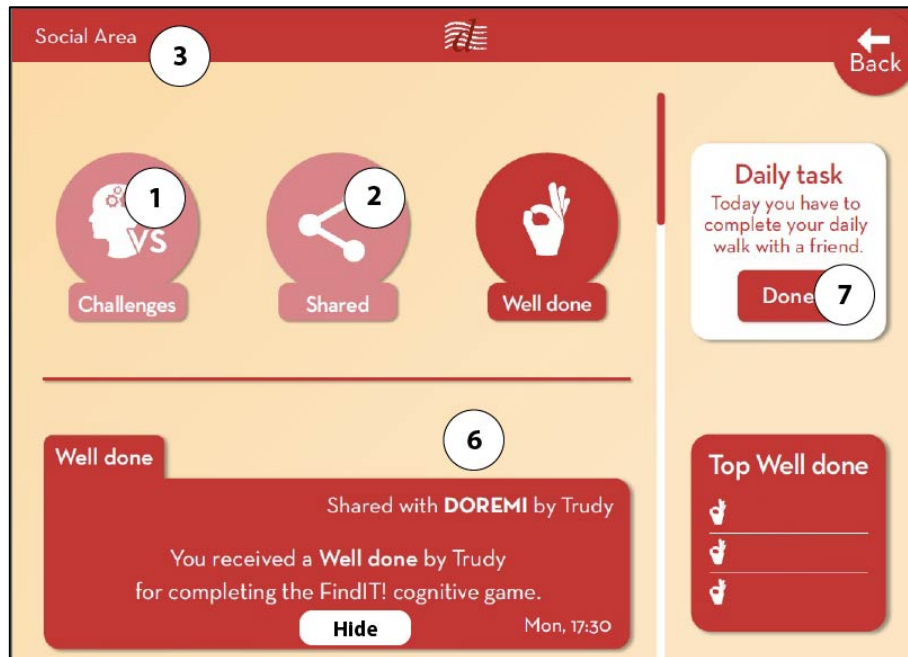


Figure 8 - Main screen of the social area (well done section).



Figure 9 - It is possible to scroll through the various challenges received.

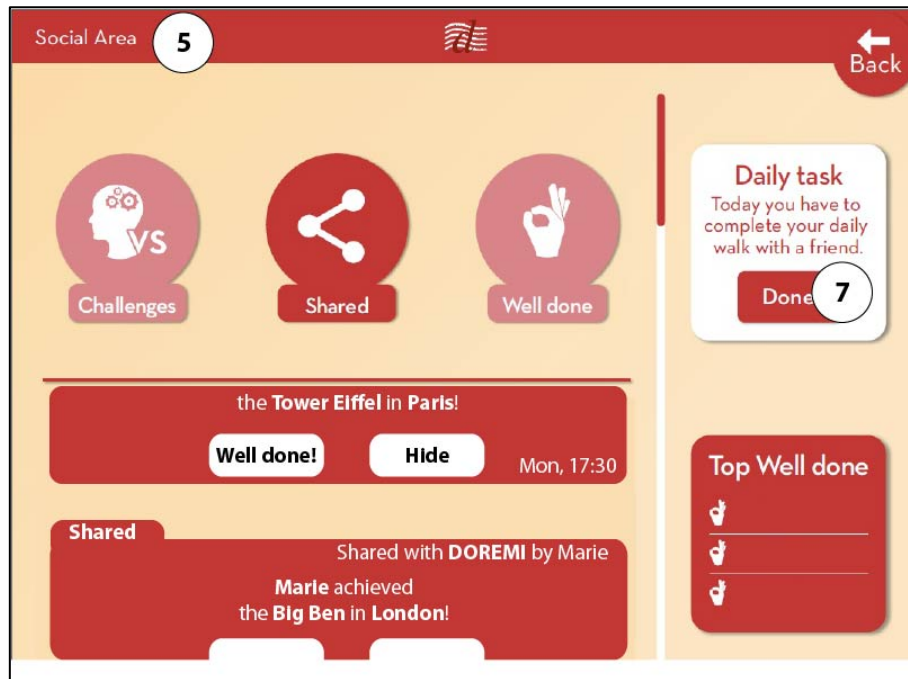


Figure 10 - It is possible to scroll through the various shared contents.



Figure 11 - It is possible to scroll through the various well done notifications.

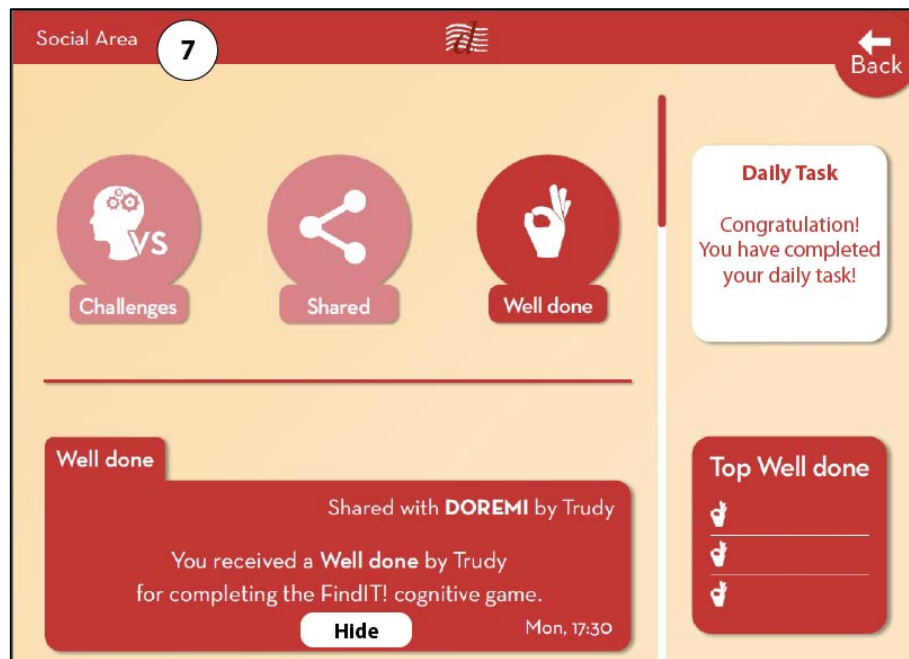


Figure 12 - When the player confirms the completion of the daily activity, the white box updates.

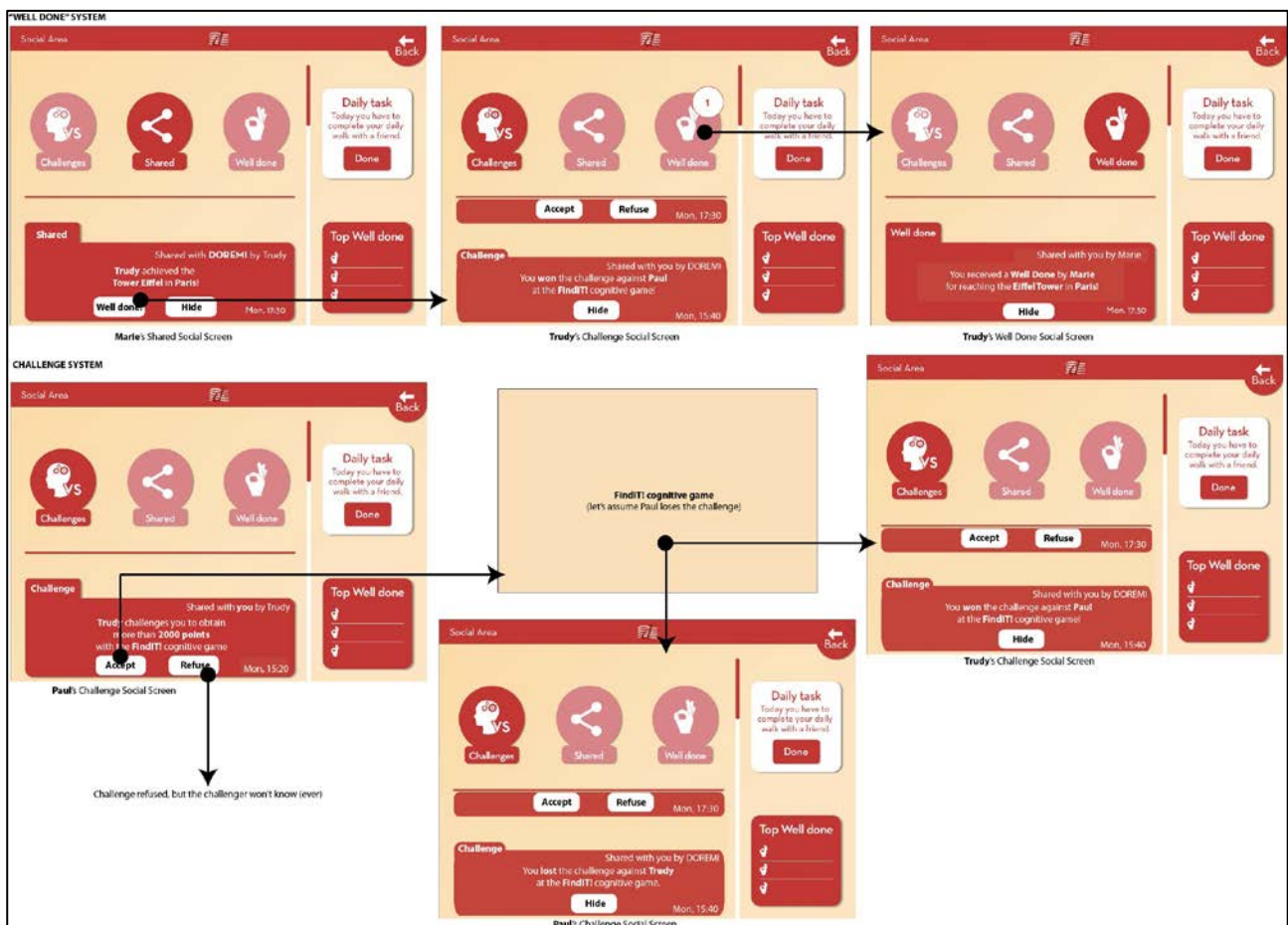


Figure 13 - The complete wireframe of the Well Done system and Challenge system (Social Area).



Figure 14 - Any player can send a Well Done to any other player's shared content.

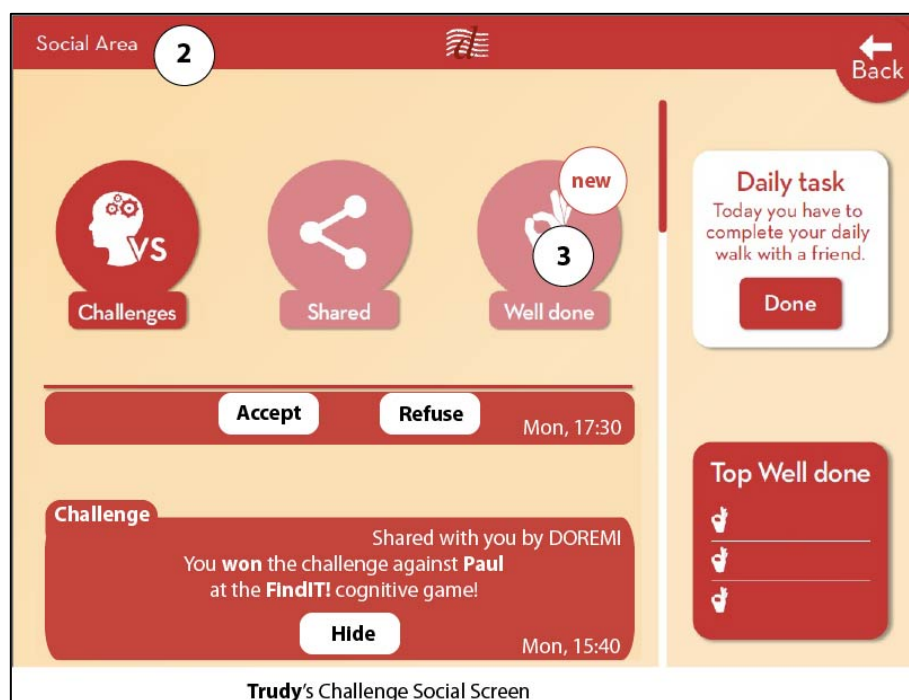


Figure 15 - When a player receives a Well Done, a notification appears in the dedicated section.

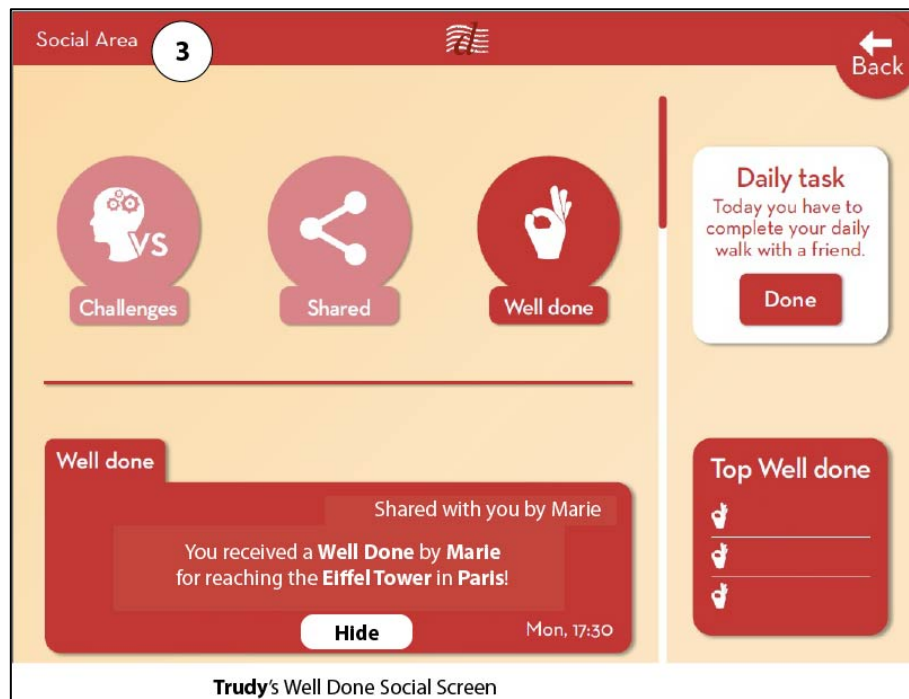


Figure 16 - Opening the Well Done section, the most recent messages appear on the top.



Figure 17 - When a challenge is received, the player can accept or refuse it.

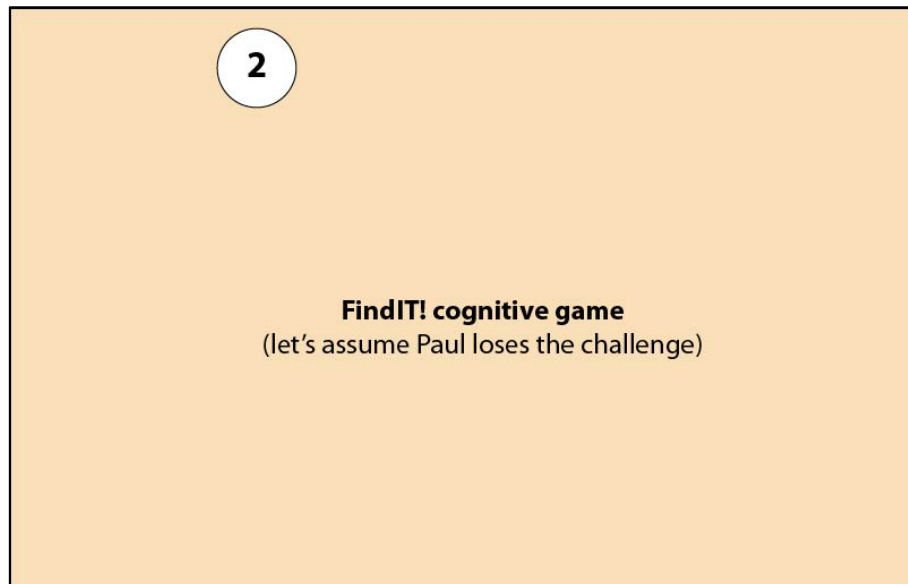


Figure 18 - If the player accepts the challenge, the game that they have been challenged to play will open (if the challenge is refused, the message is deleted and the challenger does not receive any notification).

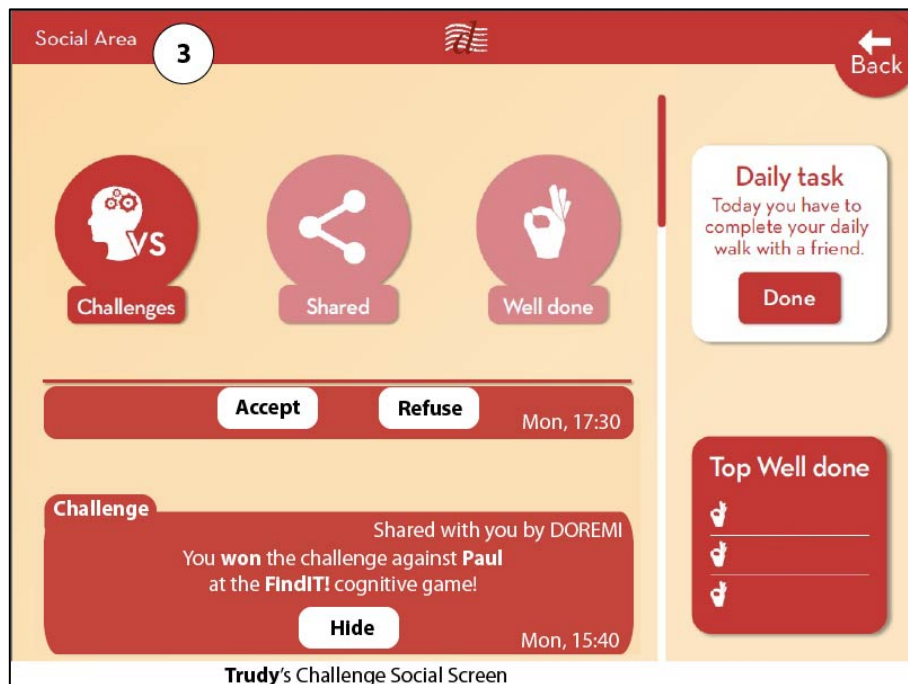


Figure 19 - The player who wins the challenge receives a notification of the win.

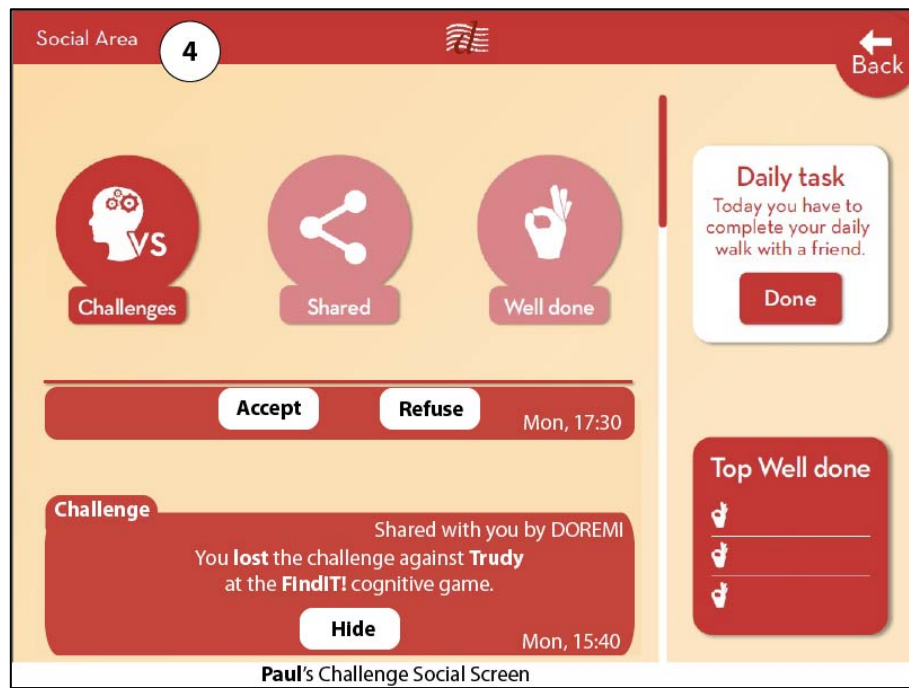


Figure 20 - The player who loses the challenge receives a notification of the defeat.

6. CLINICAL IMPLICATIONS

5.1 Healthy ageing and the Internet

Nowadays, it would be impossible to understand the meaning of healthy ageing or resilience without considering the enormous potential of the Internet and how **older adults** are taking advantage of this technology (1). Traditionally, authoritative health information has been based on facts and figures, not on the experiences of people and patients. However, people facing a new diagnosis or health related decision, or living with a long term condition, often feel that they need to know how others have experienced what they are going through (2) and seek knowledge about their health from others who have been through the same experiences (3). They now routinely do this via the Internet. Sharing experiences is part of a wider shift in the relationship between lay and medical expertise (4). The public receives this type of support from a wide array of sources, including health professionals, lay ‘experts’, governments, patient organisations, and drug manufacturers. These provide information, advice and promotion, through various mediums: inter-personal communication, consumer health information, media reports, and Internet websites. The way in which this information is presented to people together with its quality are crucial for decision-making and behavioural change (5).

The systematic review by Hibbard and Peters (2003) highlighted that in order to use health information, individuals must be able to take in and process the information, interpret it correctly, identify the important factors to integrate into a decision, weight those factors in ways that match the individual’s needs and values, make trade-offs, and bring all the factors together into a choice. Although these steps may sound easy enough, they tend to be complex and burdensome cognitive tasks when making health-related decisions, which also explains the inconsistency of empirical evidence on them. This has become more challenging as the sources of information and support have proliferated (7).

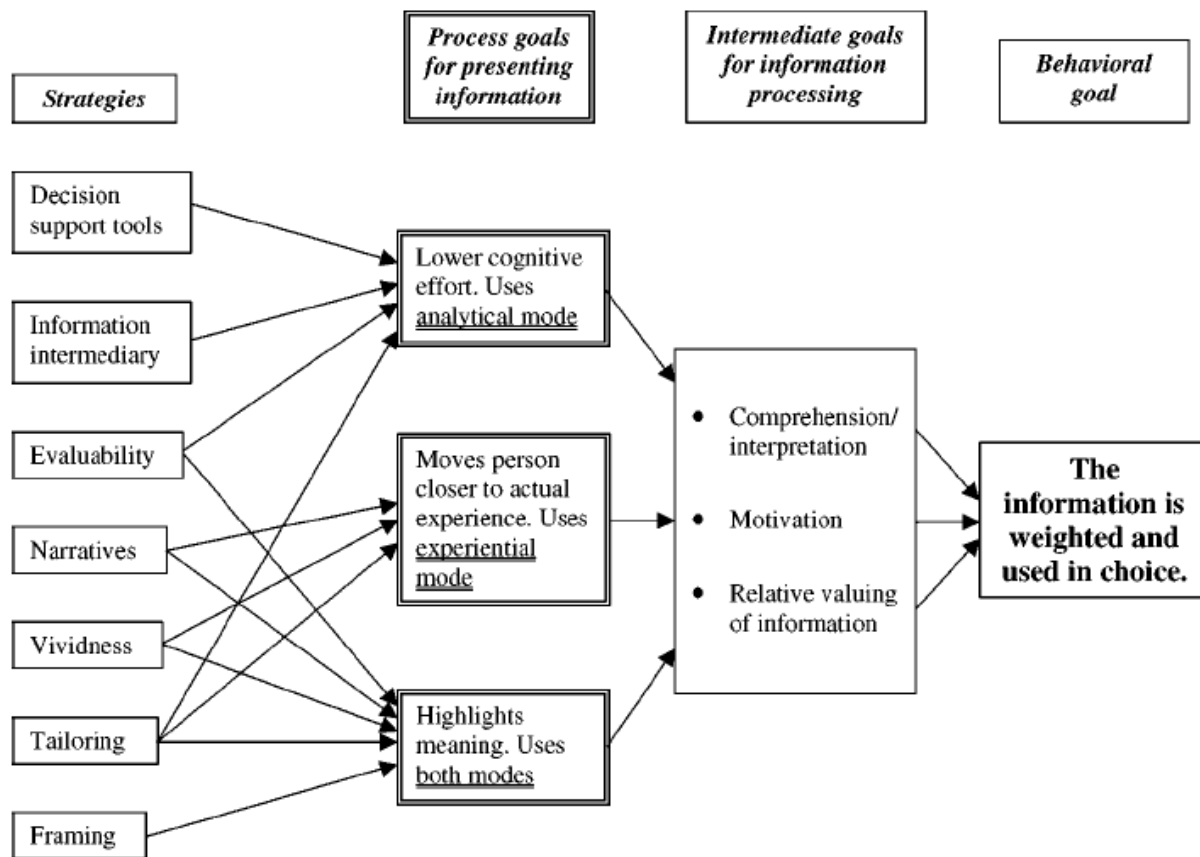


Figure 21 - Consumer use of comparative information process (6)

Hearing or reading about other people’s experiences has the potential to affect elderly people’s lives through fostering connections, helping to tackle loneliness, and stimulating people to try new activities. Online communities and websites, available worldwide at any time, both supplement and (in some ways) surpass face-to-face groups. Web 2.0 platforms, which provide a shared, user-driven environment, are making it even easier for users to collaborate in developing content, sharing information, uploading videos and photos, and sharing and commenting on personal experiences.

Social Networks	Psychosocial mechanisms	Pathways
Social Network structure: • Size • Range • Density • Boundedness • Proximity	Social support: • Instrumental & financial • Informational • Appraisal • Emotional • Homogeneity • Reachability	Health behavioural pathways: • Smoking • Alcohol consumption • Diet • Exercise • Adherence to medical treatments • Help-seeking behaviours
Characteristics of network ties: • Frequency of face-to-face contact • Frequency of non-	Social influence: • Constraining/enabling influences on health behaviours • Norms towards help-	Psychological pathways: • Self-efficacy • Coping effectiveness • Depression/distress • Sense of well-being

visual contacts	seeking/adherence	
• Frequency of organizational participation (attendance)	• Peer pressure	
	• Social comparison process	
	Social engagement:	
• Reciprocity of ties	• Physical/cognitive exercise	Physiologic pathways:
• Multiplexity	• Reinforcement of meaningful social roles	• HPA axis response
• Duration	• Bonding/interpersonal attachment	• Allostatic load
• Intimacy		• Immune system function
		• Cardiovascular reactivity
		• Cardiopulmonary fitness
		• Transmission of infectious disease

Table 1 - Excerpts of the impact of social networks on health [1]

The use of social media has become extensive and usually transcends previously reported barriers, such as educational status, race, ethnicity and access to health care (8). The sharing of health-related personal experiences, by reading or listening to them, is an important characteristic of eHealth. Active participation in the creation of health information is also likely to influence people's health experiences and has implications for our understanding of their role in their own health care management and information (9). The Internet, which by its nature is a social network, can provide older adults with various types of social support by connecting them with family and friends, as well as providing them with necessary health resources (10). Therefore, as in the traditional social network, older adults can establish a social network in a computer-mediated environment and receive support through that network. Considering the physical and sociological changes that come with ageing, social support received through the Internet may significantly benefit older adults and improve their quality of life. There are two main pathways through which social support is hypothesized to influence wellbeing. One is the direct or main effect of social support. The perceived availability of social support can be a source of general positive affect, enhanced self-esteem, and feelings of belonging and security. In turn, these positive psychological states may result in improved neuroendocrine and immune function as well as greater motivation to engage in healthy behaviours. The second way that social support influences the wellbeing of individuals is by buffering the adverse effects of stressful life events (11). A summary about the impact of social networks on health is shown in Table 1.

5.2 Behavioural economics: designing smart choices

Arrow (1963) signalled information asymmetry and the significance of medical care in human affairs. His seminal work noted that trust is a central feature of the doctor–patient relationship. Giving trust this important role stems from the uncertainty and vulnerability of the patient. In this context, Behavioural Economics (BE) is particularly important for modifying neoclassical approaches because, as in many areas of the economy, people appear to make choices about healthcare that are situation or context-specific, resulting in cognitive errors and failures to optimize. BE shares with standard economics the focus on individual decisions and the role of individual characteristics, but present evidence-based critiques to the way human behaviour has been formalized in standard economics, acknowledging human limits on computational power or will power, and increasing realism of the assumptions. The field of behavioural economics combines psychology and economics to investigate how individuals actually behave as opposed to how they would behave if they were being perfectly rational (as in the sense of maximizing their

utility). Although initial applications focused on consumer behaviour, such as explaining why people failed to save adequately for retirement, the field has moved increasingly into the area of explaining health behaviours as well as the design of lifestyle interventions (12). Healthcare and medicine are profoundly human undertakings in terms both of the complex and fragmented institutional arrangements and of the way patients and professionals process information. Despite increasing use of the Internet for all age groups and the rise of the use of health information online, evidence suggests that even with readily available information, the public finds it challenging to make use of it for treatment decisions (13). There are various theories outlined by the academic literature indicating why uptake might be so low, highlighting barriers which include cognitive and emotional challenges individuals face when making complex decisions during the patients' journey.

BE has identified major bias and heuristics in the traditional approaches to behavioural changes. Heuristics are rules that help people in situations of limited computational capacity to process information. Heuristics are not necessarily bad, since they are "procedurally rational": they are a parsimonious way of facing uncertainty given limited cognitive and computational ability. However, they tend to induce biases (violation of basic statistical principle or logic). The difficulty lies in the multiple and tenuous links that typically separate informing and outcomes, especially when there is little data generally recorded about outcomes or agreement about what outcome measures are appropriate. Clinical measures may not relate to the patient's own perception of 'quality of life', nor to economic benefits outside the healthcare system. The evidence demonstrates that having an abundance of information does not always translate into it being used to inform choices. Traditional theories present the decision making process as largely egocentric and detached from any wider context. However, it is clear that this process is more complex and less rational. Decision-making is primarily a social process rather than a cognitive one. People draw on past-experiences and are influenced by their expectations and fears and by the views of others, particularly people they trust. They internalise all of these influences, make trade-offs in a way that might seem irrational to outside observers, yet has a strong internal logic beyond the traditional models of behavioural change, such as, Transtheoretical Model (14); Self-determination Theory (15); Social Cognitive Theory (16); Theory of Planned Behaviour (17); Cognitive Behavioral Therapy (18) and the Health Belief Model (19). Health professionals implicitly accept the assumption that patients will act rationally to maximize their self-interest. However, patients may not always be the rational actors that we imagine. Major behavioural barriers to optimal health behaviour include patients' fear of threats to health, unwillingness to think about problems, when risks are known or data are ambiguous, the discounting of risks that are far in the future, failure to act due to lack of motivation, insufficient confidence in the ability to overcome a health problem, and inattention due to pressures of everyday life. Strategies have been developed by behavioural economists and social psychologists to address each of these barriers to better decision-making. These include: labelling positive behaviours in ways consistent with patient life goals and priorities; greater focus on more immediate risks of chronic diseases; intermediate sub-goals as steps to a large health goal; and implementation of specific plans as to when, where, and how an action will be taken (20). When providers attempt to promote healthy behaviours or better control of chronic diseases they typically assume that patients are what behavioural economists describe as "boundedly rational," making decisions that maximize their self-interest, subject to limits of their attention, memory and other cognitive abilities (21).

5.3 Gamification as a behavioural change enabler

Empirical studies on gamification have shown positive effects related motivational affordance and behavioural change in users (22–24). The study of Hamari, Koivisto and Sarsa (2014) is one of the few focused on health implementation of gamification in order to increase engagement of users with health protocols. They deconstructed gamification into three linked concepts: 1) motivational affordances (e.g, levels, feedback, leaderboards), 2) resulting psychological outcomes (e.g., motivation, enjoyment), and 3) behavioural outcomes (e.g., level of engagement with health-related behaviours). Social components of gamification related to network effects, social influence, recognition and reciprocal benefits, can predict attitude toward gamification tools and intentions to continue using it, and are considered essential for creating engaging gamification services (26). However, to the best of our knowledge, there is a lack of research tackling specifically social interactions for the elderly, in spite of the fact that one of the core ideologies of active ageing is to optimise opportunities for older people to participate in their own health management and in social activities. Scientific literature presents a series of common gamification mechanisms based on collection of badges, rise in high-score lists, collect points for social reasons, receiving recognition and leaderboards (27,28). DOREMI games and gamification tools should be designed to be meaningful, relevant and pleasant for the elderly population, inducing at the same time motivation, and also considering individual and contextual characteristics.

5.4 Inclusion of social components in the gamified environment

If DOREMI participants are not motivated to engage with the health protocols for cognitive/exercise/nutritional training, they may not experience the full benefit of the system, or withdraw from the study before the end of the training period. Thus, the DOREMI system will provide a gamified environment that will stimulate users to adopt a healthier lifestyle through social interactions, both at a physical and a virtual level. Social components will be incorporated in the gamified tools for the first time, to increase the level of engagement of individuals with the cognitive games and to achieve, in the long term, positive clinical outcomes related to well-being and quality of life, cognitive functions, healthy lifestyle (exercise and nutrition), perception of social support and feelings of loneliness.

The social gamified environment of DOREMI solution is not a game per se but an enabling environment in which users can find functionalities aimed at stimulating their social interactions to leverage the use of the online games composed of exergames, diet recommendations and cognitive training. For example, the social area incorporated in the ICT tool can motivate users to a more efficient use of the cognitive protocols and vice versa. The main hypothesis is that users who perform social interaction tasks proposed by the system on a daily basis, would increase their level of motivation in the training protocols and would achieve better long-term health outcomes compared to users who do not perform social activities.

5.5 Description of the main gamified social interaction activities of the DOREMI system

Various ‘game’ elements for social interactions have been described in the literature and their contribution is notable in increasing motivational affordances of users and in achieving health-related changes (25). Among them, we can mention the virtual rewards (e.g., points and badges) and the social comparison elements (e.g., leaderboards) (29). However, as discussed previously in several papers (29,30), these elements per se are not enough to produce social engagement and enhance motivation of users. To this end, the following five functions must be considered in constructing a powerful gamified tool for social interaction, as suggested by Antin & Churchill (2011): 1) goal setting, 2) instructions, 3) reputation, 4) status/affirmation and 5) group identification.

To achieve these motivational affordances, we have decided to incorporate in the DOREMI online games platform the following three options:

a) Challenges

This function allows a user to challenge a specific user he/she chooses (or one selected by a random mechanism) for each of the online cognitive games. This option will be available only for the cognitive games given that these are the only online games with specific levels that users have to overcome progressively. The challenge messages are private and can be seen only by the two participants of the challenge. The user who receives a challenge for a specific game can decide to accept or reject the challenge.

b) Share

This function allows a user to share his completed activities (i.e., physical activities, level reached in cognitive games) and obtained achievements (i.e., milestones, daily task completed). It will be visible to all users through a common wall.

c) Well-done

Each user can *well-done* other users' shared posts. A list of all the *well-done's* are presented in a common wall in the Social Area together with a list of the Top 10 *well-done* users.

In addition, **real world socialization activities** can produce motivational stimuli that lead to positive behavioural changes among DOREMI users. In this regard, DOREMI platform will suggest several indoor and outdoor tasks to be performed on a daily basis by users. These activities will appear in form of pop-up messages, arbitrarily and regardless of the personal interests of each user, and will encourage them to take actions (see Appendix 1). The *Well-done* and *Share* options will also be available here so that users can have the opportunity to share their indoor or outdoor experiences with other users or *well-done* others for their social accomplishments.

In addition to these options, users will be exposed to a pop-up asking them on a daily basis about their perceived health status, perceived social support, perceived feelings of loneliness or perceived well-being (mental) through individual questions taken out from self-report questionnaires (see Appendix 2).

Table 2 shows the key social features of the DOREMI gamified environment that encourage social support, and their functions (motivational affordances). The ways in which these features can achieve positive psychological outcomes in users are described in the last column.

DOREMI social features	Motivational affordances	Psychological outcomes
Instructions <i>Shared common DOREMI instructions by users</i>	Goal setting Group identification	Increases motivation
Challenge (sent) <i>Challenge other users to meet a specific target</i>	Goal setting Progress Status (level) Social comparison	Increases motivation by allowing users to communicate and compare their present achievements and past accomplishments with others and to challenge other users to

		meet a target behaviour
Challenge (receive) <i>Receive a challenge to meet a specific target</i>	Goal setting Social learning	Increases motivation by allowing users to see the outcomes of other users' performed behaviours and to meet the targets set by them. It also prompts users to make the game part of their daily routine
Well done (sent) <i>Reward or praise other users for their accomplishments</i>	Status (level) Affirmation Social comparison Reward	Increases motivation by allowing users to reward or to praise other users for their accomplishments
Well done (received) <i>Receive a reward or praise</i>	Status (level) Affirmation Social comparison	Increases motivation and feelings of self-efficacy through positive reinforcement
Share <i>Once the target behaviour has been performed, users can provide a summary of their status playing online games (level reached) or of the daily tasks performed in order to share their experiences and to stay in contact with persons with similar interests</i>	Group identification Social comparison Public recognition Reputation	Increases motivation and feelings of self-efficacy by helping users to connect with other people, share their experiences and compare performances
List of Daily Tasks (indoor/outdoor activities) <i>The Avatar will provide a list of Daily Tasks which support social interaction</i>	Social facilitation Group identification Cooperation Normative influence Suggestions	Increases motivation and feelings of self-efficacy by helping users to connect with one another, engage in pleasant outdoor and indoor activities that are common among elderly, and learn new skills. Users will also feel that others are performing a specific behaviour along with them
Reminders	Status (level)	Increases motivation by reminding users of where

	Goal setting	they are (current performance in online games, daily tasks accomplished, challenges/well-done received, etc.)
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Table 2 - Key DOREMI social features.

5.6 Measurement of gamified social activities

The Avatar system will offer a continuous measurement of social interaction activities performed by each user, as described in Table 3. One of the limitations is that we have been unable to record outdoor social interactions performed by each user with bracelet and other ICT tools, due to technical and privacy issues. Thus, we will use self-report questionnaires to quantify social interactions as well as other information available to the Avatar system, such as frequency and duration of the *Social area* use, type of social features performed by each user, etc. The self-report questions which are described in the Appendix 1 and Appendix 3 will be available to users at the end of the day (preferably at night, before going to sleep, in order to have a more complete image of their socialization activities during the day). Therefore, on the one hand, we will measure how many people users meet each day as a consequence of the daily tasks proposed by the DOREMI tool and how much time they spend daily interacting with each one of them. On the other hand, we will use individual questions from validated self-report questionnaires to measure perception of social support, health status, perception of loneliness (UCLA), and wellbeing (see Appendix 1). Logs from the app will be matched with data from sensors from external software.

We have to guarantee a user-friendly environment using visual representations of the questions, as it is important to keep users engaged with the online games, and at the same time, motivated to respond the self-report questions about the perception of their health status, wellbeing, loneliness and social support. We propose a graphical visualization of the frequency on each answer; the user will have to choose where exactly he/she locates himself/herself in each question's scale; the ranking scale has to be visually appealing for users.

Finally, in the long-term, the pilot study is expected to collect a large amount of data that will be used to demonstrate the effectiveness of the DOREMI solution in improving well-being and health status (SF-36), reducing social isolation (LSNS), loneliness perception (UCLA), and improving functional social support (MOSS-SS) of elderly (Appendix 4) through the social components of the gamified environment described above.

DOREMI social features	What do we measure?	How?
Challenge	- Number of Challenges sent/received - User(s) involved	Avatar system
Well-done	- Number of Well-done sent/received - User(s) involved	Avatar system
Share	- Number of Shared activities	Avatar system

	- Type of Shared activities - User(s) involved	
Daily tasks-indoor	- Time spent daily with other people - Type of activity offered by Avatar - Number of people met	Self-report question (Appendix 3)
Daily tasks-outdoor	- Time spent daily with other people - Type of activity offered by Avatar - Number of people met	Self-report question (Appendix 3)
Clinical Outcomes	- Perceived health status - Perceived social support - Perceived loneliness - Perceived well-being (mental)	- Self-report question (Appendix 2) – <i>Daily basis</i> - Self-report questionnaires (Appendix 4) – <i>After the intervention</i>

Table 3 - Measurement of social interaction activities.

7. TECHNICAL ASPECTS

6.1 High level game server and reasoning engine integration

A high level diagram of data flows between the Gamified Environment and the DOREMI backend (Game Server) has been designed and is general enough to support the plugging in of further games in all the three DOREMI sections (Cognitive Games, Exercise Area and Social Area).

Following the input of a physician and an expert, the engineering team designed the overall structure illustrated in the picture below:

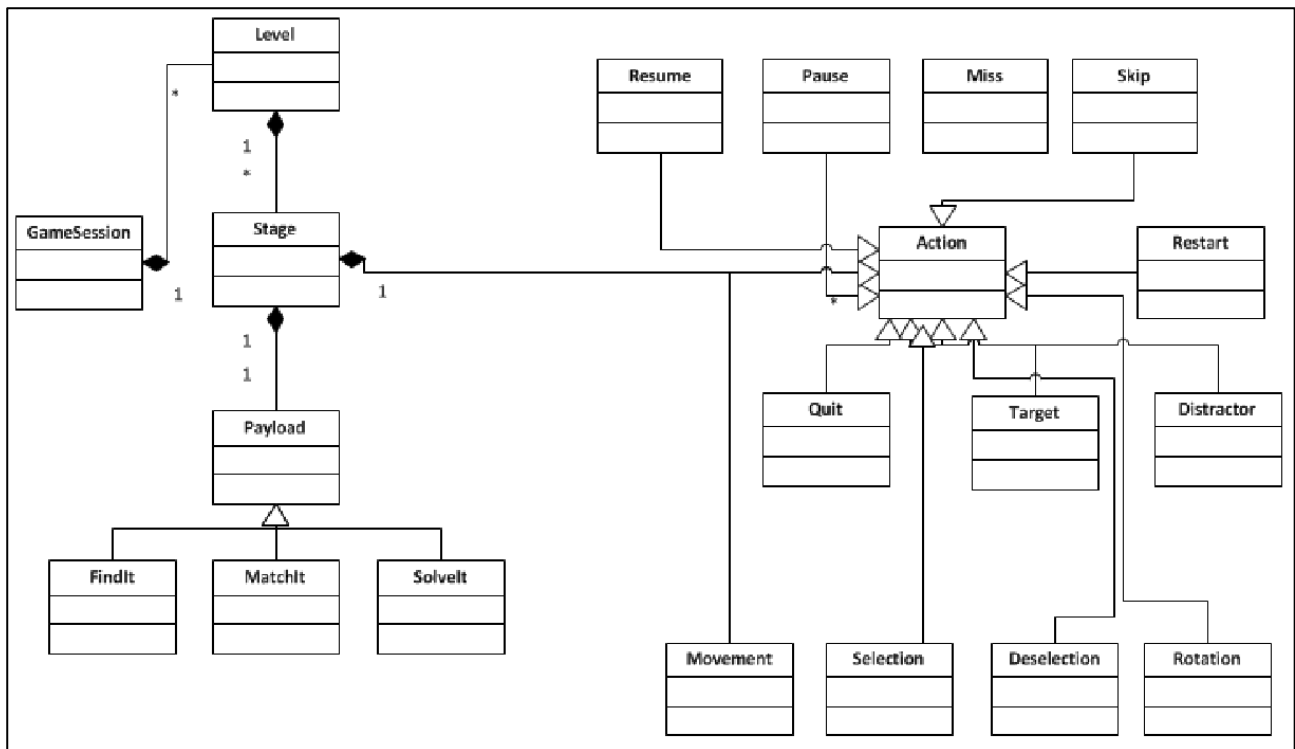


Figure 22 - Data structure

Each game has been analysed and the main entities involved for data representation identified. Every day a Game Session is started for each game required from the Patient records. Each Game Session consists of a set of levels and each level is composed by several stages. During each stage any action the user performs will be categorized and stored locally on the tablet. Once the user has completed one stage, data are sent back to the Game Server, then the current status of the Gamified Environment and the reasoning engine KIOLA will be both updated for further reasoning. The data stream exchanged between Game Server and KIOLA is in JSON format and is called "observation". Observations are documented in AIT specifications which will be included in D4.2 and are sent to KIOLA from the Game Server using the KIOLA API described in the same document. For convenience an example of an observation can be found in Appendix 1.

Every time a stage is completed the whole set of recorded user interactions will be sent to the game server and to KIOLA for storage and future reasoning. This kind of behaviour has been specifically designed in order to: minimize the data transfer exchange, and decreasing bandwidth usage, battery drain of the tablet, and latency in the user interaction of the game. On the other hand, sending a bulk set of information would involve a heavy load of data to be sent in a single time point, augmenting the risk of information getting lost, and the app crashing. As a result, the

user's performance data for that day could be lost. With the implemented approach in case of App crash or network disconnection the user will be able to start again from the stage where he left.

6.2 Social Area structure

Social games, from the technical point of view, are sharing messages exchanged between the Game Server and KIOLA reasoning engine. All the messages are stored in the Game Server database and are exposed to the client Gamified Environment by a set of REST APIs.

The social area is divided into three sub areas each represented in the Gamified Environment as a social wall: Challenges, Shared and Well done. Challenges could be created between a user and another random user or a previous challenged user (called 'Friend' in the application). The challenged user can choose either to accept or refuse the challenge. When a user reaches a significant achievement in the Game Environment (e.g. a milestone is reached, a game level completed, etc), he/she has the possibility to share the event to all the other users so that such information will be visible in the Shared wall. When a user looks at the Shared wall, he/she has the chance to send a 'well done' to another user appreciating his/her shared activity. All the *well-done*'s received from the user are shown in the Well done wall

As well as for the games, each action performed in the Social Area will be sent to the Game Server and to KIOLA reasoning engine. Below (see Table 4) some examples are provided of the "social" dataset exchanged between Game Server and KIOLA.

ACTION EXAMPLE		
VARIABLE	TYPE	DESCRIPTION
uid	guid	User id
timestamp	timestamp	Time when action is executed
action id	guid	Action id
stage ref (stage id)	ref	Stage id
type	categorical nominal	Challenge_sent, Challenge_accepted, ...

Table 4 - Instance of class Action

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9. APPENDIX

8.1 Appendix 1 - List of daily tasks requiring social interaction (domains)

With whom?

- (1) A friend
- (2) A relative
- (3) New people you'll meet

Why don't you....

- Visit (1,2)
- Go out for meal with (1,2)
- Take a walk in the park or garden of your neighbourhood with (1,2), to breath some fresh air
- Call (1,2) to share news with him/her
- Send an email to (1,2)
- Participate in a Discussion group with (3)
 - Do you need any ideas? Book club, religion, films, music, psychology, personal growth, arts groups
 - By doing this, you may meet new people who share a common interest
- Participate in a group for sports or leisure activities with (1,3)
 - Do you need any ideas? Cycling, excursions, walking, swimming, gardening, drama, yoga, bingo, singing, dancing, Karaoke, Pilates, gym
 - By doing this, you may meet new people who share a common interest
- Participate in a learning group with (3), which can help you stay cognitively healthy
 - Do you need any ideas? Computing, language, arts, crafts, cooking
- Participate in a Volunteer/Community groups with (1,2,3), which can help you find a new purpose in your life by helping others
- Participate in associations (political parties, NGOs) (3) – this is a good way to meet new people
- Visit a senior center and participate in the offered activities with other seniors—this is a great way to make new friends.
- Play cards or games with (1) - this is a good way to have fun
- Go shopping (buy the newspaper, supermarket, clothes, etc) with (1,2) - this is a good way to have fun with your loved ones
- Go to the hairdresser's or manicure (1)- this is a great way to take care of yourself.

8.2 Appendix 2 - Questions of the social area for the treatment period

The Avatar will run 4 questions regarding perception of social support, health status perception of loneliness, and wellbeing, following the frequency described below:

Day 1: Q1, always at night, 8pm

Day 2: -

Day 3: Q2, during the day

Day 4: -

Day 5: Q3, during the day

Day 6: -

Day 7: Q4, during the day

The results will be recorded in DOREMI system.

Q1) Degree of perceived Social Support

How often was there someone today available to

- a) Have a good time with
 - 1- never
 - 2- rarely
 - 3- sometimes
 - 4- often
 - 5- very often
- b) Love you and make you feel wanted
 - 1- never
 - 2- rarely
 - 3- sometimes
 - 4- often
 - 5- very often

Q2) Degree of perceived Health Status

Today my **health** is

- Excellent

- Very good
- Good
- Fair
- Poor

Q3) Degree of perceived Loneliness

a) Today I lack companionship

- Hardly ever
- Some of the time
- Often

b) Today I feel left out

- Hardly ever
- Some of the time
- Often

c) Today I feel isolated from the others

- Hardly ever
- Some of the time
- Often

Q4) Degree of perceived Well-being (mental)

“Today I feel so down in the dumps that nothing could cheer me up”

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little bit of the time
- None of the time

8.3 Appendix 3 - Daily tasks (outcome)

As it is not possible to have a virtual registration of the social activities performed by each user, we propose a series of self-report questions available to users at the end of the day (preferably at night, before going to sleep, in order to have a more complete image of their socialization activities during the day), assessing the frequency of indoor and outdoor social activities as well as the number of people met each day.

To register **indoor socialization**, we propose the following questions:

How many people did you spend time with while engaging in indoor activities today?

- 1
- 2
- 3
- 4
- >5

How much time did you spend with other people while engaging in indoor activities today?

- 15 minutes
- 30 minutes
- 1 hour
- 2 hours
- > 3 hours

To register **outdoor socialization**, we propose the following questions:

How many people did you spend time with while engaging in outdoor activities today?

- 1
- 2
- 3
- 4
- >5

How much time did you spend with other people while engaging in outdoor activities today?

- 15 minutes
- 30 minutes
- 1 hour
- 2 hours
- > 3 hours

We are not going to register virtual socialization of users. The responses of the users on the questions mentioned above will provide us with two daily socialization outputs: 1) number people met and 2) time spent.

8.4 Appendix 4 - Scales

LUBBEN SOCIAL NETWORK SCALE – REVISED (LSNS-R)

FAMILY: *Considering the people to whom you are related by birth, marriage, adoption, etc.*

1. How many relatives do you see or hear from at least once a month?

0 = *none*

1 = *one*

2 = *two*

3 = *three or four*

4 = *five thru eight*

5 = *nine or more*

2. How often do you see or hear from the relative with whom you have the most contact?

0 = *less than monthly*

1 = *monthly*

2 = *few times a month*

3 = *weekly*

4 = *few times a week*

5 = *daily*

3. How many relatives do you feel at ease with that you can talk about private matters?

0 = *none*

1 = *one*

2 = *two*

3 = *three or four*

4 = *five thru eight*

5 = *nine or more*

4. How many relatives do you feel close to such that you could call on them for help?

0 = *none*

1 = *one*

2 = *two*

3 = *three or four*

4 = *five thru eight*

5 = *nine or more*

5. When one of your relatives has an important decision to make, how often do they talk to you about it?

0 = *never*

1 = *seldom*

2 = *sometimes*

3 = *often*

4 = *very often*

5 = *always*

6. How often is one of your relatives available for you to talk to when you have an important decision to make?

0 = *never*

1 = *seldom*

2 = *sometimes*

3 = *often*

4 = *very often*

5 = *always*

FRIENDSHIPS: *Considering all of your friends including those who live in your neighborhood...*

7. How many of your friends do you see or hear from at least once a month?

0 = *none*

1 = *one*

2 = *two*

3 = *three or four*

4 = *five thru eight*

5 = *nine or more*

8. How often do you see or hear from the friend with whom you have the most contact?

0 = *less than monthly*

1 = *monthly*

2 = *few times a month*

3 = *weekly*

4 = *few times a week*

5 = *daily*

9. How many friends do you feel at ease with that you can talk about private matters?

0 = *none*

1 = *one*

2 = *two*

3 = *three or four*

4 = *five thru eight*

5 = *nine or more*

10. How many friends do you feel close to such that you could call on them for help?

0 = *none*

1 = *one*

2 = *two*

3 = *three or four*

4 = *five thru eight*

5 = *nine or more*

11. When one of your friends has an important decision to make, how often do they talk to you about it?

0 = *never*

1 = *seldom*

2 = *sometimes*

3 = *often*

4 = *very often*

5 = *always*

12. How often is one of your friends available for you to talk to when you have an important decision to make?

0 = *never*

1 = *seldom*

2 = *sometimes*

3 = *often*

4 = *very often*

5 = *always*

MOS Social Support Survey

1. About how many close friends and close relatives do you have (a person you feel at ease with and can talk to about what is on your mind)? Insert number__

People sometimes look to others for companionship, assistance or other types of support. How often is each of the following kinds of support available to you if you need it?

2. Someone to help you if you were confined to bed	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
3. Someone you can count on to listen to you when you need to talk	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
4. Someone to give you good advice about a crisis	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
5. Someone to take you to the doctor if you needed it	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
6. Someone who shows you love and affection	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
7. Someone to have a good time with	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
8. Someone to give you information to help you understand a situation	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
9. Someone to confide in or talk to about yourself or your problems	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
10. Someone who hugs you	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
11. Someone to get together for relaxation	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
12. Someone to prepare your meals if you were unable to do it yourself	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
13. Someone whose advice you really want	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time

14. Someone to do things with to help get your mind off things	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
15. Someone to help with daily chores if you were sick	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
16. Someone to share your most private worries and fears with	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
17. Someone to turn to for suggestions about how to deal with a personal problem	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
18. Someone to do something enjoyable with	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
19. Someone who understands your problems	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
20. Someone to make you feel loved and wanted	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time

UCLA Loneliness Scale

Please indicate how often each of the statements below is descriptive of you.

O indicates “I often feel this way”

S indicates “I sometimes feel this way”

R indicates “I rarely feel this way”

N indicates “I never feel this way”

1. How often do you feel you are “in tune” with the people around you? ☐

2. How often do you feel that you lack companionship? ☐
3. How often do you feel that there is no one you can turn to? ☐
4. How often do you feel alone? ☐
5. How often do you feel part of a group of friends? ☐
6. How often do you feel that you have a lot in common with the people around you? ☐
7. How often do you feel that you are no longer close to anyone? ☐
8. How often do you feel that your interests and ideas are not shared by those around you? ☐
9. How often do you feel outgoing and friendly? ☐
10. How often do you feel close to people? ☐
11. How often do you feel left out? ☐
12. How often do you feel that your relationships with others are not meaningful? ☐
13. How often do you feel that no one knows you really well? ☐
14. How often do you feel isolated from others? ☐
15. How often do you feel you can find companionship when you want it? ☐
16. How often do you feel that there are people who really understand you? ☐
17. How often do you feel shy? ☐
18. How often do you feel that people are around you but not with you? ☐
19. How often do you feel there are people you can talk to? ☐
20. How often do you feel that there are people you can turn to? ☐

Short Form Health Survey (SF-36)

1. In general, would you say your health is:

- 1 ☐ Excellent
- 2 ☐ Very good
- 3 ☐ Good
- 4 ☐ Fair
- 5 ☐ Poor

2. Compared to one year ago, how would you rate your health in general **now**?

- 1 ☐ Much better than one year ago
- 2 ☐ Somewhat better now than one year ago

3 ☐ About the same

4 ☐ Somewhat worse now than one year ago

5 ☐ Much worse now than one year ago

The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

(Circle One Number on Each Line)

	Yes, Limited a Lot	Yes, Limited a Little	No, Not Limited at all
3. Vigorous activities , such as running, lifting heavy objects, participating in strenuous sports	1	2	3
4. Moderate activities , such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	1	2	3
5. Lifting or carrying groceries	1	2	3
6. Climbing <i>several</i> flights of stairs	1	2	3
7. Climbing <i>one</i> flight of stairs	1	2	3
8. Bending, kneeling, or stooping	1	2	3
9. Walking <i>more than a mile</i>	1	2	3
10. Walking <i>several blocks</i>	1	2	3
11. Walking <i>one block</i>	1	2	3
12. Bathing or dressing yourself	1	2	3

During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of your physical health**?

(Circle One Number on Each Line)

	Yes	No
13. Cut down the amount of time you spent on work or other activities	1	2
14. Accomplished less than you would like	1	2
15. Were limited in the kind of work or other activities	1	2
16. Had difficulty performing the work or other activities (for example, it took extra effort)	1	2

During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of any emotional problems** (such as feeling depressed or anxious)?

(Circle One Number on Each Line)

	Yes	No
17. Cut down the amount of time you spent on work or other activities	1	2
18. Accomplished less than you would like	1	2
19. Didn't do work or other activities as carefully as usual	1	2

20. During the **past 4 weeks**, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbours, or groups?

(Circle One Number)

1 ☐ Not at all

2 ☐ Slightly

3 ☐ Moderately

4 ☐ Quite a bit

5 ☐ Extremely

21. How much **bodily** pain have you had during the **past 4 weeks**?

(Circle One Number)

1 ☐ None

2 ☐ Very mild

3 ☐ Mild

4 ☐ Moderate

5 ☐ Severe

6 ☐ Very severe

22. During the **past 4 weeks**, how much did **pain** interfere with your normal work (including both work outside the home and housework)?

(Circle One Number)

1 ☐ Not at all

2 ☐ A little bit

3 ☐ Moderately

4 ☐ Quite a bit

5 ☐ Extremely

These questions are about how you feel and how things have been with you **during the past 4 weeks**. For each question, please give the one answer that comes closest to the way you have been feeling.

How much of the time during the **past 4 weeks** . . .

(Circle One Number on Each Line)

	All of the Time	Most of the Time	A Good Bit of	Some of the Time	A Little of the	None of the

			the Time		Time	Time
23. Did you feel full of pep?	1	2	3	4	5	6
24. Have you been a very nervous person?	1	2	3	4	5	6
25. Have you felt so down in the dumps that nothing could cheer you up?	1	2	3	4	5	6
26. Have you felt calm and peaceful?	1	2	3	4	5	6
27. Did you have a lot of energy?	1	2	3	4	5	6
28. Have you felt downhearted and blue?	1	2	3	4	5	6
29. Did you feel worn out?	1	2	3	4	5	6
30. Have you been a happy person?	1	2	3	4	5	6
31. Did you feel tired?	1	2	3	4	5	6
32. During the past 4 weeks , how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?	1	2	3	4	5	6

How TRUE or FALSE is each of the following statements for you.

(Circle One Number on Each Line)

	Definitely True	Mostly True	Don' t know	Mostly False	Definitely False
33. I seem to get sick a little easier than other people	1	2	3	4	5
34. I am as healthy as anybody I know	1	2	3	4	5
35. I expect my health to get worse	1	2	3	4	5
36. My health is excellent	1	2	3	4	5

8.5 Appendix 5 - JSON Observations: data structure example

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        "value":75
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      },
      {
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            "value":23
          },
          {
            "profile":"number_of_semantically_related_pairs",
            "value":58
          },
          {
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            "value":"random_string"
          }
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    ],
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    {
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    {
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}
```

```

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  ],
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},
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{
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},
{
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}
]
}
}

```

END OF DOCUMENT
