

Health & Wellbeing

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Technical Foresight Report

Mental Wellbeing for Active Healthy Ageing

Executive summary

This report aims at identifying trends, challenges, and recommendations in regard of Mental Wellbeing for Active Healthy Ageing. This foresight will help expose future themes with high innovation and business potential based on a timeframe roughly six years ahead, or 2020. The purpose is to create a common outlook on the future of ICT and to establish a strong community across EIT ICT Labs nodes and partner organisations.

Trends in Mental Wellbeing

1. The desire to assist people to live independently at home is very prominent. This is done by identifying potential mental problems early and to supply support technology or home-service care to overcome some of the problems resulting from a declining mental health.
2. Remote care is increasingly popular, including self-care, self-awareness, and remote communication with carers. To achieve this a plethora of monitoring and warning devices are utilized, such as fall-detection, digital fence, and activity detection.
3. ICT support aims at helping the user improve and engage in physical, social and mental activities. These activities are crucial in preventing or slowing mental decline and support comes primarily in the form of training devices, monitoring devices, and coaching services.
4. Increasing the awareness through information about the disease is a common first step in the treatment. Learning that physical activity, social activity, mental activity, sleep quality, and diet are all important to maintain mental health may help a person make healthy lifestyle choices. ICT solutions, such as discussion forums and real-time information support, are being deployed to support increased awareness.

Trends in Emotional Wellbeing

1. Technology is used to detect emotional state and to provide feedback to the user, primarily for the purpose of helping the user correlate their perceived feeling of a day with the observed emotional state. This helps the user identify healthy social connection and healthy behaviour.
2. New non-invasive technologies are being deployed for measuring the emotional state. Self-reporting solutions are quite common, but new solutions, such as those measuring breath, are on the rise.
3. Research into the causes of happiness is increasingly popular, perhaps due to the advertisement and marketing potential. However, compliance to some recommendations that would increase happiness seems to be difficult to achieve and short-term rewards have an unclear long-term effect.

Challenges in Mental Wellbeing

1. Capturing the mental state of elderly people
 - Normal/abnormal behaviour
 - Progress of cognitive functions
 - Understanding of intentions (for proactive support)
2. Providing support for mental function (particularly memory)
 - Assisting
 - Exercising
 - Therapy
3. Dealing with comorbidities
4. Unobtrusive and natural interaction
 - Dialog systems
 - Facial expressions
 - Emotion detection

Challenges in Emotional Wellbeing

1. On the emotional wellbeing side, the biggest challenge lies in understanding the discrepancy between what seems to drive human behaviour and choices (the need for status in society) with what actually makes us happier at least in terms of positive/negative effect, which is only marginally related to status in society. There appear to be a disconnect between what genetic selection has done and that drives (or, that has selected) our behaviours and what emotional wellbeing is and needs.
2. Another challenge here is related to the breadth and length of the studies being undertaken. Nearly all studies complain that the cohort selection is somewhat biased and that the study is not long or detailed enough to draw definitive conclusions. This is also true of the smartphone-based studies, which always have a bias at the start as the cohort is often composed of people able and willing to use smartphones and curious/willing to experiment/understand their happiness patterns.
3. We add a challenge specifically on elders, which are often neglected in terms of emotional wellbeing, perhaps because studies on older adults are often more difficult. The problem here is that most research, including IT research, does not seem to be aware of what older adults need, emotionally. Studies focus on health and try to “keep people alive”, or off the healthcare system to reduce costs. Very little research is done on what makes older adults happier, and there seem to be the unstated but implies (and totally unverified assumption) that what makes elderly people happy is different from what make younger people happy. Understanding these aspects is a major challenge for the work on emotional wellbeing for an important and growing segment of the population.

Recommendations

1. Identify the real needs of elderly people through proper studies involving the real stakeholders, meaning older adults, to understand what they need to stay emotionally and mentally fit
2. Support the caregivers: caring for an older adult is one of the most stressful activities; in fact it ranks just below severe headache. We need to develop all possible means to reduce the burden on the caregivers while keeping the human contact that the elderly (like everybody else) seem to need.
3. Overcoming reluctance of elderly to address their mental health and start using ICT solutions. This can be achieved by developing technology that is not just functional, but that, as its number one goal, blends nicely with a person's lifestyle, daily habits, and one owns sense of pride and beauty.
4. Focus on self-care and preventive health.
5. Identify Intention and emotion aware solutions for true companionship and support

General and crosscutting recommendations are to make sure that when studies and products are developed, the largest possible number of team members spends time with the elderly to get a better understanding of the needs; getting rid of what are often implicit assumptions that do not find correspondence in reality.



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1 Introduction

This technical report is part of the EIT ICT Labs Foresight Study and Innovation Radar within the thematic action line of Health and Wellbeing (HWB). The report aims to identify key scenarios, trends, challenges and recommendations in regard of HWB. This foresight will help expose future themes with high innovation and business potential based on a timeframe sometimes as much as 15 years ahead, or 2030! The purpose is to create a common outlook on the future of ICT and to establish a strong community across EIT ICT Labs nodes and partner organizations.

This report has been divided into mental wellbeing and emotional wellbeing. The mental wellbeing section deals with different cognitive impairments and the reasons for why these may appear, as well as what can be done to delay the onset of symptoms, to manage symptoms, and to treat the disease. Emotional wellbeing is an equally important aspect of mental health and deals with how the emotional state can be measured, and how a more satisfying life in terms of emotional wellbeing can be achieved.

2 Mental Wellbeing

We think of lifelong brain health as a matter of *cognitive endurance*. Cognitive endurance is the capacity for flourishing mentally throughout life. Few people know about this, but our brain has a remarkable capacity for cognitive endurance if it is allowed to age without developing medical conditions. Even fewer people know that there are things that can be done to enhance cognitive endurance. Our goal is to delineate and articulate in a comprehensive manner what can be done to further cognitive endurance.

2.1 Understanding Mental Wellbeing and Cognitive Endurance

The human brain is born with a fixed number of neurons. However, it is becoming increasingly clear that the number of neurons is immense. Today it is estimated that an average brain has at least 100 billion neurons and perhaps as many as a trillion. Neuroscientists are still counting. While neurons and other cell types die throughout our lives, at a rate of about 68000 per day or one every second [Hains, 2006], it is not a lot in comparison to the number of neurons that actually exist in the human brain. Some studies have even reported no significant loss of neurons at all with advancing age [Brodal, 2010]. Furthermore, neurogenesis exist in the brain meaning that neurons are continually being born to compensate for at least a substantial portion of the neurons that die. Many believe that neurogenesis can explain why humans are able to recover as well as we some do after a stroke.

The brain also adapts remarkably well to new situations. The infant brain is very plastic and is very sensitive and can pick up new things quickly, languages especially. It is a myth that the brain loses its plasticity after the developmental period [Garcia-Segura, 2009]. The brain maintains its plasticity throughout the life span, and new connections between neurons are grown throughout the life of a person. Our brains are changed with every thought and every experience. They are also changed with physical activity. Our intellectual and social life and our level of physical activity change our brains.

In the last few decades it is becoming increasingly clear that neurons are not the only cells that are interesting to consider with respect to cognition. Other cells, so called glial cells, play important roles as well. From a perspective of brain health, it turns out that they could well hold the key to understanding the development of neurodegenerative disease and consequent cognitive decline. Glial cells do provide nourishment, they do clean-up work, and they provide structural support among many other functions. However, the neuroscientist Douglas Fields, with many others, now argue that glial cells do much more than merely support the neural structure of the brain. As Fields points out there is communication between neurons and glial cells and glial cells communicate with each other, albeit without synapses. They use clouds of chemicals instead that are widely dispersed throughout the brain [Fields, 2010].

It is a misconception that cognitive decline is an inevitable result of normal ageing. The loss of neurons is so small in comparison with the number of neurons in the brain, and neurogenesis keeps growing new neurons. Just how much cognitive

decline will occur in the absence of neurodegenerative disease or other brain conditions is not entirely clear. To some extent, it depends on the life styles we live. One thing appears clear, the cognitive decline that does occur as part of normal ageing has a more complex aetiology than simply loss of neurons [Burke et. al, 2006]. Studies of centenarians and so-called super centenarians (people who live to at least 110 years of age) have revealed that dementia is not an inevitable aspect of the normal ageing process. Many centenarians and even super centenarians are spared from dementia [Perls, 2004].

Both physical and mental activity has been demonstrated to have positive effects on the brain. Moreover, diet and nutrition also has a role to play in this. Stress and social life also filters into the aetiology of cognitive endurance. Many of us go through our lives with a kind of sleep debt. We are more or less constantly sleep deprived. What this leads to in the end are much the same symptoms as being under constant stress. We get elevated levels of stress hormones in our brains. This is not good news for memory and a host of other cognitive functions. Short-term exposure to stress hormones tends to enhance brain function, but long-term exposure impedes it. At present, we cannot do much about our genes, but they also play a role in cognitive endurance. Your genes, the stress you are experiencing, how much exercise you get, what kind of food you eat, what environmental toxins you are exposed to and so on—all of these things interact and it impossible to say what will happen with your brain in old age.

2.2 Mental Health problems

2.2.1 Neurodegenerative disease

These diseases are such that they lead to abnormal degeneration of brain cells and connections between them. While there are many forms of neurodegenerative diseases, the most common are Alzheimer's and Parkinson's disease (see 2.4.1). As Alzheimer's disease progresses the person comes to experience cognitive decline. With Parkinson's disease cognitive decline may occur but it is not part of development of the disease that such decline must occur. This is because Parkinson's disease is mainly restricted to the degeneration of neurons involved in the motor system while Alzheimer's disease has a much broader scope. While Alzheimer's disease typically begins in a restricted area of the brain, it is part of its expected progression to affect the whole brain.

Alzheimer's disease typically begins with the degeneration of neurons in the hippocampus. This is an area of the brain that is responsible for declarative memory. Declarative memory is the kind of memory that allows us to remember information. Although memories are stored in networks that seem to be hard to localize, the hippocampus has a crucial role in laying down new memories. As Alzheimer's progresses not only are the neurons in the hippocampus compromised (connections torn apart and destroyed as well as neural death), but other areas of the brain become compromised as well. The first sign of dementia is that memories are harder to access. The neuroscience explanation for this is that memories are stored in networks and those networks are now being compromised. However, the memories can still be retrieved it just takes more work. The person has to try to think in such a

way that many networks of declarative memory are triggered and somewhere in those networks the memory pops up. Eventually the Alzheimer's patient will need help in retrieving memories by a caregiver who provides such a strong triggering stimuli that the memory sought is triggered. This could also happen through some external tool such as digital reminiscence therapy tools like MemoryLane, which is like a digital diary with annotated pictures that have been segmented into activities for better overview. The idea is to review the day together with a relative or carer in order to trigger memory cues.

2.2.2 Normal ageing process of cognitive abilities

The cognitive abilities change as a normal part of the ageing process. While many functions gradually deteriorate, there are also some abilities that actually improve, perhaps contributing to the wisdom that is supposed to accumulate over the years. The cognitive decline is however gradual and dementia is not a condition met by all elderly people. In most cases, the functioning of the elderly brain is more than adequate to meet the challenges of everyday life, albeit at a slower pace.

Memory performance starts to decrease already from 20 years onward, but the rate increases above 60. Looking at the various types of memory (see figure 1), episodic memory and short-term memory deteriorate most in elderly people. This is tested for example by asking people to remember a list of words. Elderly people also seem to be more easily distracted, and this lack of concentration may surface as worse performance in memory tests as well.

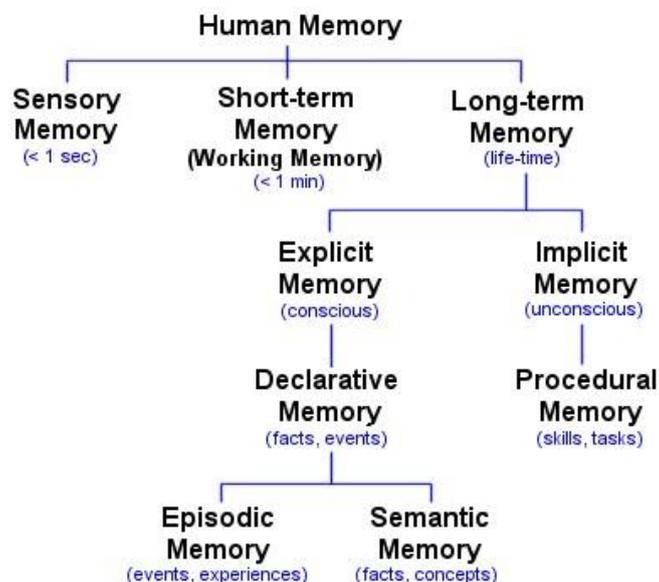


Figure 1: Types of human memory: Atkinson-Shiffrin model diagram by Luke Mastin [The Human Memory 2013]

Also the executive functioning of the brain deteriorates. This is the ability to organise, plan, initiate, navigate, control impulses, regulate emotions, adapt and recover. For example the planning needed to cook a meal has been shown to be worse in elderly people. Surprisingly, though, the emotional stability in elderly people is usually better

than in the younger population. This may be caused by slower responses, but can also be shown in brain activity, as the prefrontal cortex is more active in elderly people during emotional experiences, and the amygdala has less activity.

An important factor contributing to the deterioration of the functioning of the elderly brain is the decrease in thinking or information processing speed. This affects many abilities, and may lie at the basis of the deterioration of other cognitive factors as well. Reaction time decreases linearly with a gradual slope from the age of 20 onward. Reading speed seems to remain on a stable level, but the interpretation of information from more demanding texts requires more time for elderly.

Knowledge accumulates over the years, and the vocabulary and world knowledge of elderly people is better in general. This crystallized intelligence remains therefore rather stable, while the ability to cope flexibly with new information or fluid intelligence decreases. It affects, for example, the ability to multi-task or to learn new information.

Elderly people tend to be more friendly or altruistic than younger people. The elderly brain responds more actively to positive impulses and seems to damp negative feedback. People are often happier at the age of 60 compared to those at 20. However, the negative emotions may increase beyond the age of 70, possibly due to deteriorating health and loss of dear ones. This also causes an increase of mild depression beyond that age, while severe depression is less frequently encountered in elderly people [Aleman 2012]. Elderly people have a better insight in social relations and are better capable of sympathizing with parties in complex situations. Their judgement may therefore be more reliable.

The brains of elderly people performing a task show the PASA pattern – the Posterior-Anterior Shift in Ageing. This means that the activity of the brain changes from more activity in the backside of the brain (occipital areas) to more activity in the front side (frontal and temporal areas) [Davis et. al 2008]. The brain activity in elderly people is also more symmetrical than in younger people, meaning they use their brain halves more evenly, especially in the frontal lobe. It seems that both ways are a way to compensate for decreasing performance of the brain, especially in the front side.

This ability of the brain to compensate for decreased functioning of certain parts of the brain, in combination with the accumulating life experience allow elderly people to maintain mental abilities well equipped for everyday life and even allowing them to solve complex (social) problems with wisdom. Their emotional stability and positive attitude make them into the adorable grannies and grandpas they often are. They might just need a bit more time due to deteriorating processing speed.

The observations in this overview are based on scientific research as reported by André Aleman in his book: “Het senioren brein” [Aleman 2012].

2.2.3 Other Mental Health Problems

Geriatric mental health problems have been categorised by Alexopoulos as follows [Alexopoulos 2005]:

Major depressive disorder

Five of the following symptoms must be present: depressed mood, diminished interest, loss of pleasure in all or almost all activities, weight loss or gain (more than 5% of bodyweight), insomnia or hypersomnia, psychomotor agitation or retardation, fatigue, feelings of worthlessness or inappropriate guilt, reduced ability to concentrate, recurrent thoughts of death or suicide.

At least one of the symptoms must be either depressed mood or diminished interest or pleasure. The syndrome should last at least 2 weeks, lead to distress or functional impairment, and not be a direct effect of substance use, a medical condition, or bereavement.

Minor depressive disorder

At least two but fewer than five of the symptoms of major depressive disorder must be present. The syndrome should last at least 2 weeks, lead to distress or functional impairment, and not be a direct effect of substance use, a medical condition, or bereavement. This diagnosis can only be made in patients without a history of major depression, dysthymia, bipolar, or psychotic disorders.

Dysthymic disorder

Sad mood for more days than not, accompanied by another two symptoms of major depressive disorder. Duration of at least 2 years is required. An episode of major depression might not be present during the first 2 years of the disorder.

Bipolar I disorder (most recent episode depressed)

Individuals meet criteria for major depressive disorder and have a history of at least one manic episode or a mixed episode.

Adjustment disorder with depressed mood

Individuals who develop depression, tearfulness, or hopelessness within three months of the occurrence of a stressor. The syndrome should lead to great distress or disability, and should subside within six months of the removal of the stressor. Bereavement is not considered a stressor for an adjustment disorder.

Alexopoulos observes that depression affects most often those elderly suffering of chronic diseases or cognitive impairment. It has effects on their social lives and has an adverse effect on illnesses. Medical treatment is often effective and accepted.

The diagnostic and statistical manual of mental disorders (DSM-5) by the American Psychiatric Association (APA) [DSM-5, 2013] categorizes mental disorders by diagnostic criteria and codes; Neurodevelopmental disorders, Schizophrenia spectrum and other psychotic disorders, Bipolar and related disorders, Depressive disorders, Anxiety disorders, Obsessive-compulsive and related disorders, Trauma- and stressor-related disorders, Dissociative disorders, Somatic symptom and related disorders, Feeding and eating disorders, Sleep-wake disorders, Sexual dysfunctions, Gender dysphoria, Disruptive, impulse-control, and conduct disorders, Substance-related and addictive disorders, Neurocognitive disorders, Paraphilic disorders, and Personality disorders.

2.3 Methods to Improve Mental Wellbeing

We have attempted to try to trace all of the factors that we have considered with respect to cognitive endurance back to the brain. Our understanding of the brain is changing fast. Our task so far has been to briefly discuss dimensions that are important for placing cognitive endurance within a constructive context. Given our best knowledge, we must now ask the question what can be done. How can we increase cognitive endurance in well-thought out and sound ways? Let us turn now to some of the dimensions that could be justified as especially promising in this regard: Physical exercise and nutrition, Social life and stress, Intellect and cognitive reserve, and Genetics.

2.3.1 Physical exercise and nutrition

If there is one thing that most agree on with respect to brain health then it is that physical exercise is good for the brain. Physical exercise can as we have seen do nothing short of help us to increase our brain volume. But it is also plain to see that physical exercise will be good for our bodies more generally (not just our brains) and as such can help to combat the many diseases that flourish because of our modern high-caloric sedentary life styles. We now have to worry about stress related diseases, cardiovascular disease, diabetes, metabolic and so on—diseases that were almost unheard of in earlier societies. Exercise does not only have a direct and even immediate positive impact on brain health, but it also gives us a release from stress and gives us a way to expend that enormous surplus of calories that many of us ingest on a daily basis.

We have grouped physical exercise here together with nutrition. Nutrition is also very important and one can of course get benefits from simply a change in diet. But the two tend to go together as many of us have experienced. To be physically active and to eat healthy is to engage in a healthy conscious life style. Diet is like all other factors that contribute to health and cognitive endurance, it is not a factor that can be examined in isolation from a web of other factors. Perhaps the most important thing to understand about diet is that its importance must be understood in relation to the overall health of the person. The point is that the more damaged your system is all those factors that may contribute to poor health, the more important it becomes to watch whatever you dump in your bloodstream by means of eating habits.

2.3.2 Social life and stress

The problem of prolonged stress has become recognized within the medical community. One consequence of stress can even be physically damaged brains. Stress can literally kill neurons in extreme cases. But even if this does not happen, there is evidence of other sorts of damages. Stress can lead to compromised neurons in the hippocampus. That is they do not die, but their dendritic trees shrivel up. However, from the perspective of cognitive endurance, we cannot simply focus on the literal destruction of neurons or whatever it is that we think is the biological basis of cognition (including glial cells). We need to take a broader perspective and look at the whole person in society, because it is as the person suffers that the brain eventually also is likely to suffer.

Here we also couple our social life to stress. We are, at a very fundamental level, social beings. We not only have a need to be social, we are social primates as a fact of biology. Not surprisingly, it is becoming clear that having an active social life is a key factor for brain health and cognitive endurance. As other primates, we reduce anxiety and stress in social settings that are safe to us. Research indicates that those who maintain active social lives tend to be less likely to develop dementia. Many dangerous health conditions develop because of prolonged stress. It is when we are unable to turn off stress responses that our health suffers.

“Almost all stressed out people state social anxiety and relationship difficult as their primary causes of stress. Broadly, social anxiety comes from three major relationship categories – child-parent, marital, and career/professional” [Stress and Relationships, 2013]

2.3.3 Intellect and cognitive reserve

The basic idea seems simple. The more we use our brains the better adapted they become to what we do and consequently the better they can withstand any possible future physical decline. The best way to build your cognitive reserve capacity is likely to get exercise and reduce stress, however getting your daily dose of mental exercise can help improve the cognitive reserve as well. Physical exercise as we have seen is likely to have the greatest positive impact at the neural level. The more physically healthy your body is the more physically healthy your brain is. Should you then later in life suffer some complication such as a stroke your brain will be in better shape to recover.

2.3.4 Genetics

The last factor we have little or no control over as of today. However, things might change rapidly with respect to genetics. It is possible today to tell from brain scans whether someone reveals early physical signs indicative of neurodegenerative disease. There are also a number of genes that when present in humans increase the likelihood of developing neurodegenerative disease. A person with such a gene may or may not decide to perform regular brain scans in order to catch an onset of neurodegenerative disease as early as possible. The person could then be given medical treatment in order to arrest the development of the disease to the greatest possible extent.

2.4 Trends

In this section, we will review the trends relevant for the development and adoption of ICT solutions supporting mental wellbeing. First, demographic trends will be reviewed including some statistics and predictions on mental diseases among elderly people. Mental care trends will be observed, and some notes will be made related to the adoption of ICT technology by elderly people. Finally technology trends will be reviewed that may be of impact on the further development of solutions for supporting mental wellbeing. The main focus in this report is on elderly citizens, while some trends can also be applied to a wider age group.

2.4.1 Demographic trends:

Share of elderly in the population is increasing; people live longer; increase in age-related diseases

The average age of people, especially those living in the so-called developed countries, has risen considerably during the last century. While the life expectation of a person living around 1900 was approximately 47 years, it has now risen to about 77 years. This is largely due to advances in health care and a general improvement of living conditions. These well known facts have also had a tremendous effect on the increase in the amount of age-related diseases and associated care. Taking dementia as an example, of which Alzheimer is the most usual form, the incidence rate increases 14 times from 65 to 85 years old. Prevalence of Alzheimer increases from 10% of those above 65 to 47% for people older than 85. Thus, the longer people live, the more cases of Alzheimer will be observed as a proportion of the population. An increase in the US of the number of Alzheimer patients is expected to rise from 4.7 million in 2010 to 13.8 million in 2050, see Figure 2. World wide, the estimated number of Alzheimer's patients will approximately double every 20 years, from an estimated current number of 35,6 million to 115,4 million in 2050 [Alzheimer's Disease International, 2010]. Nevertheless, the majority of people suffering from Alzheimer's disease are in the age of 75 and above (see figure 2) and is the age-group with primarily refer to as elderly in this report.

Similar observations for other age-related diseases cause the total costs of elderly care to increase steadily. Taking into account the diminishing increasing dependency ration, concerns have been raised on the ability of society to provide sufficient care also in the future and the need for improved self-care, prolonged independent living and care aids has become evident.

While cognitive decline is partially genetically defined, age dependent and generally progressive, treatments are available alleviating the symptoms and slowing the disease. Also a proper lifestyle has been shown to have positive effects. Coping with dementia independently clearly needs support from relatives, caregivers, and technological aids. While the focus of dementia care is on the patients themselves, awareness of the mental and physical challenges of relatives and care personnel has improved and supporting their wellbeing has become a focus of attention.

In spite of deteriorating physical health and the danger of cognitive decline, elderly people tend to suffer less of neurotic disorders than the general population (in Britain 10.2% (65-69) and 9.4% (70-74) versus 16,4 % of the general population) [The Fundamental Facts, 2007]. Research has attempted to find clues for the comparatively low occurrence of depression among elderly people. Recent findings indicate, that elderly people tend to register positive feedback better than negative feedback, and in general focus more on positive matters gradually purging sources of distress out of their lives. Hence they are on average happier with their lives [Zevin et. al, 2013].

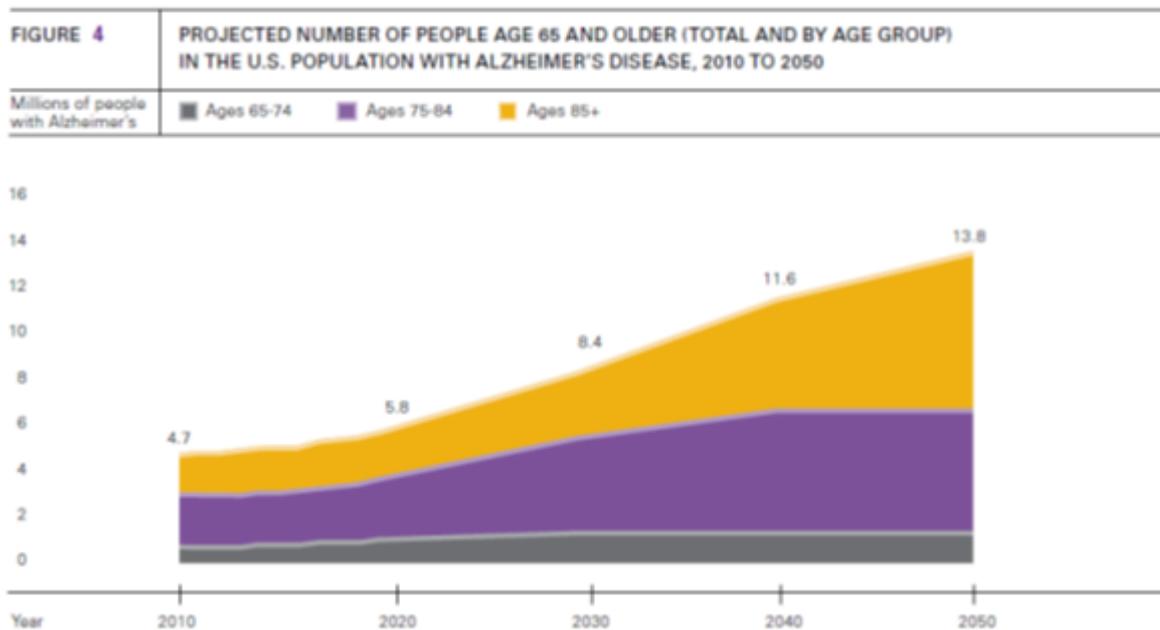


Figure 2: Increase in prevalence of Alzheimer in the US, from Alzheimer's disease facts and figures 2013 [Alzheimer 2013].

Nevertheless loneliness, deteriorating health and comorbidities are some of the main reasons for new depression in elderly people. One out of five elderly people still living in the community suffer of depression, while 2 out of 5 of those living in caring facilities report on depression problems.

2.4.2 Care trends

Due to the increasing dependency ratio mentioned above, elderly care is expected to become a considerable burden for society if arranged in the traditional way. A great number of care facilities are needed, staffed with a great number of trained nurses and doctors. This prognosis has triggered a search for alternative ways of elderly care and the development of ICT and other means to facilitate care provision. Typical objectives of related research include:

- Postpone the date of admission to a care facility
- Assist people to live independently at home
- Provide remote care
- Support means for self care
- Improve physical, social and mental health
- Improve logistics for care provision

These trends have a major impact on the care provision. Care is no longer confined to care facilities and hospitals, but often provided at homes or remotely. Care is organised in ways that expect involvement of the elderly themselves, a spouse, relatives or neighbours. Care is mediated via Internet and other suitable media. The

patients themselves can take a variety of real-time measurements, and they can be equipped with care aids. These changes demand a redesign of care services and their management, as well as the supporting legislation and social support systems.

A related trend in health care is a shift from treatment of illnesses to prevention and general health coaching. This trend is most obvious in elderly care, as they are more often treated for various diseases and the treatments – especially if they require long-term hospitalisation – are expensive. Similarly to general health care, also mental care is gradually changing to focus on coaching rather than treatment. The symptoms of dementia can be partially suppressed by a healthy lifestyle, taking care of a regular sleep pattern, healthy food, sufficient exercise and limited use of alcohol.

The need for including positive emotions in care has been addressed in various studies. Positive emotions allow for absorbing new information, processing new ideas, reconsider situations and find alternative ways of action [Fredrickson 2008, Tugade 2004]. The effect of happiness on the life expectancy has also been researched and positive dependencies have been found [Veenhoven 2008]. Emotion-oriented care has been found to have a positive effect on the self-image of patients with mild dementia and to diminish their anxiety [Finnema 2005].

A number of ICT solutions have been proposed to induce positive emotions coupled with care, in order to combat depression. Some of these solutions are built upon the concept of encouraging social interaction, others on some form of games or achievements. A thorough list surveying a number of these ICT solutions can be found in [Preschl et al., 2011]

2.4.3 ICT adoption trends:

While traditionally one of the obstacles of using computer, internet or mobile phone technology has been the lack of “computer literacy” among elderly people, it is no longer evident that these technologies are not suitable for this age group. People currently retiring have most likely used computers and mobile phones in their working life, and will continue to do so in retirement. The existing digital divide will thus gradually disappear and in research one should focus on products for the elderly population 5-10 years from now, when this shift has mostly taken place. That said, new technology will keep coming and it is therefore essential to design new technology for usability, also keeping in mind that the motivation for elderly people to learn new technology is in its usage and usefulness to their current situation. Naturally some obstacles maintain; eyesight and fine motor function deteriorates so that the same dexterity cannot be expected from the older generation. However, many applications that are targeting the elderly will be designed with some of these limitations and may have colour schemes with high contrast (for example yellow background and black text), bigger buttons, and fewer steps to reach different functionalities, and simpler navigation in general.

Nevertheless some cultural differences will remain. When one is used to communicate predominantly by one specific medium, be it phone, e-mail or social media, adopting a different medium will be difficult especially if peers are not using it either. For example, Facebook use among elderly people is clearly less popular than among young people, on the other hand, also these numbers are rising fast...

2.4.4 Technology trends

There are many potential products that could be developed. We have here limited the scope of development somewhat, yet the range of possibilities is vast. Within this vast sea of possibilities, we must nevertheless choose some possible applications. Let us go through the dimensions discussed earlier, now with an eye towards product development.

2.4.4.1 Products that support physical exercise and healthy eating habits

At least three categories are clear: (a) *training equipment*, (b) *monitoring devices* and (c) *coaching devices*. Training equipment is for directly exercising abilities that are thought to be important for cognitive endurance. So for example, physical training equipment such as fitness equipment would fall into this category. Monitoring devices are devices that record physiological and behavioural characteristics. An example would be a step-counter, a device that monitors the number of steps a person takes per day. Coaching devices go beyond monitoring devices. They do this either by providing advice to the user or by allowing the user to set goals and become his or her own coach. An example of this is the mobile application by Lin et al. which proposes different physical activities throughout the day [Lin et al., 2011].

2.4.4.2 Products that support social life and stress reduction

Here one can imagine the same basic categories as in the previous dimension: (a) training equipment, (b) monitoring devices and (c) coaching devices. Training equipment could be such that they trained the person to develop skills for relaxing or social life. Monitoring devices would such that they helped to keep track of social activities and stress levels. Examples of such devices could be Galvanic Skin Response sensors such as the Philips DTI-2 sensor, or the Affectiva Q-sensor. Coaching devices would provide advice for how to reduce stress or engage in social activities, such as the affective health application [Affective Health, 2013]. However, we could also add (d) social devices and services and (e) calm technology. One example of a social service would be to provide a social game or some other way of interacting socially. An example of (e) stress-reducing, calm technology could be a smart phone that was very simple to use and did not bother the user with frequent messages about software updates, new features and did not have any blinking blue lights and so on. Calm technology will not distract the user by directing attention to the periphery but rather helps the user focus on what is important, which in social life could be distracting phone-calls or worry about later activities.

2.4.4.3 Products that support intellect and cognitive reserve

The best way to build cognitive reserve is probably exercise and proper nutrition. When it comes to finding ways to use or brains or to do the same thing in a more intellectual way one is faced with a problem. This is the problem of motivation. Building cognitive reserve ought to be stimulating and enjoyable. What seems to have great impact are large-scale changes, massive forms of novel stimuli, such as learning a new language, moving to a new place or changing jobs. All those activities involve large-scale cognitive readjustments. Here one has to keep in mind also the

interplay with stress; if any large-scale cognitive changes come part and parcel with stress then it is going to be so much harder to make them possible.

As we have seen prolonged stress keeps the hippocampus from operating well so you will not remember as much. The same things happen with sleep deprivation. The common denominators are prolonged periods of elevated glucocorticoid levels that keep both the frontal cortex and the hippocampus from operating well. So to move to new area and to take up a new job could be the best thing you could do for your cognitive endurance or it could be the worst, depending on how much sleep you get and what your stress levels are going to be. The key here is to somehow develop products that allow people to love being cognitively challenged in major ways. Those ways are probably either going to be purely fun to use or to be rewarding from some other perspective—the products or rather the activities that they allow ought then to have intrinsic value for the user.

2.4.4.4 Affective technologies for Active and healthy ageing

To further motivate a person to adopt a healthier lifestyle that benefits the cognitive endurance there are a number of affective technologies that could be of help. A plethora of robot helpers to assist with simple tasks [Robot-era, 2013], with information, and to promote social interactions [Giraff, 2013] are currently being researched. Similarly, avatars are being used in social settings as companions, and when coupled with mood and emotions can help reduce stress and motivate the person. Coaching and informing people in their current situation are also effective means for motivation. To reduce risks for cognitive decline there are even proactive environment control factors that could play a role, such as supporting the circadian rhythm, and intention awareness.

3 Emotional Wellbeing

In the previous sections we have discussed trends and issues in mental wellbeing. We devote here a specific section to emotional wellbeing, due to the importance of the topic and to the fact that trends and techniques are only partly overlapping with those of mental wellbeing.

Understanding happiness is arguably one of the most important research goals we may set for ourselves. As Aristotle says, happiness is desirable in itself, while most other goals are a mean to achieve happiness [Aristotle, 2009], and the US Declaration of Independence remarkably asserts that this is a goal that every person should be allowed to pursue [Jefferson et al, 1776], a right equal to that of life and liberty. Many studies on happiness have been done in the past century, including some that are large scale and global [Gallup, 2012, Helliwell, 2011]), especially in the past decade. These studies look at *subjective well-being (SWB)*, that is, at self-reported measures of happiness, interpreted as both *life satisfaction* (how happy you are overall with your life) and *positive/negative affect* (how happy, smiling, or stressed you are these days or even right now). They proceed on the assumption that the improvement of SWB, that is, increasing the probability that we will give a positive answer to life satisfaction and affect questions, is a desirable goal that we, policy makers, and society at large should set for ourselves, because it leads to our own happiness. Consequently, understanding which the factors are contributing to a greater SWB is a crucial research we should undertake.

Indeed, some governments and policy makers, following the famous example of Bhutan [Ura et al, 2012], are beginning to look at happiness measures to understand what promotes the wellbeing of their citizens, to then act on those variables. This represents a fundamental shift in the policy mindset, where a scientific approach is taken to understand and consequently pursue happiness.

These studies have drawn important conclusions. First, they indicate that people are indeed able to report on their happiness with an accuracy that makes studies on happiness valid [Helliwell, 2011]. Then, they shed the light on the effect on happiness of factors such as *income* [Kahneman and Deaton, 2010], *life fortune and misfortunes* [Brickman et al, 1978], *passions* [Vallerand, 2012], *social interactions*, degree of corruption in the government [Helliwell, 2012], and even *genes* [Deneve, 2011]. We discuss some of the main studies and results in the following.

3.1 Measuring and understanding Emotional Wellbeing

The best and most comprehensive reading on happiness today is provided by the UN report on the World happiness [Helliwell, 2011]. Besides identifying a number of interesting correlations following a large-scale study, this report shows how self-reported measures of well-being can be taken as reliable indicators across countries, making it worth and meaningful to take this measure.

One of the main purposes of happiness studies is to identify factors that are causally correlated with happiness. The first aspect that often comes to mind is **money**. Many papers and views have been published on if and how much money affect happiness, with the one by Nobel prize winner Kahneman and colleagues probably being the

most deep and accurate [Kahneman and Deaton, 2010]. In their studies, they observe how income impacts positive and negative affect as well as life satisfaction. The result is that stress improves (that is, is reduced) until an income of about 40K USD/year, and then remains constant. For positive and negative affect, this threshold is 75K USD. In contrast, life evaluation does not cap out: increase in income generate increase in one's own perception of life satisfaction.

The same paper reports on another set of interesting correlations among life events and affect/life evaluation. Among the most interesting ones, it reports that being alone, caring for a child and even more for an elder family member are among the biggest stress factor aside of headache. Another interesting finding is that work is a big stress factor and that during weekends this stress is considerably reduced. While consistent with intuition, it makes the case for a need to address stress at work.

A factor that is known to improve wellbeing is mutual trust and social interactions. Both these aspects are known to correlate with wellbeing [Helliwell, 2011]. On the same thread, this paper also discusses how **policy decisions** oriented to compassion and care can increase the wellbeing of a society. It is widely ascertained that helping others is also closely connected with wellbeing for the helpers [Seligman et al, 2006] (except when this is "mandatory" as in caregiving for a family member) [Kahneman and Deaton, 2010], indicating that caring for others is for the greater good. Unemployment is another example: the effect of unemployment is not only much higher than the loss of income, but it affects the employed as well, so that everybody is damaged by unemployment (or by jobless recovery from a crisis) [Helliwell and Huang, 2011]. Even compassion-oriented policies are known to help society flourish: For example, turning prisons into life schools had dramatic effect in the quality of life of the society by reducing recidivism for the inmates [Helliwell, 2011].

A separate but important line of research involves the understanding of the relationship between **happiness and loneliness**, where loneliness is defined as "the discrepancy between a person's desired and actual social relationship" [Masi et al, 2011]. The most important line of work here is that by Cacioppo, whose team studied the topic extensively. In [VanderWeele et al, 2012] the authors emphasize that intervention to mitigate loneliness have a positive impact on subjective well-being when measured one year later. Cacioppo's team proceeded to perform a meta-analysis of work in the area [Masi et al, 2011]. First, they observe that loneliness is a widespread problem at all ages and becomes particularly severe from 55 and above, and that loneliness causes a quicker cognitive decline. Furthermore, loneliness is almost "viral" in that it "infects" those who tend to spend more time with generally lonely individuals. Several methods proved to be useful in reducing loneliness from increasing the opportunities for social interactions to addressing maladaptive cognition, the latter being the most effective. However, as the paper observes, and as all studies in the area also remark, study samples were often small and the cohort was not a randomized one, so that a deeper look into this matter is needed.

3.2 Impact of Emotional Wellbeing on health and active ageing

The relationship between health and happiness is the subject of many studies, but with very few definitive results.

In general, life dissatisfaction is a predictor of hazardous behaviours such as alcohol use and smoking, and lead to a higher chance of injury death, including unintentional injuries [Koivumaa-Honkanen et al, 2002].

Diener and Chan [Diener and Chan, 2011AP] provide a comprehensive overview of dozens of studies on the topic. What **seems** to emerge is the presence of a causal relation between positive affect and a reduced occurrence of certain diseases, specifically coronary diseases. The correlation appears to be weaker when negative affect is considered (that is, the search for a correlation between a higher negative affect and higher incidence of diseases is inconclusive). Furthermore, the authors observe that they are “not able to draw strong conclusion about which specific types of feelings are most related to health”. Indeed, the interesting aspect in this area is that the number of (longitudinal) studies is very high, but the results are sometimes conflicting. Cohen and Pressman [Cohen and Pressman, 2006] provide a review of studies with a particular focus on elderly population. A very interesting finding in this case is that a correlation has been found between health and happiness in independently living older adults, but not for adults living in assisted living structures.

People also perceive the relationship between happiness and health. For example, a qualitative study reported in [Kaplan et al, 2012] showed that participant saw a strong causal relation between stress and unhealthy behaviours, including in particular eating and sleeping habits as well as smoking.

On the contrary, happier individuals tend to take life-preserving measures. A study of over 300,000 individuals in the US has shown that happier people are significantly more likely to wear seatbelts, and that the effect persists even when taking into account many other variables such as gender, marital status, income, or exercise level [Goudie et al, 2011].

Besides being beneficial in its own right, happiness (and, specifically, frequent positive affect) creates a virtuous cycle whereby happy people tend to perform better in many personal, social, and work tasks. In particular, happiness has a causal relationship with the ability to obtain a satisfying job, to be more social, and more willing to help others [Lyubomirsky et al, 2005].

One of the longest study we are aware of in this field is that of Harvard Study of Adult Development (Vaillant et al, 2007), (Vaillant, 2012), (Vaillant, 2013), that followed 268 adults for many decades, and is still ongoing after 75 years. Among the few studies of 50+ years, this is also one with the lowest attrition. The study draws many conclusions, among which the observation that a childhood more full of love leads to a significantly higher salary (more than double), even when controlling for other factors.

3.3 Positive psychology: Improving Emotional Wellbeing

Positive Psychology is the science of “positive subjective experience, positive individual traits, and positive institutions” [Seligman and Csikszentmihalyi, 2000]. It

contrasts the traditional psychology that in the last century was largely focused on healing from “diseases” and deviations from a model of human functioning.

One of the first studies in this area is the one by Fordyce [Fordyce, 1983], who experimented the effect on happiness of behaviours that are partially under our control, such as lowering our expectations or better plan our time. The study concludes that, overall, practicing these behaviours seem to increase happiness for most individual. The study, although fairly limited in size and duration, began to raise interest in training for happiness.

Positive psychotherapy (PPT) refers to treating depression mainly by building and inducing positive emotions [Seligman et al, 2006]. In one of the first papers on the subject, Seligman and colleagues studied the effect of PPT on moderate and severely depressed young adults. Studies included weekly interventions administered individually or in groups, where subjects were asked to perform positive actions, such as writing gratitude letters or reflecting on good things that happened that day. In all cases, results showed symptomatic improvements with respect to both subjects undergoing traditional therapy and subjects in therapy with antidepressants [Seligman et al, 2006]. Following this approach, a few applications are appearing promoting this kind of daily practice¹, although mostly in religious context and with an effect (in terms of persuasion towards its usage) still unclear.

Schueller and Parks [Schueller and Parks, 2012] studied the effect of “bundles” of positive psychology exercises administered online in a study of more than a thousand persons (mostly female, highly educated, and affluent). This contrasts with most studies where exercises are administered by a therapist. The results showed positive effect also in this case, and the authors observe that small-medium bundles of exercises (2-4) are more effective in reducing depressive symptoms than larger bundles of 6, the latter being not significantly better than the control group.

Many studies show that inducing behaviours and emotions is instrumental to also inducing happiness. A recent review is provided in [Lyubomirsky and Layous, 2013], reporting on and summarizing a number of experimental studies. Specifically, the paper show that people practicing grateful thinking, writing grateful letters, counting blessings, or performing kind actions become significantly happier. The paper also discusses the observation that varying such activities, being aware of their benefit, and enjoying those results in a larger effect. One of the main issues pointed out by the paper is the lack of thorough studies on which kinds of activities impact which kinds of people as activities, activity schedules, and individual personality mean that the positive effect can vary from person to person and based on the activities and their schedule in a manner which is yet to be understood.

Algoe and Fredrickson [Algoe and Fredrickson, 2011] report on their studies on the importance of positive emotions for achieving emotional resilience observing that, although negative emotions are necessary, increasing the duration and frequency of positive emotions contribute to a better mental and physical health.

¹ See, e.g., Count Your Blessings, available at <https://itunes.apple.com/gb/app/count-your-blessings/id597684662?mt=8>

The effect of religion and religious practices on happiness is highly debated, and the results are controversial. Some authors report a positive causal correlation between religion and health and wellbeing [Young and Koopsen, 2009]. Other authors study and argue that the effect might be in part linked to increased social support and *compassion* [Steffen and Masters, 2005]. Vaillant, again from the Harvard Study on Adult Development, does not confirm that increased religious involvement leads to better health [Vaillant et al, 2007]. The authors suggest that this might be due to the fact that most studies on religion are based in the more religious US states where non-religious are social outliers.

3.4 Trends in Technologies and applications for Emotional Wellbeing

In the previous sections we have seen some correlates or determinants of (un)happiness. We now see trends in research and in technology for improving life satisfaction and subjective well-being. We will not repeat the demographic trends, as they are discussed in earlier in this document, and we also do not discuss “care” trends, as we do not take the perspective of curing a disease here but that of improving ones emotional states.

There are essentially two kinds of trends here: trends for measuring happiness and trends for improving happiness. Both of them are likely to see an increasing participation of information technology in the coming years.

3.4.1 Trends in IT for self-reported measures of happiness

Over the last decades, happiness has been measured through questionnaires administered in paper or electronically, essentially through survey software. Lately, however, the availability and wide use of smartphone and sensors have begun to make new opportunity flourish, both in terms of scale and in terms of what is measured

There is a clear trend in measurement that aims not so much at asking if a person is happy but at providing the person with frequent measures to enable correlation with their life habits and attitudes. And for this, ICT is essential.

This trend is embodied in several recent applications. The most widely known, and most relevant for this effort, is *trackyourhappiness* [Track Your Happiness, 2014], who explicitly aims at measuring activity and wellbeing via a smartphone app, and at finding correlations. The interesting aspect of this application is that it provides for a continuous tracking of one’s happiness and it correlates it with what one is thinking, showing that people focused in the present moment are more likely to be happy.

Mappiness [Mappiness, 2013] takes a similar route, though the focus here is in identifying with whom you are more likely to be happy.

The Mobile Territorial Lab (<http://www.mobileterritoriallab.eu/>) is an ongoing effort which, among other goals, aims at correlating happiness with spending patterns, to then be able to guide people in spending money on what makes them feel good.

This trend is likely to continue. However, so far it has been mainly helpful to shed light on correlates of happiness but it has not yet proven or even indicated that it can change people's behaviour to achieve greater happiness.

3.4.2 Trends in IT for inducing Emotional Wellbeing

Smartphones measure self-reported happiness and require interacting with the device relatively frequently. A different trend includes measuring aspects of one's body or behaviour automatically, by means of sensing devices.

An example of this is Spire (<https://angel.co/spire>), which is essentially a sensor that measures stress that feeds data to a smartphone or computer. The goal here is to control stress through controlling breathing patterns and hence improve wellbeing.

We expect this kind of technology and solutions to grow in the coming years as they are relatively non-invasive and can provide feedback (e.g., request to control breath) in various ways that do not require user initiatives but that are pushed to the user. Breath is just one aspect of controllable behaviours that increase wellbeing, and we expect similar technologies to permeate other controllable parameters and habits.

3.4.3 Non-ICT Trends in emotional wellbeing

We have seen above how ICT can help improve wellbeing. Besides ICT, science is undertaking an increasing number of large studies dissecting the nature and causes of happiness. The wider availability of measures, coupled with growing awareness of the importance of this research, is providing insights at a pace faster than ever.

However, what is interesting here is the trend that is manifesting related not so much to understanding which behaviours increase happiness but rather

1. Why, even if it is known that certain behaviours are more likely to make us happier (e.g., donating money rather than buying shoes), we do not follow them, and
2. If there is a greater understanding of attitude to life or way to think and approach life that can be attained and that leads to greater happiness

This trend builds on top of the "spot" approaches on "I tell you how to be happy right now" which seem to work in the short term but for which is unclear, at the moment, their long term effectiveness.

4 Foresight Results

4.1 Trends

This section summarizes the trends described in this report. For a more thorough explanation see the respective subsections in Section 2 and Section 3.

4.1.1 Trends in Mental Wellbeing

1. The desire to assist people to live independently at home is very prominent. This is done by identifying potential mental problems early and to supply support technology or home-service care to overcome some of the problems resulting from a declining mental health.
2. Remote care is increasingly popular, including self-care, self-awareness, and remote communication with carers. To achieve this, a plethora of monitoring and warning devices are utilized, such as fall-detection, digital fence, and activity detection.
3. ICT support aims at helping the user improve and engage in physical, social and mental activities. These activities are crucial in preventing or slowing mental decline and support comes primarily in the form of training devices, monitoring devices, and coaching services.
4. Increasing the awareness through information about the disease is a common first step in the treatment. Learning that physical activity, social activity, mental activity, sleep quality, and diet are all important to maintain mental health may help a person make healthy lifestyle choices. ICT solutions, such as discussion forums and real-time information support, are being deployed to support increased awareness.

4.1.2 Trends in Emotional Wellbeing

1. Technology is used to detect emotional state and to provide feedback to the user, primarily for the purpose of helping the user correlate their perceived feeling of a day with the observed emotional state. This helps the user identify healthy social connection and healthy behaviour.
2. New non-invasive technologies are being deployed for measuring the emotional state. Self-reporting solutions are quite common, but new solutions, such as those measuring breath, are on the rise.
3. Research into the causes of happiness is increasingly popular, perhaps due to the advertisement and marketing potential. However, compliance to some recommendations that would increase happiness seems to be difficult to achieve and short-term rewards have an unclear long-term effect.

4.2 Challenges

This section summarizes the challenges described in this report. For a more thorough explanation see the respective subsections in Section 2 and Section 3.

4.2.1 Challenges in Mental Wellbeing

- Capturing the mental state of elderly people
 - Normal/abnormal behaviour
 - Progress of cognitive functions
 - Understanding of intentions (for proactive support)
- Providing support for mental function (particularly memory)
 - Assisting
 - Exercising
 - Therapy
- Dealing with comorbidities
- Unobtrusive and natural interaction
 - Dialog systems
 - Facial expressions
 - Emotion detection

4.2.2 Challenges in Emotional Wellbeing

- On the emotional wellbeing side, the biggest challenge lies in understanding the discrepancy between what seems to drive human behaviour and choices (the need for status in society) with what actually makes us happier at least in terms of positive/negative effect, which is only marginally related to status in society. There appear to be a disconnection between what genetic selection has done and that drives (or, that has selected) our behaviours and what emotional wellbeing is and needs.
- Another challenge here is related to the breadth and length of the studies being undertaken. Nearly all studies complain that the cohort selection is somewhat biased and that the study is not long or detailed enough to draw definitive conclusions. This is also true of the smartphone-based studies, which always have a bias at the start as the cohort is often composed of people able and willing to use smartphones and curious/willing to experiment/understand their happiness patterns.
- We add a challenge specifically on elderly, which are often neglected in terms of emotional wellbeing, perhaps because studies on older adults are often more difficult. The problem here is that most research, including IT research, does not seem to be aware of what older adults need, emotionally. Studies focus on health and try to “keep people alive”, or off the healthcare system to reduce costs. Very little research is done on what makes older adults happier, and there seem to be the unstated but implies (and totally unverified assumption) that what makes elderly people happy is different from what make younger people happy. Understanding these aspects is a major challenge for the work on emotional wellbeing for an important and growing segment of the population.

4.3 Recommendations

1. Identify the real needs of elderly people through proper studies involving the real stakeholders, meaning older adults, to understand what they need to stay emotionally and mentally fit
2. Support the caregivers: caring for an older adult is one of the most stressful activities; in fact it ranks just below severe headache. We need to develop all possible means to reduce the burden on the caregivers while keeping the human contact that the elderly (like everybody else) seem to need.
3. Overcoming reluctance of elderly to address their mental health and start using ICT solutions. This can be achieved by developing technology that is not just functional, but that, as its number one goal, blends nicely with a person's lifestyle, daily habits, and one owns sense of pride and beauty.
4. Focus on self-care and preventive health.
5. Identify Intention and emotion aware solutions for true companionship and support

General and crosscutting recommendations are to make sure that when studies and products are developed, the largest possible number of team members spends time with the elderly to get a better understanding of the needs; getting rid of what are often implicit assumptions that do not find correspondence in reality.

5 Conclusions

With an increasing elderly population and mental and cognitive problems on a rise it is increasingly important to support mental and emotional wellbeing. Early misconceptions would have us believe that there is little that can be done to avoid mental decline because of the continuous death of neurons. However, findings show that the brain contains vastly more neurons than die through our lifetime, and neurogenesis continuously grows new more neurons. The cause of cognitive decline is therefore much more complicated and depends on many factors. Some of these factors are prominent aspects of everyday life, such as physical, social, and mental activity, sleep quality, and diet. Making healthy lifestyle choices based on the knowledge of the contributing factors can help slow, or even stave off, cognitive decline.

Being able to keep people healthy is of course a primary goal, however if a person does develop cognitive impairment there are a number of support solutions that can help the person live independently at home for a longer period of time. A number of monitoring devices exist to help ensure that the person is safe, and to help identify when new problems caused by the mental decline arises. Sometimes the technological support that is necessary can be a very simple and inexpensive device that would both help improve quality of life for the person, and save a lot of money for the healthcare. The same is of course true for making healthy lifestyle choices that will help slow the mental decline.

Informing the person in the risk of developing, or already suffering from, cognitive decline, about healthy behaviour is important. The research to develop technology for providing feedback and for visualizing the person's behaviour is therefore crucial. This technology is often required to achieve other support systems, such as coaching services, recommender systems, and intelligent monitoring and warning systems. From an ICT standpoint this should be the most important activity while aiming for increased self-care and improved independence for people suffering from cognitive impairments at home.

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