Assistive Technologies for People with Dementia: Personal Review

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Table of Contents (Simple Version)

Key Words; Memory, dementia, Alzheimer, ICT, Computer, Technology, rehabilitation, Robots

Note: The following personal review was edited by Kiyoshi Yasuda as my studying note. Therefore, the English grammar and expression style have not been checked by natives. Most of article cited in this review were published until 2016. The cited parts are longer than those of normal reviews. I appreciate the authors which I cited. The table of contents (detailed version) is attached at the end of this files.

I uploaded this review on my home page for interested readers to overview the literature on this theme. If you are interested in the articles cited in this review, be sure to refer to the original article. When you cannot find the articles, please try to find it on search engines such as Google Scholar.

I have written a book named "The rehabilitation for dementia and MCI: Daily supports by assistive Technology" in 2018 in Japanese. This book will be going to be translated and published until the end of 2022. So, if you are interested with my studies, see the details in the translated book.

Preface

It is estimated that approximately 100 million people will have dementia by the year 2050. More than 50% of people with dementia live at home. Although most people live with a spouse or other family members, the people with dementia who live alone is rapidly increasing.

Dementia usually starts with a progressive decline in memory function. Dementia symptoms vary greatly from forgetfulness to incontinence, wandering, etc. At an advanced stage, people with dementia are no longer able to take care of themselves and require assistance to perform even simple daily activities. Because dementia inevitably increases with aging and there is no complete cure, specifically for the degenerative type of dementia, i.e., Alzheimer's or Pick's disease, the most promising way to provide relief is to assist them in their daily lives.

Memory loss is the main symptom of dementia. These memory disorders manifest as deficits in information storage, inability to retrieve information, and failure to make effective use of the information. For example, a person who is no longer able to retrieve location information for the toilet or home develops incontinence or wandering. The first thing that we should do for such individuals is provide them with the necessary information where and when needed.

Assistive technologies (ATs) can facilitate provision of information. AT is a compensatory rehabilitation approach to maintain independence, manage potential risks, and reduce stress on caregivers in their daily lives. Because people with dementia often demonstrate various memory impairments and behavioral psychological symptoms of dementia (BPSD), various types of ATs are required.

ATs help people through both low- and high-tech interventions. Low-tech interventions can be classified into daily tools (e.g., diary, memo-pad, and calendar) or commercially available electronic devices (e.g., timer, tape recorder, and telephone). Although low-tech interventions or memory aids involve relatively simple equipment, they are practical, easily applicable, indispensable, and can be continuously used. People with dementia face a great number of problems. However, the number of reports on memory aids is still quite limited, especially for home-living mild and moderate dementia.

As a speech and language therapist, over the last 30 years, I have been involved in the evaluation and rehabilitation of people with dementia or memory impairments. I have developed various memory aids (e.g., bracelet-type note pads and special diaries for dementia) and many interventions using electronic devices (e.g., IC recorder and DVD) or information communication technology (ICT) systems. Automatic playback of voice instructions and music using an IC recorder has been shown to successfully relieve BPSD, including wandering and agitation. Introduction of these

memory aids and interventions will contribute to enrichment of the AT field, especially for people with mild/moderate dementia living at home.

Majority of older adults wish to live at home for as long as possible. High-tech interventions are also promising in enabling continued independent living. High-tech devices include computers, robots, safety monitoring, and conversation system, and aim to maintain communication and social contact as well as independent living.

I have also collaborated with many engineers to develop various high-tech intervention systems to support daily lives and communication for people with dementia. Conversation mediated by remote videophone considerably enhances psychological stability and reduces BPSD in some cases. In addition, we have invented a toilet-assistance system, a wandering-prevention system, a virtual-agent conversation system, and robots designed to search for lost items. Furthermore, I have proposed the concept of an assistant dog to wear ICT devices and help people with dementia.

Based on our empirical experience, this review will overlook various practical and promising studies, regardless of whether or not the studies are based on randomized controlled trials (RCTs). I hope that through reading this book, readers will be able to find clues to develop smarter and more effective ATs.

To date, many engineers have proposed various high-tech intervention systems. However, from a clinical point of view, they are often difficult to adapt to daily situations. Through this review, engineers will come to know many practical cases of high-tech interventions for people with dementia and will be encouraged to develop interventions quickly and with efficient perspectives. Furthermore, this review may inspire professionals in other fields, such as animal trainers, dressing/interior designers, and social entrepreneurs, who rarely participate in assisting dementia, to take interest, which will lead to a wider interdisciplinary development of ATs.

People with dementia show decline in abilities with disease progression. Therefore, AT must be strengthened, modified, and changed to maintain the quality of life at each stage of the disease. The continuation of collective efforts to improve ATs will enable people with dementia to make full use of their remaining capacities.

Chapter 1 Memory and Memory Impairments

1.1 What is Memory

Memory is essential to human experience: Memory is essential to the human experience, allowing us to integrate our past into who we are today and to imagine what we might be in the future (LaVoie & Cobia, 2007). Beyond controversy, memories have a great a great significance to human function. People later in life face a gradual loss of memory function. People are losing the ability to store new memories. This memory impairments are common in elderly people and is often related to the devaluing aspects of the social environment.

1.2 Classifications of memory

Baddeley's Theory: A popular theory speculates that memory is organized into encoding, storage, and retrieval processes (Baddeley, 1995; Bourgeois, 2007). Information to be remembered has to enter the system through the senses (visual, auditory, tactile etc.), then is held temporarily in a working memory or short-term memory place. In this holding area, the information is checked and comprehended. Long-term storage is thought to contain declarative (such as episodic, and semantic memory), and non-declarative or implicit memories (such as skills and habits acquired with practice).

Episodic memory: Episodic memory is defined as memory for personal experiences which are dated and located in subjective time and space (Tulving, 1972, 1983; Tulving, Schacter, McLachlan et al., 1988; Yasuda et al, 1997) (eg. remembering your high school graduation or what you had for dinner last night). Damage to the underlying brain structures disrupts one's ability to accurately recollect the events of one's past and encode new episodes (LaVoie & Cobia, 2007).

Function and Lesion of Episodic Memory (Yasuda, 1997): The frontal lobe or the basal forebrain are implicated with the following functional aspects of episodic memory: Appreciation of time-sequences, contextualization of the experience, retrieval of the context for each experience, and recollection of how an episodic memory was acquired. Recently, the precuneus, the splenial, the retrosplenial, the posterior cingulate and the diencephalic regions were also suggested as participating in a network with a distinctive role in episodic memory

Semantic Memory: Semantic memory consists of general knowledge about the world acquired through the media, education, and other sources of information (eg, knowing that tigers, but not leopards, have stripes). According to Tulving (1983), it includes memory for faces, melodies, topography, knowledge of language, and so on. Semantic memory is abstract and lacks associations to a learning context.

Impairment of Semantic and episodic memory: Evidence supporting the dissociation between episodic and semantic memory is rich, coming from researches done with amnesic patients (LaVoie and Cobia, 2007). This is exemplified by a patient (Fujita, Ishikawa, Kumakura et al., 1991) who mistook a TV scene for an event that had actually occurred, and in which he was personally involved. Although the content of TV or movie scenes would be classified as semantic memory, the patient misclassified them as his own episodic memory. In memory acquisition, strategic mediation by the frontal lobe is required (Yasuda et al., 1997).

Working Memory (LaVoie & Cobia, 2007): In contrast to the episodic and semantic memory systems, which refer to long-term memory systems, working memory refers to an memory system responsible for short-term storage of information used for cognitive processing activities. While this system can be compared to earlier notions of short-term memory (STM), it is a much more complex system as facilitator of higher order cognitive activities. This system exists both to support the maintenance of task-relevant information and to engage the appropriate processes during cognitive task performance. For example, the ability to perform multiplication problems (eg, 173 × 42) requires the ability to hold the information in memory while also carrying out processes on those items.

Anterograde Amnesia (Bauer, 2008): A profound defect in new learning is called anterograde amnesia. The essential deficit is that that patient is impaired in deliberate recall of information initially learned after illness onset. Such patients may fail to recognize or learn the names of newly encountered persons. They may appear disoriented in place or time because they have failed to learn their location or have lost the ability to monitor. Amnesic patients are frequently capable of tracking routine conversation, but their deficit becomes obvious when they are asked to recall an event that occurred only hours or minutes before.

Prospective memory: The ability to remember to carry out tasks in the future has been termed prospective memory (Sohlberg & Mateer, 1989). This kind of memory impairment is the one most frequently experienced as problematic by amnesic patients (Yasuda, 2002).

Retrograde Amnesia (Bauer, 2008): The amnesic patient usually also has difficulty in recalling information learned prior to illness onset, an impairment that is often worse for relatively

recent events than for events that occurred in the remote past. Retrograde amnesia is forgetting the previously acquired semantic knowledge or autobiographical (episodic) memory.

Source Amnesia: In source amnesia, recollection of the informational source of a memory item is lost despite intact item (content) memory. For example, we might remember specific information about a book or movie but be unable to recollect where that information was learned (Bauer, 2008). The content and source of recollected information are potentially dissociable (Shimamura & Squire, 1987).

Meta-memory and "Feeling of Knowing": Hirst & Volpe (1982) reported the meta-memory program in Korsakoff patients. The most widely studied meta-memorial capacity in amnesic patients is the feeling-of-knowing (FOK) phenomenon. In a typical FOK experiment, subjects are asked to freely recall the answers to general questions of varying difficulty (e.g., "What is the tallest mountain in Japan?") until a certain number of failures occur. For these unrecalled items, subjects are then asked to judge the likelihood that they would be able to recognize the correct answer if it was presented. FOK predictions are then evaluated by a subsequent recognition test (Bauer, 2008).

Basal forebrain amnesia: This Amnesia would occur due to basal forebrain lesions in the anterior communicating artery. Some authors have described impairment in placing memories in proper chronological order ((Damasio, Graff-Radford, Eslinger et al., 1985). Confabulation appears to be characteristic, particularly in the acute period (Bauer, 2008).

Procedural Memory (LaVoie & Cobia, 2007): Non-declarative memory refers to a set of systems that cannot be accessed through consciousness, but rather express their contents through task performance. This system has been linked with the concept of procedural memory. Procedural memory is the memory system that supports motor, and perceptual skill learning. This system is characterized by gradual learning (eg, riding a bike, playing a musical instrument). With repetition, the performance of skills can become automatic.

The Semantic Memory Remain in the Elderly (LaVoie & Cobia, 2007): Dissociations have been reported in older adults, with episodic memory consistently showing significant age-related declines, but semantic memory showing little change across the life span. The deficits in episodic memory are linked to deficits in processing context-dependent memories. On the other hand, semantic memory is not a context-dependent system. The processing deficits are likely to have little impact on semantic system function, making semantic memory a relatively stable in old age.

Procedural Memory Shows Little Decline (LaVoie & Cobia, 2007): Procedural memory also shows little decline across the life span. While older adults are slower and less accurate relative to

young adults when performing motor tasks, they do appear to retain new skills over an extended period of time. The procedural memory were well preserved and intact despite the age-associated differences in the amount of time needed to acquire and perform the task.

Age-related Memory Declines: As one effect of age-related cognitive decline, decreased prospective memory may lead to forgetfulness about routine daily activities, Activities of Daily Living (ADLs) and Instrumental Activities of Daily Living (IADLs). ADLs include basic tasks such as eating, drinking, bathing, and toileting, while IADLs include tasks such as managing medicines, managing money, lighting, preparing meals, and so on (Pollack, 2002). Working memory function is particularly sensitive to the effects of aging. Older adults perform more slowly and less accurately than young adults in a variety of dual-tasks (LaVoie & Cobia, 2007).

The Types of Memory to be Impaired in Dementia (Bourgeois, 2007): The types of memory that present challenges in dementia are those that require conscious encoding, or new learning. Episodic memories, such as what you ate for lunch, or the answer to the question you just asked; overlearned or habitual memories, such as walking, playing the piano, or counting to 100, are more resistant to the effects of neurological disease because they have been stored and retrieved repeatedly over a lifetime, often unconsciously and without effort. Retrieval of memories from remote long-term storage is also relatively preserved: caregivers remark that persons may remember details from their childhood.

1.3 Dissociation between Episodic and Semantic Memory

Case Reports of episodic and Semantic memory impairments: Though the semantic/episodic dichotomy has been questioned by several authors (Yasuda et al., 1997), De Renzi et al. (1987) reported for the first time a patient who showed a severe impairment of semantic memory for words, objects, famous persons, and public events in the absence of episodic or autobiographic memory impairment. A similar pattern of deficits was reported by Grossi, Trojano, Grasso et al. (1988). Their patient could not even give a vague definition of pedagogy, the main subject of her school curriculum, but she did recall that she had obtained remarkable grades on it. Yasuda et al. (1997) also report a patient who showed a dissociation between impaired semantic memory and preserved autobiographic memory. Yasuda et al describe patient M.N., who demonstrated significant impairments in the ability to recollect well-known historical events, historical figures, popular proverbs, technical terms related to her profession and other types of semantic memory. She was, however, able to freely recall events from her own past (eg, former boy friends, school field trips). Magnetic Resonance Imaging revealed bilateral lesions in the

temporal lobes and in the right basal frontal lobe. Yasuda et al. (1997) hypothesize that bilateral lesions of the anterior half of the middle region of the temporal lobe plays a crucial role in causing deficits in semantic memory. Similar semantic memory impairments have been noted in four patients with non-progressive brain injury, two with severe head injury, and two with herpes simplex virus encephalitis (LaVoie & Cobia, 2007).

Case Reports with Opposite Pattern: The reversed pattern, selective impairment of autobiographic memory and preservation of semantic memory has also been reported (Damasio, Eslinger, Damasio et al., 1985; Tulving et al., 1988; Dalla Barba, Cipolotti & Denes, 1990). A patient of Tulving et al. (1988) could not recollect any events related to the time he worked at a company, yet remembered the meaning of the technical terms used in his job, whereas general knowledge such as technical terms or the content of a movie Three individuals were described as anterograde amnesia who suffered bilateral hippocampal damage. They all have a severe loss of episodic memory for recently experienced events. Specifically, all three patients report difficulty recollecting the location of objects that they have placed down, require frequent reminders of scheduled appointments and events (LaVoie & Cobia, 2007). Despite this impairment, however, all three individuals are able to acquire factual knowledge (eg, "What is the capital of Italy?"), demonstrating spared knowledge of vocabulary/language, all aspects of semantic memory. The double dissociation described above supports the semantic-episodic memory dichotomy (Yasuda et al., 1997).

Lesion of Semantic Memory: Binder, Desai, Graves, and Conant (2009) analyzed 120 functional neuroimaging studies focusing on semantic processing. These activations formed a distinct, left-lateralized network comprised of 7 regions: posterior inferior parietal lobe, middle temporal gyrus, fusiform and para-hippocampal gyri, dorsomedial prefrontal cortex, inferior frontal gyrus, ventromedial prefrontal cortex, and posterior cingulate gyrus. The expansion of these regions in the human relative to the nonhuman primate brain may explain uniquely human capacities to use language productively, plan, solve problems, and create cultural and technological artifacts.

Lesion and Sub-categorization of Semantic Memory (Yasuda et al., 1997): As to semantic memory, neuropsychological studies have indicated that the right hemisphere plays a predominant role for the following semantic memories (RH-dominant semantic memory): Topography, musical knowledge, memory of faces and various attributes of people. On the other hand, for proverbs, public events, words of songs, low frequency words, etc. are verbally related nature. These memories are likely to be mediated by the LH (LH-dominant semantic memory). Damage to the

anterior half of the middle region (centered on area 21) plays a crucial role LH-dominant semantic memory.

Some researchers suggest that semantic memory is also represented in the prefrontal cortex, and in the parietal lobe. It is important to note that the so far reported case of the semantic amnesia (L.P., T.J., M.N.) did have bilateral lesions. Although some cerebral laterality exists, deficits of semantic memory, including the RH-dominant semantic memory, may require bilateral damage. For instance, semantic memory for idioms may require the LH linguistic processing as well as the RH metaphorical/inferential processing. Bilateral impairment, which means hemispheric inability to reciprocal compensation may result in a severe deficit of semantic memory.

1.4 Evaluation for Dementia, Proper Names and Discourse

Hess, Dieberg, McFarlane, & Smart (2014) found improvements in global cognition (MMSE, ADAS-cog etc) and clinical dementia ratings (CDR). Across all of the studies, the measurements of global cognition were the most robust in terms of detecting significant changes in cognitive performance. It may be that global tests of cognition are inherently the most sensitive to changes in cognitive performance because they take into account numerous cognitive domains.

Anomia for Proper Names: Numerous studies have associated aging to cognitive decline, such as forgetting of proper names of close friends and family (Bonner & Idris, 2012), as well as deterioration in discourse processing, especially of complex information such as text, the thread of conversations/TV programs (Bonini & Mansur, 2009).

Proper names are of practical importance for verbal communication. For instance, they are indispensable for transmission of autobiographical information concerning a person. Yasuda, Nakamura, & Beckman (2000) have revealed that proper names are neuro-psychologically and anatomically processed in a manner which differs from the processing of common nouns. Proper names are labels attached to referents, as being without semantic meaning.

Why are peoples' names difficult to retrieve (Yasuda et al., 2000): Peoples' names were sufficiently comprehended by globally aphasic patients. Curiously enough, they are the most difficult words even for non-brain damaged people to retrieve. This is because proper names are associated with one person arbitrarily. Therefore, peoples' name anomia reflects a general inability in pairing an arbitrary label with a person.

Proper names consist of a one to one combination without intermediating semantic meaning. This combination implies that proper names would receive their activation only from a unique representation of the corresponding person. The single retrieval cue would make peoples' name retrieval more difficult than recall of common nouns, which consists of a one to many combinations.

The experiment of Bredart (1993) supports the one to one hypothesis.

Declining Memory for Discourse: Regarding the relationship between memory and language, most of the studies have evaluated the memorization of word lists. Recent research in older listeners have revealed difficulties when engaged in complex tasks involving the auditory processing of naturalistic signals in realistic environments (Bonini & Mansur, 2009). Tasks affected include discourse activity in conversation or following a story in a book or on television, in which recognition, comprehension and storage of the material is impacted. The retention and comprehension of discourse involves diverse mechanisms. On the other hand, retention and comprehension of information from a discourse requires the participation of working memory in multiple degrees of processing such as lexical, syntactic or semantic, in order to obtain the sense of the discourse. The complexity of the task in natural situations involves additional challenges, because frequently events occur in situations of time pressure, as is the case with the news on the radio, in which the broadcaster transmits the message in a sequence of chained facts.

Memory for Single Radio News (Yasuda, Hasegawa, & Ono, 1990): Discourse comprehension involves a multiple level of processing such as lexical processing, syntactic analysis, and thematic analysis to yield a representation of the meaning of the discourse. Concurrent storage of that representation is also required. The most important finding of Yasuda et al. (1990) may be that aphasic subjects have been found to comprehend discourse better than they comprehend sentence stimuli. Sufficient comprehension of discourse by the aphasic subjects also imply a preserved ability to store the representation of discourse. Psychological research claims that the ease of comprehension and storage depends on the resources (or capacity) available in working memory (Daneman & Carpenter, 1980; Light & Anderson, 1985).

Memory of Serially-presented Radio News (Yasuda, Nakamura, & Beckman, 2000): Sixteen mild aphasic subjects, eight age-matched normals, and eight younger normals listened to a single radio news story and four serially presented radio news stories. Half of the aphasic subjects performed as well as age-matched normals in a single-news-story comprehension task. However, they demonstrated a drastic deterioration in performance when asked to listen to a series of four news stories. Age-matched normals, and aphasic subjects, to a lesser extent, showed an impairment in the comprehension and storage of the news story heard last in a series of four news stories. It was shown that discourse retention seems to obey hierarchic importance with the main ideas occupying higher levels and details at the lowest levels. It was also noted that when comprehension and storing

of information are simultaneously solicited in a task, aging presented preservation of comprehension yet loss of storage. These results were discussed in terms of the comprehension and storage resources of working memory (Bonini & Mansur, 2009).

Story recall was impaired in the left hemisphere damaged patients (see Frisk & Milner, 1990 for review). An issue to be explored is whether the discourse employed in the above-cited studies might have been still too simple or too short to reveal aphasic subjects' deficits. A remaining experimental issue is, therefore, whether aphasic subjects could maintain sufficient comprehension if they were exposed to longer discourse. We are likely to encounter serial discourse in daily life. For example, about four radio news stories are usually broadcast in a five-minute radio news program.

A large number of studies have examined the position effect on word-list recall (see Greene, 1986 for review). In the only investigation on discourse-list recall, the recency effect predominated over the primary effect (Tannenbaum, 1954). The Age-matched Subjects demonstrated a significant decline in comprehension of the news story in the last position, revealing a superiority of the primary over the recency effect. The High-Aphasic Subjects also displayed the same tendency, albeit less reliably. Conversely, the Younger Subjects showed a relatively better performance for the news story in the last position, thus suggesting an age-related difference in patterns. The classical primary, or short-term memory system models (see Greene, 1986 for review) appear to be inadequate for explaining the position effects described here.

The presence of an age-related reduction in working memory resources has been suggested (Salthouse, Mitchell, Skovronek et al., 1989). When comprehension and storage were concurrently required in a task, the elderly demonstrated preservation of comprehension while their storage was impaired (Cohen & Faulkner, 1981; Zacks & Hasher, 1988; Foos, 1989; Foos & Wright, 1992). The same may be said with regard to the Age-matched Subject's scores on the serial condition. Why did the High-Aphasic Subjects demonstrate both comprehension and storage deficits in the serial condition? The age-related reduction in working memory resources may be aggravated by a decrease in available resources as a result of brain damage (Daneman & Carpenter, 1980; Miyake, Carpenter & Just, 1994; Martin, Shelton & Yaffee, 1994).

Memory for 30 min. Discourse (Yasuda, 2003): There is a need to understand the abilities of human being in real and natural settings. Radio or TV news stories are among the most typical kinds of popular discourse in daily life. Yasuda et al. (2000) investigated the comprehension of four serially-presented radio news stories, and a single radio news story by normal people, or people

with mild aphasia. The next issue to be explored is whether the four news stories employed in the above study might have been still too simple or too short to reveal our comprehending abilities, since we often listen or watch spoken discourse or movie more than one or two hours long.

People with aphasia, or MCI, even middle-aged people sometime complain of difficulty to comprehend long novels, hour-long TV programs such as documentary film or, drama etc. Such hour-long materials may be more difficult to comprehend than serially presented radio news stories. Until now as far as we know, the six min. materials of four radio news stories was the longest materials which have been used to test comprehension ability of human beings. However, testing by using one-hour materials is difficult to perform in normal training session in our hospital.

Therefore, we tried to investigate the comprehending ability of 30min. discourse by normal people and people with aphasia. In order to evaluate the comprehension of long discourse, three kinds of participants (younger normal, senior normal and people with mild aphasia) were presented of 6 min. and 30min. discourse. And the following two main abilities were explored: 1) Compared to 6 min. news stories, to what degree are 6 min. discourse comprehended? 2) Compared to 6 min. news stories or discourse, to what extend are 30min. discourse comprehended by three groups.

We expected the performance of 30Min.discourse wild be worse, compare to 6Min.discourse. the 30Min.duiscourse is 5 times of 6Min.discourse, require more resources to comprehend and store the contents. Unexpectedly, the declining of scores 30Min.discourse was minimal in the two normal groups. The mild aphasic subjects only showed 5% decline. Compared to the serially presented news stories, people are suggested to be comprehending the 30Min.discourse very sufficiently.

As for the position effects within the 30Min.discourse, the score of the last position in two normal subjects group was slightly higher than those of the first position. On the other hands, mild aphasic subjects' group did not show this trend.

In order to comprehend discourse, working memory are required. Yasuda et al.(2000) proposed the discourse processing model, consisting of comprehension resources and Discourse storage resource unit (D unit). In comprehending serially presented news story, normal elderly people can maintain comprehension resources, while their D unit are declining its resources resulting poor performance of the last news.

The discourses used in this study were the freely spoken episodes. The contents were very redundant, the episode occurred in the same context. The information included was not much. On the other hands, the news story was spoken on written texts, in which the information is tightly packed, and each news are unrelated each other.

As the results of this study, capacity of D units is depending on the information quantity or

density per time or a given length of time. The 30Min.discourse in this study, information density was low, therefore the last part declining was not observed. We need to explore the criteria to measure the density of information in a discourse. By using this criteria, we can forecast the comprehension and storage level of people in future.

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Chapter 2 Dementia, and Assistive Technologies

2.1 Symptoms of Dementia and Pharmacologic Treatment

Number of Dementia Patients: With advances in medical technology, the average life expectancy of world population is increasing. Since the probability of becoming cognitively impaired increases with age, one side effect of increasing life expectancy is the emerging number of dementia patients（Huang et al., 2014). It is estimated by the year 2050 that 115.6 million people globally will have dementia (Fernandez, Arthur, & Fleming, 2013). Approximately 60% of people with dementia live in their own homes, generally with a spouse or other family member as their carers (Bonner & Idris, 2012). There has been a fundamental shift in healthcare policy in many first world economies to encourage and facilitate people with dementia to live longer at home, on the provision that their care situation is appropriate to need (Carswella, McCullagha, Augustoa et al., 2009).

Type of Dementia: The International Classification of Diseases, 10th revision (ICD-10) describes dementia as a syndrome typically characterized by chronic, often progressive disturbances in higher cognitive functions including memory, thought processing, orientation, comprehension, calculation, learning capacity, language and judgment (WHO, 2009; Yuill & Hollis, 2011). There are several etiologies for irreversible dementia such as Alzheimer's disease, vascular disease, Lewy Body disease etc (Hopper & Bayles, 2001). The most common types of dementia are Alzheimer's disease (AD) and vascular dementia (VaD) (Alzheimer's Society, 2009). According to the ICD-10, AD is a neurodegenerative cerebral disease with unknown etiology (WHO, 2009). It is primarily characterized by the accumulation of neurofibrillary tangles and amyloid plaques that damage neurons, altering brain function. The ICD-10 defines VaD as a progressive vascular disease resulting in small infarctions that have cumulative effects on brain function (WHO, 2009). The distinction between AD and VaD is not always clear. Most authorities consider the second most common etiology of dementia to be a coexistence of these two disorders known as mixed dementia, as pure VaD is uncommon (Patterson & Clarfield, 2003). Frontal lobe dementia affects mood which can lead to aggression and inappropriate behavior. Dementia with Lewy bodies is characterized by hallucinations, and muscle tremors and stiffness. Other forms of dementia include Creutzfeldt-Jakob disease (CJD), Huntington’s disease, alcohol-related brain damage, and HIV/AIDS related dementia (Yuill & Hollis, 2011).

Pharmacological Treatment for Dementia: There are currently no treatments to reverse the course of dementia. However, pharmacological treatment do achieve a slowing of the impairment (Carrion, Aymerich, Baillés et al., 2013). Acetylcholinesterase inhibitors aim to improve the

cognitive symptoms of AD and mixed dementia; however, the efficacy of these treatments remains limited. Recent systematic reviews on the use of acetylcholinesterase inhibitors have indicated that clinical trials tend to report small effects sizes; there is a lack of demonstrated clinical importance of such drugs, and evidence that they improve quality of life remains inconclusive (Qaseem et al., 2008; Rodda & Walker, 2009, Yuill & Hollis, 2011).

Pharmacological Treatment for BPSD (Fernandez, Arthur, & Fleming, 2013): BSPD has been suggested that over 50% of patients with dementia will experience behavioral and psychological symptoms of dementia (BSPD). Symptoms can include agitation, wandering, altered sleeping patterns, disinhibited behavior which may include inappropriate sexual behavior and harmful behaviors such as aggression. People with dementia exhibiting BPSD have some universal emotional needs that are often not fulfilled. These needs include: (1) being needed and feeling useful, (2) to be able to care for others, (3) having an increased sense of self-worth, (4) to love and be loved, and (5) to be able to convey their emotions without inhibition (Fernandez, Arthur, & Fleming, 2013).

BPSD is frequently treated with pharmacological interventions with antipsychotic medications being the treatment of choice. Concerns with the use of these medications include the risk of mortality, their side effects and their effectiveness in relieving Behavioral and Psychological Symptoms of Dementia (BPSD). Extra pyramidal symptoms, falls, gait disturbances, sedation, tardive dyskinesia and cerebrovascular incidents have been widely reported in literature associated with the use of antipsychotics for people with BPSD. Living with dementia is not only distressing for the patient when they experience BSPD, it also has a negative impact on the quality of life of their carers. Evidence-based guidelines have therefore been developed to advise on prescribing requirements for these drugs (Fernandez, Arthur, & Fleming, 2013). The clinical value of pursuing non-pharmacological options as a first line approach is becoming increasingly recognized (Yuill & Hollis, 2011).

Symptoms and Progression of Dementia: Dementia, often referred to as a disease, is a process of transition from a healthy, active state to a dependent state with progressive loss of memory, functional skills and independence (Fernandez, Arthur, & Fleming, 2013). They cause a gradual deterioration in a wide variety of cognitive domains. Initial symptoms of dementia are subtle memory loss and forgetfulness, which progress to profound memory loss, cognitive dysfunction, and behavioral and emotional disturbances (Yasuda, Beckman, Yoneda, Yoneda, Iwamoto, & Nakamura, 2006). Memory Problems: loss of memory, particularly short term; forgetting of names of close friends and family; inability to recall the names and operation/purpose

of devices and objects. Forgetting to eat, drink and take medication (Bonner & Idris, 2012). Wellbeing Related Problems: anxiety and even depression due to forgetfulness; confusion and disorientation in relation to the surrounding environment; anger and frustration.

People with AD lose the ability to store new memories, this impacts very directly upon their ability to participate in, and contribute to, a normal conversation. A fundamental problem for people with dementia, subsequently their caregivers, and relatives is the 'dehumanizing' effect engendered by this cognitive impairment (Gowans, Campbell, Alm, Dye, Astell, & Ellis, 2004).

Mild Cognitive Impairments (MCI; Hess, Dieberg, McFarlane et al., 2014): MCI, which is often a prelude to dementia, is also associated with disproportionate atrophy in the medial temporal and temporal cortices. The severity and extent of dementia-related atrophy increase as a function of time, destroying cognitive and functional abilities at each stage. This damage is irreversible and devastating to both the individual sufferers and their families or carers.

The Early Stages of Dementia (Clare & Woods, 2003; Yuill & Hollis, 2011): The early stages of dementia include difficulty learning, decreased ability to form new memories and significantly impaired episodic memory, whereas other types of memory such as semantic memory and procedural memory may remain relatively intact or mildly affected. For individuals with mild to moderate dementia, memory and cognitive difficulties often result in personal factors such as anxiety, depression, decreased self-confidence or motivation and withdrawal from activities.

The Mild to Moderate Stages of Dementia: In the mild to moderate stages, functional changes influence activity engagement; however, individuals still have some ability to learn new information or skills given the appropriate environmental conditions, support and patience (Clare&Woods, 2003). The severe stage consists of profound physical symptoms such as incontinence, significantly limited mobility, extremely impaired communication and dependence on others for all activities of daily living (Yuill & Hollis, 2011).

2.2 Evidence of Dementia Prevention theory & Brain Activation theory

Currently, there is no cure for dementia; therefore, it is paramount that researchers identify behavioral interventions that can prevent, attenuate, or impede the progression or genesis of this condition (Hess, Dieberg, McFarlane et al., 2014).

Can physical Exercise Prevent Dementia: Some types of exercise can have a beneficial influence on affective behavior. An exercise program seems to have a positive impact on mood. Studies examining the effects of physical activity on sleep were few but showed positive effects on both sleep quantity and quality, particularly in people with mild sleep disturbance. The exercise group showed improvements in stress-induced cardiovascular reactivity and self-reported sleep

quality (Eggermont & Scherder, 2006). Physical activity that targets cardiovascular fitness may offer neuro-protective benefits and attenuate the neuronal structural and functional changes that are associated with MCI and dementia. The current literature reports that exercise in midlife by healthy adults increases cognitive functioning in various domains and reduces the likelihood of developing dementia later in life. The literature offers mild support for exercise as an attenuating or stabilizing intervention for certain cognitive domains.

Unfortunately, it is difficult to draw meaningful comparisons about the efficacy of physical activity from the current literature because inconsistencies exist across the studies, in terms of the intervention, neurocognitive outcome measure, statistical reporting method, and disease severity and associated levels of care (Hess, Dieberg, McFarlane, & Smart, 2014).

Evaluation: The spectrum of physical training interventions adopted in these trials included Tai Chi, flexibility, relaxation, balancing techniques, and varying intensities of aerobic exercise and strength training. Unfortunately, the notable variation in the modalities of physical intervention prevented speculation regarding which exercise modality was optimal. More attention and interaction may have influenced their motivation to perform on the tests and influenced the scoring of the global assessments. Because of the considerable variation in physical activity programs, it was not possible to draw any specific conclusions about which physical activity program was optimal. Therefore, future research should use a standardized approach to investigate and comparing the efficacy of different exercise modalities on cognitive performance.

Walking and Etiology of Dementia: Reduced physical activity can be an indirect consequence of dementia since motor function is affected in many of the dementias (Eggermont & Scherder, 2006). For example, in Alzheimer's disease (AD), extra pyramidal 'Parkinsonian' symptoms (rigidity, tremor and bradykinesia) have been observed (Prehogan & Cohen, 2004) and even in their absence impaired balance and reduced speed of walking is reported (O'Keefe et al., 1996; Pettersson, Engardt, & Wahlund, 2002). In Vascular dementia (VaD), walking speed is slower than in AD (Tanaka et al., 1995) and in subcortical ischemic vascular dementia (SIVD), gait disturbances such as decreased step length and gait apraxia with co-existing extrapyramidal symptoms are noted (Román, Erkinjuntti, Wallin et al., 2002).

2.3 Review of interventions and Rehabilitation for Dementia

Non-Pharmacological Interventions: There are currently no treatments to reverse the course of dementia. However, certain treatments, both pharmacological and psychotherapeutic, do achieve a slowing of the impairment, especially with regard to cognitive deficits related to dementia. Patients with dementia exhibit a wide range of cognitive dysfunctions as well as behavioral and

mood changes, and as a result often require an individualized and multimodal treatment plan (Carrion, Aymerich, Baillés et al., 2013). Currently, there is no cure for dementia; The only way to relieve the situation is to assist the daily life of dementia patients (Hess, Dieberg, McFarlane, & Smart, 2014).

Cognitive Training: Research has demonstrated that maintaining a consistent pattern of frequent participation in cognitively stimulating activities is associated with reduced risk of developing dementia (Wilson et al., 2002; Yuill & Hollis, 2011). Regular participation in such activities may play a role in preserving the capacity of the brain to endure and compensate for neurodegeneration. Such a mechanism or "cognitive reserve" was described by Stern (2002) as the degree to which an individual is able to efficiently recruit alternative brain networks in order to optimize cognitive function following brain damage or pathology. Valenzuela and Sachdev (2005) found that higher cognitive reserves were associated with complex patterns of mental activity sustained throughout the life cycle and that increased mental activity in late life was associated with lower rates of dementia.

Interventions that target the cognitive and memory deficits and the associated difficulties with activities of daily living are the subject of ever-growing interest. Cognitive training and cognitive rehabilitation are specific forms of non-pharmacological intervention to address cognitive and non-cognitive outcomes (Bahar-Fuchs, Clare, & Woods, 2013).

Randomized Control Trials and Dementia (RCT; Bahar-Fuchs, Clare, & Woods, 2013): RCTs have long been regarded as the highest form of evidence in medical research because of the lower risk of bias associated with them. The present review is an abridged version of a Cochrane Review and aims to systematically evaluate the evidence for these forms of intervention in people with mild Alzheimer's disease or vascular dementia. Eleven RCTs reporting cognitive training interventions were included in the review. However, there is still no indication of any significant benefits from cognitive training. The results of the single RCT of cognitive rehabilitation show promise but are preliminary in nature.

Review of Dementia Rehabilitation: Rehabilitation is about 'enabling people who are disabled by injury or disease to achieve their optimum physical, psychological, social and vocational well-being' (McLellan, 1991). This concept can be applied to people at different life stages and with different types of problems or disorders. In fact, Cohen & Eisdorfer (1986) argued that rehabilitation was the most appropriate framework within which to think about dementia care. Rehabilitation can focus on a range of different areas of need, and goals can be adjusted flexibly in response to changing needs

Occupational therapy for dementia: Occupational therapy encompass everything individuals do to occupy themselves, including self-care, recreation, work and employment. The research also demonstrates that occupations remain highly valued and occupational priorities include maintaining independence with tasks and social interactions (Pettigrew, 2014).

A randomized control trial (RCT) found community occupational therapy sessions that included cognitive and behavioral interventions for individuals with mild to moderate dementia to be associated with improved functioning in daily activities, reduced caregiver burden and a higher effects size in comparison with drug trials or other psychosocial interventions (Yuill & Hollis, 2011).

The person who is occupied with an interesting task or activity will be happier, and less likely to become upset or agitated, than the person who is left alone and without any means of stimulation. Creative modifications to familiar activities have been shown to maintain interest in lifelong hobbies. For example, the former quilter may no longer be able to use a needle to sew but will still be interested in matching fabrics of different patterns and shapes (Bourgeois, 2007).

Drill and practice for memory deficits: In general, the research literature falls into several approaches to the remediation of memory deficits. The first approach is to attempt to restore memory through repetitive drill and practice (Sohlberg & Mateer, 2001). It is assumed that with repetitive drill and practice the brain will compensate; intact areas will take over the functions. Computer programs for retraining memory are based on the drill approach, but there is little evidence that gains in basic skills-such as attention, concentration, visual perception, simple memory, and organization generalize to functional daily-life activities (Sohlberg & Mateer, 2001). The current popularity of the "use it or lose it" theory by the general public is motivating people to do crossword puzzles, learn a new language, or memorize license plate numbers in order to prevent memory loss and dementia; the published research in this area is equivocal, however (Bourgeois, 2007).

The next approach to remedy memory disorders is to teach the person to use a strategy for remembering desired information. Some of the more common strategies include visual imagery (picture-name and face-name associations,), mnemonics (phonetic system, loci method), and verbal elaboration strategies (story linking, first letter mnemonic,) (e.g., Fogler & Stern, 1988). These strategies provide an organizational structure for the information to be recalled and specific devices (or "tricks") to use to access the information. Unfortunately, there is scant

evidence that many of these strategies are effective in the long run. In fact, the use of a strategy can places heavy demands on the already disordered cognitive system and may not be a realistic approach for all persons with memory impairment (Bourgeois, 2007).

Cognitive rehabilitation and Cognitive training: The limited evidence that is currently available, mainly drawn from reports of single case experimental designs, suggests that cognitive rehabilitation interventions can produce significant improvements in targeted areas, at least for a proportion of participants. Clearly there is a great deal more work to be done here, but recent reviews are positive about the potential for cognitive rehabilitation (De Vreese, Neri, Fioravanti et al. 2001). Cognitive rehabilitation will not remove memory and cognitive problems, but it can make a considerable difference to quality of life and help people maintain involvement and well-being (Clare, Chapter to appear in M T Marshall (Ed), Think Rehab).

"Evelyn had a diagnosis of early-stage Alzheimer's disease. The strategy we decided on was to introduce a calendar. A central part of the intervention involved getting Evelyn into the habit of using her calendar. It was positioned in a prominent place, and Ed agreed to prompt Evelyn three times each day to look at her calendar and find out what day it was. This continued for three weeks, at the end of which Evelyn was using the calendar regularly and was able to explain what she needed to do in order to find out what day it was." (Clare, 1999; Clare, Wilson, Carter, Hodges, & Adams, 2001; Clare, Wilson, Carter, & Hodges, 2003).

Compensatory memory aids: The compensatory approach to remedy memory deficits is to provide a compensatory system, or memory prosthesis, in the form of a memory aid or cues. Some compensatory systems substitute for a memory function, such as an alarm clock, watch, or calendar; others perform a memory function, such as computer software and autodialing telephones. A prosthetic environment is one in which stimuli and cues evoke and reinforce appropriate functional behavior, such as labels on cupboards and signs on the bathroom doors. A wide variety of compensatory memory aids have been successful, including memory notebooks, bell timers and alarm clocks, written notes, shopping lists, tape-recorded messages etc. (Bourgeois, 2007).

Augmentative and Alternative Communication (AAC; Bourgeois et al., 2010): The basic goal of augmentative and alternative communication (AAC) is to help persons with communication impairments increase their participation in desired activities and create opportunities for social interaction through various modes of communication. AAC, especially high-tech computer-based and speech-generating devices, is most often used by individuals with severe oral-motor or

expressive language impairments and is rarely considered for persons with dementia who continue to speak well into the late stages of their disease.

Speech-language pathologists, however, have been using various forms of AAC to support communication participation of persons with dementia. Many non-electronic or low-tech communication approaches have been used successfully to support social interaction of persons with dementia. AAC may include memory wallets, notebooks, calendars, signs, color codes, timers, communication boards, labels, and other tangible visible symbols that provide cues for interaction. Persons with dementia use AAC successfully, and SLPs may want to demonstrate to patients and caregivers the effectiveness of these tools. Also, various memory processes that remain relatively intact until later stages can be harnessed for maintaining desired behaviors, such as conversation.

2.4 Assistive Technology for Dementia

Assistive Technology: The Alzheimer's Society summarizes the benefits that "Assistive Technology can promote independence and autonomy, both for the person with dementia and those around them help manage potential risks in and around the home, reduce early entry into care homes and hospitals, facilitate memory and recall, reduce the stress on carers, improve their quality of life *(Alzheimer's Society Factsheet*, Bonner & Idris, 2012). Carswella, McCullagha, Augustoa et al. (2009) believe a major challenge for health care research will be to balance the lack of physical resources with a technological solution to aid people with dementia and their carers living at home and minimize potential hazards.

Low Tech Intervention (Bourgeois, 2007): Think of the memory aid as a prosthetic device to help the individual to remember better-like eyeglasses help people to see better, hearing aids help to hear better, canes to walk better, and dentures to eat better. Glasses, hearing aids, canes, and dentures provide valuable assistance with basic life functions (seeing, hearing, walking, and eating that are essential for maintaining a satisfactory quality of life.

Ours is busy, fast-paced world full of names, faces, places, facts, and figures to remember and use. We have appointments to keep, phone number to call, important facts to remember so many that we often experience memory overload. How many of us can function without our memory aids calendars, appointment books, shopping lists, Post-it notes, small scraps of paper in a coat pocket or at the bottom of a purse? Many manufacturers are taking advantage of our inadequate memories by offering technological substitutes, such as computers, calculators, personal digital assistants, and cell phones. In this age of computers, we depend on technology to augment our memory capacity. Similarly, he may have depended on the Global Positioning System (GPS) feature of his automobile but does not acknowledge the potential utility of the GPS for familiar

locations around town.

High Tech Intervention: High tech intervention helps a person with cognitive or memory deficits function more independently in their daily life. A high-tech intervention is a compensatory strategy that helps a person to maximize their strengths and abilities. A high-tech intervention is computer-based system. It may also include additional devises such as a cell phone, pager, or digital camera.

Various Assistive Technology: The majority of older adults wish to live in their own homes, for as long as possible. This creates a growing interest in technologies to enable older people to remain living independently at home. Several publications were identified about devices targeting social isolation (video-phonic communication, affective orthotic devices or companion-type robots, personal emergency response systems), autonomy loss and cognitive disorders (wandering management systems, tele-monitoring) (Piau, Campo, Rumeau et al., 2014).

Broadly, assistive technologies fall into two wider categories, and they are 'Active' Devices and 'Passive' Devices. An active assistive device is one which requires the direct action of the user to make it work. Examples include remote control devices such as door motors, and even the pendant button of a social alarm. A passive assistive device is one which operates without the intervention of the user. A passive device will generally operate automatically in response to some external event. Examples include a fall detector, a flood sensor and a bed occupancy sensor. For the most part, assistive technologies utilized by those persons with dementia fall into the category of passive devices (Bonner & Idris, 2012).

The increase in the number and capabilities of devices to be connected is one of the central themes in the Internet of Things (IOT); smart devices can communicate with smart homes and smart cities via the Internet. Wireless communication networks (i.e. cell phone networks, mesh networks, WiFi networks) essentially connect end users with a city's network to provide assistance in public transportation, medical appointments and socialization activities, for example (Peterson, Prasad, & Prasad, 2012).

While the AD patient is in the early stages, they can live independently using cognitive aids, such as a pager or tablet, to assist in task remembrance. Such devices will only be useful for the AD patient with the ability to use the technology. Nygard, Pantzar, Uppgaard et al., (2012) found that when "mild cognitive impairment (MCI) is involved, the AD patient often found it difficult to use or understand how to use everyday technology" (Willis, & Price, 2014). Lancioni et al. (2009) found that "behavioral intervention in promoting activities of daily living (ADL's) through computer-mediated verbal instruction that required little to no effort on the part of the patient

proved to increase the overall independence of the AD patient" (Willis & Price, 2014)

Various Stages of dementia and AT (Yasuda, 2007): Memory loss is the main symptom of Alzheimer's disease and related conditions. These memory disorders manifest themselves as a deficit in processing information and an inability to retrieve information when it is needed and make effective use of it. For example, a person who is no longer able to locate the toilet becomes incontinent. The best way of helping people with this condition is therefore to provide them with information as and when they need it. Memory aids must thus be designed, or commercially available computer equipment adapted, to facilitate their access to this information.

Yasuda (2007) have developed various non-electronic devices as memory aid tools (bracelet-type note pads, bolo tie-type note pads, memo presenters in front of eyes etc). Yasuda (2007) have also tried to support some daily behaviors for individuals living at home by using some electronic devices (e.g. Sony IC recorder, ICD-PX240). By automatic outputs of voice instructions and music with the IC recorder, we have successfully decreased wandering, subdued agitation, increased food intake etc. Additionally, a doll with utterance function and video movies with reminiscent pictures for individuals were used as well. As a result of those trials, an important point to note is that indispensable information or music should be given to the individuals before anxious behaviors may occur.

Most people with dementia enjoy talking, with the exception of the worst affected, and a videophone would enable them to contact volunteers at any time of the day or night. Regular conversations may significantly reduce the frequency of the behavioral and psychological symptoms of dementia and enhance psychological stability, and this would in turn reduce the burden borne by caregivers.

2.5 Assistive Technology and progression of Dementia

Evaluation for AT: Review of the extant literature reveals few clinical studies specifically involving persons with dementia (Bharucha et al., 2008). There is little general awareness of what devices are available, and what benefits they can bring (Bonner & Idris, 2012).
Intervention-duration must be tested continually, given that AD is a degenerative disease and cognitive impairment could change the results of the interventions (Willis, & Price, 2014).

Refusal of AT: In a 2006 research report on the attitude of older people to TV, radio, the Internet and mobile/portable devices, the majority of older people were classified as reluctant participants. (Mulvenna, Doylel, Wright et al., 2011). It is an unfortunate fact that AT in its many forms can fall very easily into disuse, despite its very real beneficial features. A review document in The Netherlands (2003) showed that there can be a 'fall-off' of use of up to 75% for a variety of

reasons. The main factors for non-use relate to: Poor assessment of client needs; Inappropriate choice of equipment; Lack of client support and instruction; Lack of carer/family support and instruction; Lack of continuous support for client and/or carer; Equipment not meeting clients and carers expectations and/or needs (Bonner & Idris, 2012). The acceptance of a digital assistive device by a person with dementia is a process that begins with identifying and personalizing the functions of the device according to individual needs, and then supporting the usage and the gradual integration of the device into daily life (Karlsson, Axelsson, Zingmark et al., 2011).

Ethical Issues and AT: A person with dementia may reject the installation of surveillance technology because he does not see any reason for its installation. On the other hand, a family carer may find this necessary to improve the safety of the person with dementia (Topo, 2009). The level of cognitive impairment directly affects whether the AD patient is competent or incompetent to make decisions regarding which technologies they will permit into their homes and lives. Corvol et al. (2012) found in their research on "ethical issues in case management of the gerontology patient that there was a conflict in principles when what was beneficial for the patient conflicted with the respect for patient autonomy" (Willis & Price, 2014).

A classic example is the ethics of using bed, chair or door sensors to determine the movements of a 'wanderer', along with a GPS location tag-. One of the key questions is who is the ultimate beneficiary of the use of the technology? There is no doubt that a full-time family carer will benefit from alarms, alerts and location devices, as they contribute to both the carer and the cared for being able to live a more normal life, as well as giving the carer the chance for some respite with peace of mind (Yuill & Hollis, 2011).

The Costs and Benefits of AT: Bowes, Dawson, & Greasley-Adams (2013) reviewed to identify and assess evidence regarding the costs and benefits of assistive technology in supporting people with dementia. Assistive technology is often portrayed as offering huge potential for the future. However, the cost effectiveness study (Henderson et al 2013) suggested that the addition of tele-health to the care regime was not cost effective. The findings appear contradictory in that reductions in hospital admissions should save costs: however, there is a possibility that tele-health is shifting costs from secondary health services to primary care (Bowes, Dawson, & Greasley-Adams, 2013).

Assistive technologies that facilitate formal care at home, such as memory support systems, monitoring tele-health, and GPS systems show potential to support people with dementia to stay at home, and therefore may be cost effective. Several notes of caution need to be considered however:

technology can promote further isolation of people already excluded from social interaction if it is a substitute for human contact; some technologies, especially those which offer surveillance and monitoring require sensitive evaluation of potential intrusiveness and threats to autonomy; some technologies have been designed without input from users and may reflect the needs of service providers rather than people with dementia (Bowes, Dawson, & Greasley-Adams, 2013).

Carers' burden and AT: Risk of caregiver distress increases when care recipients experience escalating behavioral symptoms, withdraw from social interactions or begin to demonstrate a pattern of reduced participation in activities previously considered meaningful (Yuill & Hollis, 2011). A systematic review ICT conclude that better supported carers will be able to care longer at home, and that therefore entry to institutional care for people with dementia can be delayed. Cheng and Zhuang (2010) consider that early detection and diagnosis could potentially reduce healthcare costs, as well as facilitating effective support for people with dementia. It is widely reported that the costs of care at home are lower than the costs of institutional care. Informal carers make a very significant contribution to care at home, and few studies take into account the total social cost of care, including items such as the costs of carers being out of the labor market (Bowes, Dawson, & Greasley-Adams, 2013).

European Research Project (1999) provided a tool for practitioners in dementia care to assess the benefits and drawbacks of AT use when supporting a client. The Alzheimer's Society has outlined similar considerations as regards the appropriate use of AT. For example, the fear that assistive technology may be used to cut back services and reduce human contact. Inevitably, utilizing AT can also be perceived as a means of reducing levels of care and care costs.

2.6 Policy for Assistive Technology

The use of reminder systems e.g. medication: The use of home security and social alarm systems-for example, smoke and heat detectors, alarm systems and crime surveillance, as well as monitors that pick up any unexpected changes to an older person's routine. In July 2005, the Department of Health published 'Building Tele care in England' where it emphasized how: 'Tele care offers the promise of enabling thousands of older people to live independently, in control and with dignity for longer' (Bonner & Idris, 2012).

The announcement of the Preventative Technology Grant (PTG) was the first real suggestion that AT may finally be considered as a mainstream care option. The PTG undertaking was due to commence in April 2006. A similar initiative was launched in Scotland in the same year. The Whole System Demonstrator (WSD) published its outline findings in December 2011. The main disclosures were that the use of tele health and tele care equipment and support services in the trial areas

indicate a 45% reduction in mortality rates, a 20% reduction in emergency hospital admissions and a 15% reduction in attendances to accident and emergency departments (Bonner & Idris, 2012).

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The Chapter 3 Low Tech Intervention by Non Electronic Tools (Memory Aids)

3.1 Review of Non-Electronic tool-Assistance (Memory Aids)

Necessity for Assistive Technology (AT; Bourgeois et al., 2010): One cannot assume that a person can use the information stated in a therapy task for a real -life situation. The hospitalized patient could be instructed to read the orientation facts written on a message board and the family could be instructed to display a similar message board at home with the relevant information. The objective of memory devices is to assist independent living of people with dementia and to promote their well-being through using these devices. Development of simple memory devices are required to enable the person to keep him/herself informed with plans and activities which, they have finished, such as eating meals, taking medicine.

Memory Aid for the Normal Elderly (Bourgeois, 2007): More naturalistic memory aids, 'such· as daily planners and appointment books, are often more acceptable, particularly if the person had used one during his or her years of employment. In addition to the calendar pages for tracking appointments, there can be a telephone directory, and notes pages for lists of names, categories of words, and other useful things to remember. The calendar can be used to keep track of appointments. The person who agreed to consult the family calendar every morning after breakfast is more likely to continue to depend on the calendar for information about the date and the day's activities.

In the early stages of memory impairment, it is the more complex familiar routines and information that begin to be problematic, such as learning to use a cell phone or to navigate home media with several different remote controls. The constant changing and upgrading of computers and computer software require learning and re-learning multiple steps and procedures for accessing familiar programs. Written lists of procedures are helpful at all stages of electronic use, from when first learning a new system, to later when a written list is a comforting support in the event that part of the procedure is forgotten.

Memory Aids for Mild Dementia: In the early stages of memory loss, individuals are usually very aware of the memory problems and usefulness of the memory aid (Bourgeois, 2007). Some people dropped out of the study due to the progression of the disease. If the assistive device had been implemented earlier, the person might have had better ability to learn to use the device and to get used to it. Assistive devices for people with dementia should be implemented as early as possible (Enable, 2004).

Whether the elderly has a pathological memory deficit or not, the elderly person cannot avoid the memory decline with their aging. At the early stage of memory decline, they must be taught how to prepare the memory decline in future, including early usage of memo pads, electronic devices. If someone develops the MCI, or, dementia, the early application is strongly recommended (Yasuda, 2007).

In order to help these usages, we need to develop special system, tools. There are needs of developing a number of different memory aids, such as special diary systems, wearing memo pads etc. that can effectively help people access daily information. It is helpful to describe all the actions for operating the equipment. Additionally, they are strongly recommended to use them every day. Sporadic use of them would often make them forget how to use them (Yasuda, 2007). The person may need training to use the cuing system to a level of criterion that will maximize the potential for maintaining the behavior after treatment. In some cases, caregivers need instruction on providing appropriate prompts to maintain an effective cuing system (Bourgeois, 2007).

Memory Aids for Moderate Dementia: Moderately memory impaired persons have little trouble using the memory aid when it is on the table in front of them, in their pocket or purse, or handed to them by the caregiver. But they may not remember to look for it or to ask someone to help them find it. It may be helpful to have a designated place to keep the wallet/book so that the memory-impaired individual can learn to expect to find it in that same place and can put it back (Bourgeois, 2007). When using these memory aids, it is important to make sure that they are not completely hidden from view, so that people do not forget that they have taken notes (Yasuda, 2007).

Bourgeois (2007) provides caregivers with ways of making memory aids wearable. This can be accomplished by making the memory aid small, lightweight, and portable and using adaptable devices to carry the memory aid. Persons have been observed to keep their memory aids in a shirt pocket, or attached to a keychain on a belt loop. As people who have reached the moderate stage of the disorder are no longer able to remember the day's events, Yasuda (2007) advise them to carry a notebook with them. This is not necessarily as easy as it sounds, however, as they may either forget to take it or forget that they have it with them. Sometimes, they may not be brave to take it out of their bag or pocket. Yasuda (2007) have designed wearable memory aids. This allows them to take notes, and these can later be transferred to their diary. If people find this task boring, they can simply stick the paper memo straight into the diary. It is important to use the memory aids and the diary in conjunction with the electronic devices described below. If they cannot remember what they

have done during the day, they take notes and carry these around with them.

A programmable voice alarm should be used to prompt people in a moderate or severe stage to keep to their schedule. A few years hence, mobile phones may well have most of the functions described above. I therefore recommend that these people familiarize themselves with mobile phones as early as possible. They will be able to use them to buy tickets and pay at the checkout (Yasuda, 2007).

Memory Book (Bourgeois et al., 2010): Memory books are portable or wearable books to be used in a variety of locations. The memory wallet is a collection of sentence and picture stimuli which are designed to prompt recall of the stated facts and other related factual information. Alternatively, one can purchase a pocket-size photo album with clear plastic sleeves into which the illustrated pages can be inserted. The memory wallet can be organized chronologically beginning with the birth date or organized into topics using tab inserts to denote each topic. The sentences in the memory wallet can either be typed in large print or hand printed in a bold, simple print style. The best pictures to include are those that clearly represent the stated fact that show one or two people. Persons with dementia reported having difficulty remembering words, the names of familiar persons and places, and the topic of a conversation. The apparent solution was to provide a collection of pictures and sentences that the person could read and that would remind him or her of specific people, places, and events to discuss. The memory book is an enlarged version of the memory wallet.

Memory Book for mild Dementia (Bourgeois, 2007): In the early stages of memory loss, individuals are aware of their memory lapses. Therefore, they can participate in the development of the categories and content of their memory book. One individual listed the various different jobs he had held over his career.

Memory Book for moderate Dementia (Bourgeois et al., 1997): Individuals in the middle stages of dementia may be unaware that they are dominating the conversation or that their conversational partner may have already heard that information. In fact, some people have been observed to read aloud and elaborate about each page in their memory book, and then start over from the beginning again. The positive view of this stage is that the person in the middle stage of dementia can be very happily occupied in the task of telling someone else all about his or her memory book. The complexity and length of the sentences causes reading errors, or the book becomes too cumbersome to carry. Similarly, memory books that are portable or wearable can be used in a variety of location.

Memory Book for Severe Dementia (Bourgeois, 2007): In the late stages of dementia,

individuals' cognitive decline may be expressed as reduced verbal output, apparent lack of interest in visual stimuli, and self-stimulatory behavior such as repetitive vocalization, tactile exploration, and repetitive movements (e.g., rocking, pacing). A memory wallet or memory book may not use it independently to read aloud the printed statements or elaborate on the topic. The physical characteristics of the aid may need to be altered for it to be a useful prompting system; there may need to be larger pages and font size. The subject of the memory book may need to be something highly interesting to the person, such as a hobby, or sport. It will be the caregiver's job to assist with turning the pages, and to provide a narration of the memory aid if it does not elicit any coherent output.

Applying Memory Aids: Moreover, as far as the psycho-behavioral symptoms, caregivers are usually told the syndromes which disorders their lovers will show and they are advised to accept their lover's behaviors since there are no other way to cope with. But is this coping enough to relieve caregiver's stress? (Yasuda, 2007). The most common behavior challenges that have been addressed successfully with written memory supports include repetitive questions, expressions of anxiety and fear, and physical agitation. Many of the most difficult situations for caregivers to handle on a daily basis are the repetitive questions or statements made by their loved one. Caregivers reported the usefulness of a memory book page to resolve difficult behaviors such as repetitive questioning (Bourgeois, 2007). Another issue regarding accessibility of memory aids in nursing homes is staff compliance with supplying the aids. Wearable memory aids should be included in individualized care plans, just as adaptive devices such as walkers, splints, eyeglasses, and hearing aids (Bourgeois, 2007).

Role of Speech-Language Pathologists and Carers: Individuals who have memory impairment were frequently supplied with a memory aid by a speech-language pathologist or other health care professional (Bourgeois, 2007). So speech-language pathologists should participate more actively. Speech-language pathologists have been using various forms of AAC to support communication participation of persons with dementia. Many non-electronic or low-tech communication approaches have been used successfully to support social interaction of persons with dementia. AAC, in the form of external aids that incorporate stimuli highly relevant to a person's daily life, may include memory wallets, notebooks, calendars, signs, color strings, timers, communication boards, labels, and other tangible visible symbols that provide cues for interaction (Bourgeois et al., 2007).

The contents of memo should be dependent to caregivers' comments. However, more, easy, convenient, and efficient memory aids should be developed also by the professionals, since the caregivers usually does not have any afford to develop such aids. A methodology for assessment of effects of memory aids are also required, as well as develop a cost/benefit approach (Yasuda, 2007).

As individuals lose awareness of their cognitive and communication difficulties, caregivers may need to learn how to facilitate communication interactions that maintain social closeness without expecting equitable participation. For example, caregivers can name and describe a photo of a recent family event (e.g., graduation or birthday party) as a focus of interaction. Finally, in the end stages, professional caregivers may benefit from direct instruction in the use of tone of voice, familiar objects, the environment, and touch to provide comfort and to maintain quality interactions (Bourgeois et al., 2010).

3.2 Presentation Tools for Memo

Sticky notes (Azheimer's society, 2015): You can use sticky notes anywhere in your home to remind you to do a one-off task: Stick one on the freezer to remind you to take something out to defrost. Stick one on your bookshelf to remind you when you have to return a library book. Once you have completed the task, throw the sticky note away. This way you can keep things tidy and won't accidentally remind yourself to do something you've already done (Alzheimer's society, 2015).

Stationary reminders (Azheimer's society, 2015): You can make more permanent signs, for example a laminated A4 sheet, to remind you to do recurring tasks: Stick a sign to the inside of the front door to remind you to take your keys, purse, wallet or a shopping list with you. Have a sign above the sink reminding you to wash your hands before cooking (Azheimer's society, 2015).

Message within the Field of Vision: Patients with dementia of the Alzheimer type are described to have disturbances in basic visual, complex visual and oculomotor functions. Moser, Kömpf, & Olschinka (1995) could demonstrate both an attentional deficit to externally triggered, unpredictable targets and an impaired systematic, voluntary, internally organized scanning of the environment due to motivational and perceptional deficits.

So, we need a device which the eye gaze is naturally guided to the memo. Yasuda (2007) designed a device which could deliver the required message at all times, displaying it within the user's field of vision in the simple way. The reminder was called "hanging memo from the cap ". A wire was threaded through lengths of tubing running around the peak of a cap and on either side. A card was suspended from the middle of this wire and was normally flattened against the underside of the peak. When the user needed the information, he or she could pull the wire forward and read the card right in front of them, bearing messages such as, "You are in hospital."

Yasuda (2007) used this system with a woman with severe prospective memory impairment. During rehabilitation activities, she was obviously anxious and wondering where she was. He had written a card to hang in front of her eyes which said, "You are in hospital. Don't worry." On reading these sentences, she would nod her head and resume her work. Yasuda (2007) also used this device for a man with Alzheimer's disease. Sometimes, while he was reading a book, he would look around with a worried expression on his face. He, too, would raise his head to read the card and then return to his book.

Yasuda (2007) used a simple sun visor without a cap. As the application, the caregivers are recommended to use this system. For example, when the patient can recognize the caregiver' face, the caregiver may hang their younger-age face that the patient can recognize.

Recently, Yasuda also invented another device to show the information all time in front of users, by using the cosmetic compact mirror. The four cards are folded. When user or caregiver wants to present the information, the cover of the mirror is turned into back, inserted into pocket as the supporting base. Then, the connected four cards are unfolded, spread out to show the information on the four cards.

3.3 Wearing Memory Aids

As people who have reached the moderate stage of the disorder are no longer able to remember the day's events when they come to enter them in their diary. Yasuda (2007) have designed a lot of wearable memo pads. This allows them to take notes before they forget, and these should later be transferred to their diary. To be important to develop these wearable memory aids, these aids should be fashionable.

Wrist Type (Yasuda, 2007): For quick and easy access to a reminder when people with dementia move their arms, memo can be written on armband, a stiff plasticized card can be attached to a piece of Velcro wrapped around the person's arm. This card can carry a list all the tasks to be performed through the day, or the tasks that they have been completed.

Bracelet Type (Yasuda, 2007): This bracelet memo pad works as the band for the wristwatch. The top of the surface of the bracelet can be turned up to reveal several transparent pockets into which several sheets of paper with information are inserted. The bottom of the bracelet's surface can also be turned up to reveal a notepad for writing memo. Furthermore, there is the storage space for the small and stretchable pencil. The user can set the scheduling alarm of the wristwatch alarm.

Neck-tie Type (Yasuda, 2007): Memo pad in the form of a bolo tie was designed. This fashionable tie consists of a hinged clasp, where the upper section lifts up to reveal a small notepad and a short pen. Yasuda (2007) have given these to more than ten people, most of whom use it to

write their shopping lists. If people with Alzheimer's disease wear their lists around their necks, they can consult them more easily, and instantly.

Brooch Type (Yasuda, 2007): This is a flower-shaped leather brooch, with a sheet of paper and a pencil fixed to the back. The users simply need to turn it over to see the reminder. If a string is threaded through the upper part, it can be attached to a bag. Women generally carry a bag when they go shopping, so with this system they can look at the reminder without having to open their bag and thus avoid unnecessary purchases. There is another version which a timer is built in.

Belt Type (Yasuda, 2007): A small notebook is placed that is pinned to the cloth. It could also serve as a kind of badge, or emblem. Inside, there is memo pad and pen. If the note on the memo has to be consulted all the time, the attached chain can be fastened to keep the pad open at 90 degree's angles in order note are always looked. This system is developed to be useful for people with moderate-severe dementia with frequent, repeated questions. This system may occasionally become a nuisance for touching with arms. But, it reminds the wearer of the existence of the notebook and its contents.

One Hand-Writing Type (Yasuda, 2007): All the memory aids described above need the use of both hands for making notes in them. Therefore, it is impossible to make notes if you are already holding something in your hand, especially while you are moving. In order to make one-handed writing possible, Yasuda (2007) have developed a writing aid consisting of a front (iron metal) plate and a back plate. The back plate is attached to the chest with a clip, and a magnet is suspended from the back of it. On the inside of these plates, a notepad and pencil are included. For writing, the front plate folds back underneath and sticks to the magnet of the back plate. These operations make the aids stale to write. The user can still make notes immediately on this writing aid, even if one hand is occupied.

Additionally, these memos written in these wearable memo pads must be reorganize into categories into the diary. Without these procedures, the memo would so often scattered, or impossible to be searched later. Therefore, these memos can then be transferred to the diary, such as "the memory assist book" (Yasuda, 2007, 2013), described below. Users can simply stick the memos straight into this diary. It is important to use the memory aids and the diary in combination.

3.4 Diary and Calendar

Simple Memory Aids (Izheimer's society, 2015): People with memory problems have suggested some of the following aids to help remember things. C***alendar or diary:*** Put a calendar, wall chart or notice board in a place where you will see it frequently- on the fridge or by the telephone. Or keep a 'page-a-day' diary or notebook with you. Get into a routine of checking a diary, calendar or noticeboard-perhaps

when you wake up in the morning, every mealtime, or every time you make a drink. ***Newspaper delivery:*** Get a daily newspaper delivered so that you always know what the day and date are when you get up in the morning. ***Calendar clock:*** You could use an automatic calendar clock. As well as showing the time, it will remind you of the date and day of the week. ***Keep a journal:*** Write a few sentences or stick photos in a daily journal. You can look back in it to remind you what you have done or how you felt. A journal may also give you something to show others or to talk about.

Special Diary for the Memory Impaired and Dementia (Yasuda, 2007): People in an early stage of dementia can keep a diary and write reminders. However, many people do not categorize the various information on their diary. As a result, it is difficult to search necessary information when needed. Yasuda (2007) published the Memory-support book "Kioku sapo-to cho" to make searching easier later on. Therefore, the page of this book are categorized into following sections. ***"To do"*** section: They can write what they intend to do in the day. ***"Done"*** section, and ***"Menu"*** section, where they can write down what they have done, and what they have eaten.

"Accounts" section: This section is for jotting down income and expenditure. ***"Reminder" section***: As people often ask the same questions, the answers to frequently recurring questions should be written under this section. They can then copy out this information every day until it has been memorized. ***"Plans"*** section: They can jot down notes such as, "On such-and-such a day, go to such-and-such a place", copying this information out each day until they reach the date of the planned trip. This considerably reduces the likelihood of their forgetting schedule.

If they find it tiresome writing the same information out every day, they can note it on a "Post-it" which can then be moved from one page to the next. On the left-hand page, there is wide space to stick receipts, patient information leaflets for medication, photos, calculation drills, parts of newspaper etc. They can also write down important words and names, which can then be copied out each day so that they do not forget them (Yasuda, 2007).

Yasuda (2013) published the new memory-support book. In this book, two new sections are added; ***"Check"*** section for goods which people with dementia frequently lost, such as wallets, eyeglasses, mobile phone etc., and ***"health check"*** section for logging the daily health condition, such as blood pressure levels, sugar level etc.

3.5 Location Management for Items

Memory Tapestry: Photographs used as pictorial prompts, the wife had taken Polaroid photographs of what was inside each drawer and cupboard so there were photographs on each door (Cash, 2004). Extra finding efforts are required if following item are stored distributary; Memos for repetitive questions, tools that people lost frequently, medicine et a. Yasuda and Shimane made a

prototype of the wall-mounted "Memory tapestry" (Yasuda, 2018).

The top parts is for the storage of medicine, note paper, pencil holder, one day calendar. The digital clock is also positioned, which can show the correct day. If tablet or computer are set here, video phone conversation, or remote monitoring are possible, such as medication intake can be confirmed through video camera. The white message board should be iron so that caregivers put up magnetic sheets, on which answers of repetitive question are shown.

The storage bags for each item would be transparent. The name tags are slicked to each pocket. In this system, people and caregivers are obviously to know whether all of items are returned or not.

His /her old photo or grandchild's photos may help people with dementia focus to this tapestry. It is more effective if you put alarm clock or IC recorder, and emit alarm, favorite songs, recorded message from grandchild.

3.6 Clothing for Memory

Memory Vest: Bourgeois (2007) provides ideas for devices, along with step-by-step instructions and pictures for making wearable memory aid devices. Included are vest pockets, wheelchair, and walker bags, a necklace, and a belt. Yasuda and Shimane are developing a memory vest which is designed for help the dementia patients to recall the events happened in their daily life, such as key, glasses, wallet, mobile phone, etc. In order to do these possible, the first version of the memory vest has a lot of pockets on it, which are specially designated for the items to be input. It is also equipped portable devices including an Android smart phone, two IC recorders, and digital video recorder to log the daily life of the patient. This video recorder can record all of scenes where wearer visit, conversations whom wearer talk with, behaviors that wearer did. The history of user activity is stored in a database. People with dementia often forget to take the needed one. However, except the most severe cases, they do not forget wearing clothes. So, if the needed items are included in this vest, they do not forget to bring (Matsushita et al., 2012).

3.7 Non-Electronic Home Environment

Univ. of stirling (2013) published the booklet *10 helpful hints for dementia design at home*. If housing is designed well, it can extend the amount of time a person with dementia can remain at home. It can also reduce the sort of adverse incidents that lead to hospital admissions. This book provides a brief introduction to key design features that will enhance the internal and external living environment of people with dementia.

People with dementia need higher than normal levels of light in order to make sense of their environment. Choose well-designed signs and mount them low: weak neck and shoulder muscles as well as poor eyesight mean that the optimal height for signage is 1.2 meters from the ground.

Contrast is more important than color. Contrast makes things visible, while a lack of contrast makes them invisible. Always avoid contrast changes where different flooring surfaces meet. People with dementia can struggle with 3D perception and may misinterpret changes in contrast as steps or holes.

Way finding difficulty and disorientation within a facility can also add to agitation. Elders were more successful with processing architectural information (e.g., doorways are meant for going through, stairs are meant to go up) rather than graphic information. Items in display cases with higher personal meaning or significance often assisted residents in finding their way to their room within the facility. Nolan et al. (2000) found the same result when they used photographs as cues, but the photographs were of the residents from 50 years ago. Thus, the residential environment that houses people with dementia can be a therapeutic tool to enable identity, way finding and reminiscence through its spaces and objects within it (Gulwadi, 2013).

Memory Box: Gulwadi (2013) examined the use and usefulness of memory boxes (wall-mounted display cases) at the entrances to resident rooms in dementia care facilities. Each memory box is often a simple rectangular wall-mounted box with a wooden frame and a glass insert, designed to hold personal memorabilia of the resident. Memory boxes have three purposes: to establish one's identity; to serve as a spatial orientation cue to assist residents in finding their way back to their room; and to act as a tool for reminiscence. Memory boxes and their contents help provide a good starting point for conversations that lead to healthy reminiscence.

Summary: Medical technologies will affect our understanding and management of dementia and communication. As technology use becomes part of the lives of people of all ages, the options for AAC tools and strategies will become dramatically more sophisticated, yet simpler. Cell phones, smart cars and smart homes, robots, prediction search engines (e.g., Bing), and technologies yet to be invented will need to be part of our clinical tool kit (Bourgeois et al., 2010).

Persons with dementia use AAC successfully, and SLPs may want to demonstrate to patients and caregivers the effectiveness of these tools (Bourgeois et al., 2010). Yasuda (2007) argue that people with dementia see their abilities decline as the disease progresses. Assistance must be increased or modified accordingly. Rehabilitation consists in helping both them and their caregivers by making maximum use of their preserved capacities at each stage, using memorization techniques and equipment. To do this, considerable attention needs to be paid to the difficulties people with dementia and their caregivers encounter at each stage, a range of memory aids needs to be offered to

them and the most appropriate ones chosen. There are a number of different memory aids, from multifunctional diary systems to electronic reminders, providing access to them is adapted as the disease progresses.

We need to examine whether such products can enable people with dementia and support their wellbeing by giving positive experiences, reducing worries and unrest, and reducing the burden on careers. The researchers introduce new and unfamiliar technology into the daily lives of people with dementia. The results from the assessment trials demonstrate that technical devices can facilitate independent living of people with dementia and reduce stress and anxiety for their careers, but not always. According to our hypothesis, use and usefulness of a device would be dependent on factors related to the person with dementia, the career, the product, the environment, the researcher, motivation, habits etc (Enable, 2004).

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Chapter 4 Low Tech Intervention: Assistance by Electronic Devices

4.1 Assistance by Electronic Devices

Purpose of Assistance by Electronic Devices : To identify and review the latest research in the use of low and high technology in the areas of mild cognitive impairment and dementia. Navigation aids and computerized diaries assisted in maintaining independence in the normally ageing and mildly cognitively impaired. Benefits in this population with dementia included reductions in behavioral and psychological symptoms and carer's burden and increased independence, task engagement and safety (Westphal, Dingjan, & Attoe, 2010).

The idea of using computer technology to enhance the performance of cognitively disabled people dates back nearly forty years. Early aids included talking clocks, calendar systems, and similar devices that were not very technologically sophisticated; yet many are still in use today (Pollack, 2002). The innate course of Alzheimer's disease is cognitive decline. This poses an additional concern for research and development as they continue to work toward solutions for a group whose situation may change on a daily basis (Willis & Price, 2014).

The overall objective of At Home with AT (Assistive Technology) was to explore the potential of existing low-key technological devices which are readily available. A range of devices available for purchase on the open market were identified from a wide variety of sources (Cash, 2004).

Augmentative and alternative communication (AAC), especially high-tech computer-based and speech-generating devices, is most often used by individuals with severe oral-motor or expressive language impairments and is rarely considered for persons with dementia who continue to speak well into the late stages of their disease (Bourgeois et al. 2010). People with mild to moderate dementia are capable of handling simple electronic equipment and can benefit from it (Lauriks, Reinersmann, van der Roest et al., 2010).

Review of Assistance by Electronic Devices : Older adults can be supported socially and emotionally through technology that helps alleviate the isolation. The preferred ICT solutions that person with dementias and carers brought with aids for reminding appointments, Electronic Memory Aids (EMA), Electronic calendar, and aids to find items. To enhance communication, simple photo phones, videophones or mobile phones were proposed and tested. Technological support for leisure activities was recommended by Sixsmith and Wherton, and amongst other things an activity guidance system with music and sung messages and a picture gramophone were tested. To enhance feelings of safety, several Global Positioning Systems were developed. Also, monitoring systems inside and outside the house were tested in which alarm messages are forwarded in case of potentially dangerous behavior of the person with dementia (Pollack, 2002).

Evaluation: The user driven or user-participatory design method is advocated to enhance the chances of developing an ICT device that is user-friendly and useful for the target group and will be accepted by users. It is therefore important that more studies are undertaken to evaluate the user-friendliness, usefulness and effects of ICT solutions in the target group. Not all ICT applications and services on today's market have been tested in advance or applied successfully for people with dementia. Although some untested systems could be beneficial to people with dementia or their carers, one cannot be sure of the efficacy of these systems (Lauriks, Reinersmann, van der Roest et al., 2010). Engström, Lindqvist, Ljunggren et al. (2016) studied relatives' opinions of IT support at a residential home for persons with dementia before and after. Relatives' opinions of IT

support were generally positive

To assess whether verbal-instruction technology could help persons with mild and moderate Alzheimer's disease maintain their recaptured performance of daily activities, (i.e. table setting, coffee, tea or snack preparation, use of make-up and shaving). Most patients also showed mood improvement during activity. Verbal-instruction technology might be considered a critical tool to help persons with Alzheimer's disease enhance their activity and mood (Lancioni, Singh, O'Reilly et al., 2010).

Evaluation for ENABLE Project: Within the multi-national ENABLE project (enabling technologies for people with dementia) existing products were identified and their effectiveness to support memory, improve quality of life and reduce the carer burden was assessed. These assistive technologies were found to facilitate independent living and some devices may reduce anxiety in people with dementia as well as their informal carers. EMAs proved efficacious in stimulating memory in people with dementia (see review Grandmaison & Simard 2003). All in all, these studies show that persons with dementia are not only capable of handling electronic equipment, but also benefit in terms of more confidence and enhanced positive affect, thereby indirectly reducing the carer's perceived burden (Lauriks, Reinersmann, van der Roest et al., 2010).

For the health professional it often meant a device that would allow the person to remain safely at home for longer, for example the cooker monitor to ensure health and safety. Cares had to spend considerable time in locating items lost within the home. The locator required new learning, but some people with dementia were able to use it independently (ENABLE, 2004).

Greater success for the person with dementia was achieved with products that required the least interaction such as the night and day calendar, a device that can be plugged in and left alone. It was imperative to consult with the person using the device about where and how to place a device within the home to ensure use. A medicine reminder was placed in the kitchen so that it would go off at times when the person would be having a meal. In other cases, two nights and day calendars were provided so that one could be placed in the bedroom to provide orientation at night, and also in the living room for the day time.

Some products such as the locator required a high level of interaction, whereas the other products required a lower level of new learning. If the motivation, attention or interest of the person with dementia was low or average there was a risk that he/she neglected the device, or did not remember why it was there. Co-habiting could create extra problems for the carer, not having time to relax, e.g. from repeated questions. The progression of the dementia itself was one of the reasons why a useful product was no longer used after a period of time. If the technology had been implemented earlier the person might have been more able learn and get used to the device. Ideally, one may think that all technologies should be provided free of charge.

Summary (Cash, 2004): Whether people with dementia can use devices, it depends on how early on in the dementia it is introduced. People with dementia should be supported in finding appropriately qualified people to install devices. Staff involved in installing devices in the homes of people with dementia should be given appropriate training to work in the homes of people with dementia.

At Home with AT was an innovative study that investigated the ability of low technological devices to provide support to people with dementia. Devices are readily available for purchase: can be used in the existing home of the person with dementia: do not require the installation of

sophisticated computer equipment. Devices could be returned to a central distributing agency when no longer useful thereby ensuring their most effective use. The need for assistive technologies should be included as a part of the person's care plan.

Instrumental ICT support for coping with behavioral and psychological changes in dementia is relatively disregarded as yet, while support for social contact can be effectively realized through, for example, simplified (mobile) phones or videophones or (entertainment) robots. GPS technology and monitoring systems are proven to result in enhanced feelings of safety and less fear and anxiety.

Support for social contact and company is realized through simplified mobile phones or video phones, that have been reported to facilitate communication between people with dementia and their family or friends. Enhanced positive affect as well as increased activity and communication levels have been observed with computer software providing music or video memories or robotics, such as a toy dog or an entertainment robot.

Though successfully applied in a single study (Yasuda et al. 2006), instrumental ICT support for coping with behavioral and psychological symptoms in dementia is relatively disregarded as yet and the same holds for personalized information on the diagnosis, condition and personal care appointments (Lauriks et al. 2010).

4.2 Reminder

Review for Reminder: Electronic devices offer some distinct advantage over stationary memory aids. For example, alarms or chimes are available on many wristwatches. They can be used as a reminder for patients to carry out a regular task, such as taking medication or consulting a diary/notebook. However, they also have limited utility because patients frequently forget what the alarm signifies.

Desktop and laptop computers with a scheduling program are another form of electronic memory aid. Some scheduling cueing system can also automatically log the task completion information. Nevertheless, these aids are not easily portable. These devices are acceptable for use as compensatory aids by consumers with moderate to severe brain injury. Researchers agree on the usability of memory aids for persons with dementia, the importance of defining their own reminders and of giving them and their informal carer's control over the reminders (see Yasuda, Misu, Beckman et al.,; Yasuda, Beckman, Yoneda, Yoneda, et al., 2006; Lauriks et al., 2010; Bonne and Idris, 2012, as review).

Reminder Intervention by IC Recorder: Yasuda, Misu, Murasugi et al., (1999) developed an "Voice Output Memory Aid (VOMA)" which can generate previously-recorded spoken messages at programmed times. Eight separate messages could be repeated up to 128 times a day. With the VOMA, patients do not need to remember what the alarm signifies or to read the message on a narrow display. Yasuda et al. (1999) applied this aid to assist the daily prospective tasks of two memory-impaired patients: one with the Alzheimer's dementia and one with thalamic infarction. The two people, who were automatically given instructions about going for a walk or making notes in their diary at the planned time. We noted a considerable increase in the completion rate for the cued tasks.

Automatic output of verbal messages was again attempted by Yasuda, Misu, Iwamotovet al., (2002b) for an individual with Alzheimer's disease by using a Sony IC recorder. The messages were aimed at dealing with several daily problematic behaviors such as going out alone, refusing to take bath etc. To remedy behavioral disorders such as wandering, The Sony IC recorder emitted the

intermittent messages giving reasons why he should not go out (Yasuda *et al.*, 2002b). This intervention were thus able to reduce this man's wandering to a considerable extent and enhance his completion of daily tasks, such as taking medication. The messages were recorded by a speech therapist. The subject was far more willing to follow the instructions of specialists than those given spontaneously by her relatives. However, after the individual became accustomed to receiving the messages from the aid, he began to disregard them.

Yasuda et al., (2002a) evaluated the utility of an Sony IC Recorder as a voice output memory aid for patients with prospective memory impairment. The IC Recorder can output about 500 previously recorded messages at programmed times. The spoken messages prompted various daily tasks of eight patients with acquired memory impairments. One of these tasks such as diary writing, or a letter-writing drill was selected for each patient as a main task, and its completion was logged.

The Sony IC Recorder is small and light enough to fit into a shirt pocket. Two batteries usually need to be changed once every three or four months. The IC Recorder (IC Rec) has a total capacity of long recording time. The IC Rec can present the user with about 500 spoken message at the programmed times. Daily and weekly outputs are also possible. The message is loud enough to be clearly heard. The time of recording is automatically saved and is shown when searching for a message.

Patients who participated were four males and four females, with memory impairments ranging from moderate to severe memory impairments. The primary goal of this study was for eight patients to perform various daily tasks by responding to spoken messages provided by the IC Rec.

Case 4 *: A 56-year-old women showed a sudden prospective memory deficit and retrograde amnesia for the last several years. The MRI scan revealed the widespread neuro-pathological changes in both hemispheres including the thalamus. Her prospective memory deficits made it impossible to carry out her routine daily activities. A phase: the previously performed tasks were again picked up as the main task (the letter writing drill) and sub tasks. In spite of her promise, she could not carry out these tasks for three months. B phase: The IC Rec emitted the recorded messages. From the first day of the IC Rec intervention, she was able to carry out letter writing drills and other sub tasks six days a week. Her daughter was pleased and excited with the impact that the messages from the IC Rec had on her daily tasks. Second A phase: Three months latter, the IC Rec was withdrawn. Without the IC Rec the patient continued to perform the above tasks for a month. She gradually began to forget to do these tasks in the following two months. Total successful performance was reduced from 76% in the B phase to 34% in the second A phase.*

Dramatic improvement was observed in five of eight patients. this study provides additional evidence of the effectiveness of electronic memory aids. Teaching the use of memory aids, however, involves time and patience on the part of both therapist and patient (Wilson & Hughes, 1997a). It is important to note that little knowledge of the IC Rec was needed on the part of the patients who merely responded to the spoken message produced. Success with the IC Rec was achieved quickly with no enduring training.

In this study, the experimenter recorded all of messages for eight patients. Most caregivers thought that their voices were too familiar to the patients and might have hurt the patient's pride. They, therefore, insisted that the experimenter's voice would be more appropriate than that of caregivers. The Sony IC recorder is still on market (SonyICD-PX240).

New Devices and System for Reminder: ***PEAT*** was the marketed cognitive orthotic system

that relies on automated planning technology. PEAT, which is marketed primarily to patients with traumatic brain injury, is deployed on a handheld device, and provides visible and audible clues about plan execution. PEAT maintains a detailed model of the client's plan and tracks its execution. Also, upon the addition of a new action. (Pollack, 2002).

Autominder's project is to develop a system that is flexible, adaptive, and responsive, and is thus more effective than a glorified alarm clock. To attain this goal, Autominder must maintain an accurate model of the client's daily plan, monitor its performance, and plan reminders accordingly. Consider, for instance, a forgetful, elderly person with urinary incontinence who is supposed to be reminded to use the toilet every three hours, and whose next reminder is scheduled for 11:00. Suppose that, using its on-board sensors, our robot Pearl observes the person enter the bathroom at 10:40, and conveys this information to Autominder. In this case, the client's plan must be adjusted, so that the next scheduled toileting occurs approximately three hours later, i.e., around 13:40. If the client's favorite television program is aired from 13:30 to 14:00, it might be better to issue the reminder at 13:25. (Pollack, 2002).

Memory Glasses is a context-aware memory aid that is embedded in glasses. The goal of the system is to deliver reminders to the wearer in a timely, situation-appropriate way, without requiring intervention on the part of the wearer. This system is different from passive reminder systems, which cannot know the user's activity context. Memory glasses leverages a variety of computer perception techniques, based in part on captured visual images, which permit context awareness. The accuracy of context-awareness when delivering a prompt is important since distraction at the wrong time (e.g., crossing the street or driving a car) could be life-threatening. In addition to Mild Cognitive Impairment, mild Alzheimer disease, and other dementias, this device is expected to be helpful in cueing memory for names (anomia) and faces (prosopagnosia) (Bharucha et al., 2008).

4.3 Assistance by other Electronic Devices

Medication reminder box (Cash, 2004): Several techniques and interventions have been used to help increase medication taking including social support, education about the impact of adherence, improved design of medication labels and instructions, and various prospective reminding devices. Medication reminder box range from low-tech solutions, such as plastic boxes divided into sections labelled by times and day, to electronic devices that have various levels of sophistication. The compartments have spaces for a number of different tablets. ***Medicine Reminder box with alarm*** contains all the medicine for one week and is filled by a carer (ENABLE, 2004). When it is time for the person with dementia to take a tablet, the carousel gives an audible signal and goes on doing so every minute for half and hour until the tablet is taken out.

The more complex are systems that dispense the drugs at the correct time and sound an alarm if the drugs are not taken within a given length of time. The user is required to push a button on the device to indicate when the medication has been taken successfully (Alzheimer's society, 2015). It also requires someone to dispense the medication in the correct doses into the reminder. In some cases a carer performed these tasks. If a carer was unable to undertake these tasks, it required the support of a pharmacist. The device is battery operated and it requires someone to take responsibility for changing the batteries.

If you have a tablet device, you can use functions such as reminders. There are other applications (APP) on Computer or tablet device: that you can download from the internet. For example, you could

use a medication reminder app to remind you when to take your pills, and which medicine to take (Alzheimer's society, 2015).

Existing automated reminding systems are sometimes ineffective because they do not take into consideration the user's context when making decisions regarding how and when to provide reminders. ***Intelligent assistive technology and systems lab (2005)*** will be able to determine user-specific information and characteristics in order to provide reminders that are more appropriate for that particular person's preferences and habits. 1) The system will provide various types of reminders, such as pre-recorded verbal messages. These prompts will be customized for each user; e.g. use of first or last names in the prompts etc. 2) The system will be able to automatically determine where in the home the person is located and provide reminders in that location. 3) The system will be able to automatically determine if the person has taken the medication. 4) If the person does not respond to the issued reminders by the system within an appropriate time frame, the system will provide this feedback to an external source, such as a neighbor or family member.

Locator for lost Items: People with dementia often forget where they have put things like keys, spectacles or their purse. Their carers can spend a great deal of time searching for such objects and can find this very irritating. It can also lead to accusations of theft by the person with dementia against carers (ENABLE, 2004). ***Locator Device*** has four color-coded buttons each of which has space for a picture or the name of the object to be located (Cash, 2004). Four tags whose colors correspond with the buttons on the locator unit can be attached to items by means of a key ring. When the user touches a button, it initiates a bleeping sound from the tag attached to the misplaced item. If the user lives alone, they have to understand how to operate the device. The most commonly tagged items were keys, handbags, wallet, remote controller, hearing aids etc.

With ultra-small sticker with Bluetooth, user stick on any device, person or animal, and find them with your Smart Phone. ***StickNFind*** (2012) is only 4.1mm thin. That means user stick it on your keys, TV remote, kids, cat, dog, iPod, phone, tablet, wallet, purse, passport, laptop, backpack, suitcase. Stick-N-Find Stickers have a range of about 100 feet. The radar Screen will display all user's devices in a radar type Screen. User start walking in a specific direction and see if it gets closer or farther.

Then we have the Virtual leash feature. This allows user to create a virtual Leash on a sticker, if that sticker moves away more than the selected distance from user's phone, user's phone will alarm you. User can also create a Reverse Virtual Leash: User put a Sticker on user's keys etc. if you forget user's phone behind, the sticker on keys will buzz.

Shinnishi, Iga, Higuchi et al. (2005) proposed a novel concept of ID tag called "***Hide and Seek"***. Hide and Seek is a small interface device which can be attached to books, physical real artifacts and so on. When a user calls the name of a physical artifact to voice recognition system, Hide and Seek responds to the user by sound. The device changes the generated sound with the distance between the user and the device. Searching an object in office or home is time-consuming even if they are organized and stored in boxes with proper labels. Nakagawa, Tsukada, & Siio (2008) proposes

ease-of-use technique to create picture database about contents of boxes, and to browse them through network. They have implemented a system to easily take pictures inside boxes and identify them using an RFID reader and tags that are attached to the boxes.

Monitoring Systems for Safe (Lauriks et al., 2010): Implementing monitoring technologies and detection devices or alarm systems inside and outside the home of elderly persons is potentially useful to enhance safety and security of the person suffering from dementia as well as carers. GPS technology for tracking wandering or lost persons as well as monitoring systems to detect fire or gas leakage or signal night-time activity allow for unobtrusive yet efficient assessments of safety. A fully automatic multi-sensor system composed of Infra Red (IR) sensors connected to a personal computer installed in a patient's room was evaluated by Chan et al. (2002). This smart tool system proved valid in assessing and recording data on activities such as getting out of bed, mobility and travel patterns of a psychotic patient with moderate cognitive decline and behavioral disorders.

By fusing data from a network of heterogeneous sensors and applying artificial intelligence, these systems not only improve activity and behavioral recognition above and beyond the capacity of unimodal sensors, but also advance the level of sophistication of the supervision, guidance, and feedback provided to their users (Bharucha et al., 2008).

CareWatch consists of a security system control panel, wireless receiver, and motion, door opening and bed occupancy sensors to alert the caregiver of both emergency and non-urgent situations through customizable text or voice alarms. The investigators plan to measure the family caregiver's sleep, daytime fatigue, mood, burden, and depression.

CareMedia leverages fundamental advances in video image processing to track and analyze the activities and behaviors of nursing home dementia unit residents. Specifically, the project attempts to capture in real-time, continuously video/audio data that were processed to identify normative behavior, and aberrant low frequency, high impact behaviors such as falls, physical, and verbal aggression. A feasibility study involving four ceiling mounted video cameras and microphones in then on private spaces of a locked dementia unit. (Bharucha et al., 2008).

Social safety alarm systems usually is activated by neck or wrist-worn pendants, and is able to monitor a wide variety of activities and situations via additional sensors. Normally, any alert is picked up by a monitoring center that contacts the resident, family, carers, mobile wardens or emergency services, depending on the seriousness of the situation. Telecare equipment such as a pendant is sometimes viewed as a 'badge of vulnerability (Bonner & Idris, 2012). Tele health refers to remote monitoring of a person's vital signs. Readings are transmitted to an appropriately trained person who can interpret the health readings and make decisions about potential interventions in

real time, without the patient needing to attend a clinic.

Fall-Detection System (Bharucha et al., 2008): The Smart Inactivity Monitor using ***Array-Based Detectors Project*** deploys wall-mounted low-cost, array based passive infrared sensors to detect inactivity and falls. Although it does not require the individual to wear or activate a device, falls were accurately detected. In contrast, the University of Virginia is developing ***a piezo sensor-based system*** that records floor vibration patterns. Neither system has been deployed in real world residential settings with dementia subjects.

A pilot study evaluated the efficacy and performance of a fall-detection system that uses a ceiling-mounted video camera. The system can only track one person at a time. The investigators are now linking this fall-detection system with a community emergency response team and experimenting with artificial intelligence techniques to determine what level of assistance a fallen person may require in various scenarios.

Sleep Monitoring (Bharucha et al., 2008): Continuous telemetric monitoring is tested for an active social alarm system of the user's activity. Results of these studies support the use of telemetric actgraphy in long-term screening and follow-up of elderly subjects for sleep and circadian rhythm-related problems associated with dementia and changes in functional capacity.

Wandering Monitoring: The step watchs particularly are able to assess amount and daily course of wandering behavior in people with dementia. In this context, Boundary alarms (activated by a wristband) or electronic tagging with bracelets and monitoring stations were found to be effective, reliable and successful in detecting wandering. A bedside monitoring system tested in a hospital setting with patients with dementia who frequently wandered during the night, additionally provides floor lighting upon wandering detection and relays an alarm to a personal handheld device alerting the carer to the situation (Lauriks et al., 2010).

We wish to look at genuine alternatives to restricting the movements of those with dementia, such as locking doors, making a door difficult to open, or using floor patterns/color schemes which would discourage crossing a threshold. This is unnecessary when suitable devices, such as technological systems could be used. Technological systems in which GSM is combined with GPS (Global Positioning Satellite), could be a solution to the problems encountered by getting lost and wandering behavior (Rasquin, Willems, de Vlieger et al., 2007).

The person with dementia is recommended to carries the mobile phone when leaving the house. If a carer or relative needs to know his or her whereabouts, a 24-h control center can be called. By getting the coordinates of the phone they can pinpoint the person's location with an accuracy of 5 m. The computer generates a map of the area, and then automatically sends this map via email to the

carer who can view it on a mobile phone ((Lauriks et al., 2010).

There may be an over-emphasis on these risks and their costs, at the expense of consideration of the autonomy of people with dementia. A further GPS device was tested, suggesting it is promising for supporting people with early stage dementia in terms of facilitating more freedom to go out (Bowes, Dawson, & Greasley-Adams, 2013). It is also important to recognize that wandering can serve to keep the person physically active and allow them to express needs or emotions that they otherwise might not be able to communicate (Peterson, Prasad, & Prasad, 2012).

iWander is a device that collects GPS and other sensor data about location, weather conditions, stage of illness, etc. This data is then evaluated using Bayesian network techniques to determine the probability the person is wandering. Although the experimental results showed its effectiveness in detecting wandering behavior, GPS cannot prevent the person from going outside in the first place (Oshima, Yasuda, Machishima et al (2015).

Wandering Prevention: A number of different door alarms were identified. The one trial was a wire free PIR contact door alarm with a portable alarm unit. This device requires someone to attach contact switches to the door and door frame. A wire free door alarm, contacts fitted on a door send a signal to an alarm unit when the door is opened (Cash, 2004). ***Electronic keys and door sensors*** can accommodate for entry and exit of the home and fall detectors can alert caregivers or emergency personnel when an incident occurs (Peterson, Prasad, & Prasad, 2012).

Yasuda et al. (2002b) dealt with the above behavioral disturbances using verbal messages delivered by a Sony IC recorder. The automatic verbal messages presented information to him, for example, ”Dog-walking has already finished. You do not need to go out with the dog”. These messages were automatically output about 20 times a day. His leaving home has ceased.

In case of an emergency, the person with dementia can activate an emergency button which sends a message to the call center where the situation, location and geographical information and location coordinates are analyzed and relayed to care providers, search teams and family members. This system was expected to be beneficial in helping locate elderly people with dementia (Lauriks et al., 2010).

The Intelligent Mobility Platform is a walker-based device that uses a laser beam range-finder, a handheld computer with a touch-screen interface, and a navigation software to orient a person in the proper direction using a red arrow. ***Opportunity Knocksis*** is a cell phone-embedded device using Global Position Sensor chip and Bluetooth that learns the individual’s standard routes in the community. It alerts the person of a navigational error by making a knocking sound and subsequently recalculating the proper route. ***Activity Compass*** is another Global Position

Sensor-based system that accomplishes much the same as Opportunity Knocks. None of these systems is commercially available, and all wait rigorous clinical testing in applicable populations (Bharucha et al., 2008).

Reminder at special location : ***The Memo Minder*** is a message recorder/player. A message of up to 20 seconds in length can be recorded onto a circuit board. The message is triggered by a passive infra-red motion detector whenever anyone moves within a range of 5 meters. The following reminders were recorded; *To remember to lock the door and take the keys with them when they were going out, Not to go out during the night, To wait until home care arrived, To indicate whether it was a day to attend the day center*. It is important to locate the device in a position where the message can be activated by the movement of the user (Cash, 2004). Several devices of this type are commercially available. ***Motion sensor*** goes near a door and senses movement nearby. User can set it to play a voice message as a prompt when you approach. One placed by the phone could remind you to check that callers are not bogus, or you could have one near the kitchen door to remind you to check you have switched the oven off (Alzheimer's society, 2015). In order to guide one person who was no longer able to find the toilet at night, Yasuda (2007) fitted a similar device near the bedroom door which played the message, *"The toilet is on the right"*.

Special Watch and Calendar: Some people with dementia do not know whether it is night or day, and may go out or phone relatives in the middle of the night. Carers are also often stressed by frequent questions as to what day or time it is. The ***Night-and-Day Calendar*** has a display, which shows the day, the date and 'Morning', 'Afternoon', 'Evening' and 'Night'. At midnight, the day and date change automatically. Similarly, the sign shifts from 'Morning' to 'Afternoon' and so on, at set times **(**ENABLE, 2004).

Forget-Me-Not device could be useful for persons who are confused about day and date. Beneficial effects of computer systems on orientation, feelings of anxiety and independency was observed in a patient suffering from Alzheimer's disease. Computer screens in the bedroom and living room reduced the needed support and the number of nighttime calls to the informal carer (Lauriks et al., 2010).

Alarm Clock and Timer: An alarm clock is a watch with an alarm, or a kitchen timer to remind you when you need to leave the house for an appointment, or when you have to check something cooking in the oven. Write down on a piece of paper nearby why you have set the alarm, so you know why it is going off (Alzheimer's society, 2015).

For people who forget tasks to be performed within ten or twenty minutes, it might be useful for them to wear a timer around their neck. These people often have difficulty remembering why the

timer has gone off, so a pencil and a small notepad can be attached to the back of the timer listing the tasks to be carried out. They can then carry out a program of household tasks regulated by the audible timers. One person with mild dementia used to place timers at strategic points around the house, such as the refrigerator, the cooker and the bathroom (Yasuda, 2007).

Devices for frequent question: Carers are also often stressed by frequent questions as to what day or time it is. This can be very irritating and have a negative effect on the relationship between the carer and the person with dementia **(**ENABLE, 2004). There have been few reports on patients with dementia using electronic devices to assist them in following daily schedules. Yasuda (2007) attempted to evaluate the use of an IC Recorder and Lingo for voice output to a patient with Alzheimer's disease.

Yasuda (2007) also developed ***Voice alarm linked to a touch sensor.*** Certain people have to have catheters in their stomach, nose, urethra, *etc*. Some of them forget why these Catheters are there and try to pull them out. He conducted a trial where one such person was given a device equipped with a voice alarm linked to a sensor which generated a message whenever the catheter was touched. This system proved to be partially effective.

Other Devices: ***Gait analysis*** employs motion sensors and accelerometers can predict falls before they occur. ***Automated shut-off devices*** for cooking appliances or ***water isolation devices*** in the event of a tap being left running. Many devices can be linked to the telecare which can be used to summon assistance in the event of an alarm being raised. This may include a ***fire or flood alert***, a notification of a fall, an alert when they fail to get out of bed in the morning, or perhaps sending an alarm when a person leaves the house at an unusual time of the day/night. Bath plug that prevents flooding by letting excess water out of the bath. Bath water level and temperature monitor and controller. ***Flood Prevention*** automatically turns off taps if water level reaches a certain level, and keeps temperature within certain limits. ***Refrigerators*** can monitor weight in the contents to evaluate if food is being eaten regularly and ***water taps*** can register how often the tap is used (see Peterson, Prasad, & Prasad, 2012; Bonner & Idris, 2012 as review).

4.4 Assistance by Cell-phone, and Smart Phone

Memory problems may mean that people with dementia can forget well-known numbers and/or how to look them up. This is a particular difficulty when the person with dementia lives alone.

Phone : A ***pre-programmable telephone*** (calls initiated by just pressing one large button containing a name or photo). Trials among people with mild to moderate dementia indicate that these assistive technologies can enhance well-being by giving positive experiences and reduce anxiety in people with dementia and their informal carers (Lauriks et al., 2010). A ***picture telephone***

had nine large pre-programmable keys, to which a photograph or the name of a person could be added. This allows the person to dial a number by pressing one key and eliminates the need to remember a string of numbers. A similar telephone was located but the pre-programmable buttons on this telephone only had space for a name to be written by the side of them. The person with dementia needs to be able to recognize the names written by the side of the buttons in order to identify the correct button to push (Cash, 2004).

The aim of Poon, Hui, Dai, Kwok, Woo (2005)'s project is to examine and compare the feasibility, acceptability for older patients using telemedicine versus a conventional face-to-face method. There was significant and comparable cognitive improvement in clients in both treatment arms. The videoconference arm was highly accepted by the clients and the community center.

People with mild dementia are able to learn how to use a mobile phone with an "errorless learning" method (Clare et al. 2000). The "Mobile Tele coach", a one-button mobile phone which allows direct answering, had an effect on positive social experiences and self-esteem in people with dementia (Lauriks et al., 2010). The FP4 project ***MORE*** was aimed at redesigning existing mobile phones and simplifying the user interface to meet the many differing needs of elderly and disabled people. Various MORE-based telephones with an integral GPS function were produced by Benefon (Lauriks et al., 2010).

Yasuda (2007) proposed the following ideas. A simplified model intended for use by the elderly can be used as a memory aid, rather than as a means of telecommunication. ***Memo pad attached to the mobile phone*:** a small notepad can be glued to the back of the phone and a pencil attached to it by a strap. This allows subjects to jot down the names of people they meet. ***Recorder*:** this function can be used to record the user's own voice or those of people talking to him, and these can then be played back to check exactly what has been said. For example, users can ask their doctors to record their explanations during consultations. ***Programmable voice alarm*:** as with a Sony IC recorder, recorded messages can be automatically output at programmed times and photos displayed simultaneously on the screen. For example, when the doctor's voice says, *"Take your tablets"*. ***Timer*:** some mobile phone models have an in-built timer. For example, if a dish needs to cook for 20 minutes, the timer can be set for 20 minutes. ***Address book*:** with age, it becomes increasingly difficult to learn and retain names. To overcome this problem, a number of different categories of names can created (work, friends, hobbies, *etc.*) and people's names classified accordingly. When someone cannot remember the name of the person he or she is talking to, one solution is to pretend to receive a phone call and search for the person's name in the address book. ***Portraits*:** sometimes, a person's face is more easily remembered than his or her name. Therefore, it may be useful for

subjects with a memory disorder to ask the person with whom they are talking to let them take a photo with their mobile phone. ***Video***: They can also make a video and thus keep a record of the latter's voice and facial expressions. This avoids having to record his or her name. ***Photos of storage places*:** When they leave an object somewhere, they should therefore take a photo of it, showing the place where it has been put. That way, when they can no longer remember where it is, they have only to look at the photo. ***GPS*:** If they carry one around with them, they can be located using GPS from another mobile phone. This is why it is so important for them to familiarize themselves with mobile phones from the very outset. They may also forget to take it with them or recharge it. The "Programmable voice alarm" function should therefore be activated, so that it automatically reminds them every day to *"Take your mobile phone with you"*.

PEAT™ software is designed to provide cueing and planning assistance for people with memory, attention, and cognitive disorders. Typical users include patients with traumatic brain injury (TBI), neurodegenerative conditions including Alzheimer's disease, and attention deficit and hyperactivity disorder (ADHD). PEAT lets people become more independent by helping them to plan and execute daily activities, and to stay on schedule. It is also important that users carry a mobile version so that they can add and modify their calendar, names and notes throughout the day. PEAT automatically cues the user with sounds and pictures, monitors task performance and adjusts the schedule whenever delays, interruptions or other calendar changes occur. Automatic Cue Card uses graphics and sounds to remind users when to start and stop tasks on schedule and within deadlines. Automatic rescheduling whenever tasks are added, rescheduled, interrupted, or canceled.

Prospective Memory Aids reviewed below are context-aware and use artificial intelligence to determine whether and when an appropriate reminder or procedural is necessary for task execution. They are programmed either to improve performance of multiple different tasks throughout day (***Memory Glasses***, ***Memo Clip***, ***Friedman***) or a sequence of steps in either single or multiple tasks (***ISAAC***, ***AutoMinder***, ***Friedman***). However, clinical trials specifically with dementia subjects are lacking for all of them (Bharucha et al., 2008).

Some studies are targeting life-logging aspect for the elderly, such as the ***HERMES*** project. The key services are reminding the user of what happened in the recent past, helping users to manage their daily schedule, and offering a series of exercises to strengthen the user's memory. The HERMES project aims to boost existing memories, while ***Memory Lane*** proposes a solution for building lasting episodic memories, and to recall past activities for maintaining those memories (Hallberg, Kikhia, Bengtsson, Sävenstedt, & Synnes, 2010).

4.5 Researches for Future Assistance

The ***MAPS*** project is focusing on the HCI issues involved in building a hand held cognitive orthotic. The Independent Life Style Assistant Project (***ILSA***) is another recent related effort. There are a lot of projects as follows; Research Projects and Programs, MIT research Affective Computing, The Remembrance Agent, The Personal Area Network, Wearable Audio Computing, Columbia Mobile Computing Laboratory, Georgia Tech wearables, University of Toronto Humanistic Intelligence Lab, U. Washington HIT Labs guide to wearable computer literature, MoBIC: Mobility of Blind and Elderly People Interacting with Computers University of Magdeburg project, WebABLE "First-Stop-Shop" for people with disabilities (Pollack, 2002).

Sense Cam is a wearable digital camera that is designed to take photographs passively while it is being worn. It is fitted with a wide-angle (fisheye) lens, thus ensuring that nearly everything in the wearer's view is captured by the camera. Sense Cam records events as they happen, requires little effort on part of the user, is thought to lead to consolidation of autobiographical memory (Bharucha et al., 2008). Carnegie Mellon University Quality of Life Technology Center is developing a product called the ***MemeXerciser***. This product is a Life-logging technology which provides memory support to AD patients by capturing life experiences via sensors or cameras. Their research is based on the product SenseCam (Willis & Price, 2014).

Yasuda et al. (2003) have produced a system where they wear a CCD small camera under the peak of their cap. This is linked to a digital video recorder kept in a pouch on their belt. With this equipment, they can record the speech noises and scenes around them, the faces and voices of the people they talk to, and what they are holding or reading. Prior to the test, five objects were placed in four different rooms. We then instructed one of the subjects to find the objects while playing and viewing the video. It took the subject 7.54 minutes to find them all, whereas it took 29 minutes to find only one item, for onother subject while not viewing the video (Yasuda, 2007).

Foo, Pang, & Zhang (2014) developed ***UbiCuts*** system. It consists of a wearable image/video/voice capturing device and a suite of mobile apps. To use the device, older adults need to open the app, send a voice message or take a photo/video using the wearable device or a smartphone. The first prototype of the wearable image-capturing device is in the shape of a bracelet that supports the capture of images but not videos. The second prototype will be able to capture images, video and voice, and the "Surveillance" app will be able to monitor both indoor and outdoor safety of older adults and the disabled. The image matching simply requires mere pattern recognition.

An ***adaptive prompter*** for people with Alzheimer's disease will use ubiquitous sensors to

monitor the performance of routine tasks, and provide prompts when a client gets “stuck”. For instance, a sensor in the bathroom might notice that a person with A.D. has picked up a toothbrush but then stopped; in response, the adaptive prompter would provide guidance to the person about putting toothpaste on the brush and using it to brush his or her teeth (Pollack, 2002).

A prototype ***agitation monitoring system*** for persons with dementia illustrates the ability of multiple simple environmental sensors. The investigators instrumented a laboratory with acoustic, pressure and ultrasound sensors to detect movements of a single experimental subject. The intensity and duration of the movements were rated according to the total body movements and up and down movements’ subscales of the scale to observe agitation in persons with dementia of the Alzheimer type. The ultrasonic and pressure sensors alone detected agitation in 59% and 73% of instances, respectively. This prototype system demonstrates the application of multiple inexpensive sensors to tackle a specific clinical problem (Bharucha et al., 2008).

Fabrics with embedded biosensors have now been developed that permit continuous remote physiologic monitoring of multiple vital functions. These “***smart garments***” are capable of alerting family and professional caregivers of aberrations and incident medical conditions that may otherwise escape detection until complications are evident and unavoidable. A large-scale field trial has only recently been launched for one of these bio textile-based systems (***Smart Shirt***). These include light weight, capacity to embed biosensors in inconspicuous everyday clothing, resistance of these biosensor fibers to physiologic functions such as sweating, ease of laundering, and lack of discomfort or potential for allergic skin reactions (Bharucha et al., 2008).

The ***eHealth Strategic Objective*** is aiming to create an intelligent environment. The focus is on key technologies, such as biosensors and secure communications in smart clothes and implants, as well as software tools for monitoring and managing health status and patient safety. Such technologies are not yet being applied and validated for persons with dementia (Lauriks et al., 2010).

There were no mentions of computer chips which could be implanted in the brain which would remind it to breathe, eat, eliminate, or other bodily functions. It is really no different than an artificial heart valve or a bionic arm or leg. The literature all agreed on the basic types of assistance, which was to record memories and play them back or ensure the safety of the AD patient. Could a memory chip be implanted in the brain which would allow the AD patient to keep the memory of themselves alive? (Willis & Price, 2014).

The fear of all people facing Alzheimer’s disease is not just losing who their family is, but in losing themselves. Social media could assist in keeping the AD patient in touch with other people

and help with facial recognition of those people using the profile picture and making a game of matching names and faces. A personal website with pictures uploaded of family, friends and the AD patient at different stages of their life could assist in keeping memory alive (Willis & Price, (2014).

4.6 Summary

People with dementia are ideal nominees for benefitting from context-aware technologies and, from an engineering stand point, they are an ideal challenge to design for. The best, currently known method to intuitively and seamlessly change and adapt the environment to the fluctuations of the user is through technologies associated with Ambient Assisted Living (Peterson, Prasad, & Prasad, 2012).

There is a gap between what individuals with dementia want, what developers design, and how outcomes are evaluated. Despite widespread acceptance that ATs improve quality of living (QOL), there is relatively little data to support such claims. The results shows the need for future ATs to be more integrated into the environment, combined with ambient and intelligent technologies, the Internet of Things (IOT), and the potential of cloud computing. They will also become more personalized to individual needs and user requirements (Peterson, Prasad, & Prasad, 2012).

Some of the standard high-tech ATs consist of following modalities (Peterson, Prasad, & Prasad, 2012). ***Communication*** (e.g. e-mail, real-time alarms, telecare and medical networks, social support networking). ***Robotics*** can perform household maintenance (e.g. vacuum), as a butler (e.g. assistance with bathing or eating) or companionship activities. ***Home automation*** technologies could monitor and ensure home safety features (e.g. fire and smoke alarms, ventilation, sensors for water temperature, power control). ***Sensors*** for monitoring, initiating alarms and data collection (e.g. motion detection, PIR, water usage, thermostats), and computer-vision (e.g. user recognition, motion analysis). Radio Frequency Identification (***RFID***) technology is used to locate items in the home and GPS/GSM for navigation or locating the person outside the home.

The technology will also become more personalized to individual needs and user requirements and social and health care services will have streamlined electronic records and communication.

Homes in general will have more electronic features, such as keys, window and door locks and sensors. Gait sensors and accelerometers will not only be able to predict falls, but to determine the physiological root and recommend training or rehabilitation. Context-aware systems have the capacity to be cognizant of environmental activities and characteristics through networked equipment, such as mobile, pervasive and ubiquitous computing components (Peterson, Prasad, & Prasad, 2012).

Cloud Computing will play in connecting the Internet of Things for the future of dementia care

(Peterson, Prasad, & Prasad, 2012). Furthermore, there is potential for communities (Smart Cities) to play a role in the future of living with dementia by connecting the user and their devices (Internet of Things) to services through Cloud Computing. Of course, there are major issues in data storage, system integrity, privacy and security, networked architecture and service provision, but it is worth starting a dialogue on these issues and setting forward-thinking, goal-directed research ambitions for the future of dementia care. We can imagine what the future holds, now we need to create it (Peterson, Prasad, & Prasad, 2012).

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Chapter 5 Various Non-Pharmacological Approaches

5.1 Review of various Approaches

To reduce the stress of individuals with dementia and the burden on caregivers, various interventions have been introduced (Yasuda, Kuwabara, Kuwahara et al. (2009). In parallel with pharmacotherapy, Various non-pharmacological approaches have been implemented to address the emotional needs that cause the inappropriate behaviors. These include doll therapy, physical activity programs, music therapy, aromatherapy, massage and touch, and art therapy. Systematic reviews of literature published in the Cochrane Library have demonstrated reductions in BPSD following the use of physical activity, music therapy, aromatherapy, massage and touch, and art therapy (Fernandez, Arthur, & Fleming, 2013).

The American Psychiatric Association (APA) has described four different psychotherapeutic approaches that can be useful for treating people suffering from dementia (Carrion, Aymerich, Baillés et al., 2013). (1) ***Cognition-oriented approaches*** (reality orientation, skills training, spaced-retrieval intervention, cognition oriented approaches etc. (2) ***Emotion-oriented approaches*** (supportive psychotherapy, reminiscence therapy, validation therapy, sensory integration, simulated presence therapy、diversional therapy etc. (3) ***Behavior-oriented approaches*** (behavioral therapy, activity, physical exercise, Montessori therapy, job therapy etc. (4) ***Stimulation-oriented approaches*** (recreational activities or therapies, music therapy, dance therapy, art therapy, exercise, multisensory stimulation, aromatherapy, play therapy, gardening therapy, animal assisted therapy, lighting therapy, cosmetic therapy, fashion therapy, massage therapy etc.

Brain exercise: There is also recent anecdotal evidence of the effect of brain training using video games. 'Brain exercise' products have been marketed, promising to help people stay mentally fit and even help prevent dementia. However, research does not support these claims as yet. In a review of studies, they found no good evidence that brain training prevented or slowed down mental deterioration in healthy older adults (Carswella et al., 2009).

Errorless Learning: Errorless learning (EL) technique requires learning or encoding new information without error. In order to achieve this result, prompting cues are given to the person before he/she could commit an error. This process is repeated over multiple trials, until the individual can complete the whole task without the help of those cues. The effectiveness of an errorless-based technique was investigated in facilitating the learning and the retention of procedural components of three new routes with a woman with mild AD. Results showed that there was over a 50% mean increase in participant's ability to travel along the two routes, following the intervention. (Caffo, Hoogeveen, Groenendaal et al., 2013).

Reality Orientation Training: RO training is a widely employed technique to improve the ability to deal with reality of confused elderly people and people with dementia. Such technique has been used in the rehabilitation of persons with memory deficits, episodes of confused behavior, and time–place–person disorientation. There are two main forms of RO: (a) class RO, in which information about time, place and significant life events of the patients are presented and actively rehearsed every day for about half an hour under the supervision of a therapist, and (b) 24 h RO, which involves the whole staff every time they interact with the patients during the activities of daily living and at other times. The usefulness of 24 h RO in reducing ward disorientation was reported for four out of five patients (Caffo, Hoogeveen, Groenendaal et al., 2013).

Cognition Oriented Approaches: Our research results suggest that reality orientation is effective in slightly slowing down functional impairment in people suffering from dementia, bearing in mind that slowing functional impairment does not mean slowing disease progression. However, studies are too heterogeneous to identify which intervention might be more suitable for mild, moderate or severe levels of dementia. There is a possibility that the intervention itself may be teaching patients to answer cognition tests. In addition, data from several studies showed that improvements tended to be unstable and disappeared sometime after the intervention had finished (Carrion, Aymerich, Baillés et al., 2013).

Cognitive Stimulation Therapy: Cognitive stimulation approaches have the potential to assist in striving towards therapeutic goals such as minimizing psychomotor behaviors, enhancing social relationships or reducing caregiver distress (Yuill & Hollis, 2011). Cognitive stimulation is an intervention for people with dementia which offers a range of enjoyable activities providing general stimulation for thinking, concentration and memory usually in a social setting, such as a small group. A wide range of activities were utilized to stimulate thinking and memory generally, including discussion of past and present events and topics of interest, word games, puzzles, music and practical activities such as baking or indoor gardening.

The findings suggested that cognitive stimulation has a beneficial effect on the memory and thinking test scores of people with dementia. There was evidence that the people with dementia who took part reported improved quality of life. They were reported to communicate and interact better than previously. No evidence was found of improvements in the mood of participants or their ability to care for themselves or function independently, and there was no reduction in behavior found difficult by staff or caregivers. Family caregivers, including those who were trained to deliver the intervention, did not report increased levels of strain or burden. The intervention does not appear to be appropriate for people with severe dementia (Woods, Aguirre, Spector et al., 2012).

As research suggests that rehabilitation of cognitive function is biologically possible, cognitive stimulation approaches may have therapeutic benefits for individuals with mild to moderate dementia by facilitating the delay of progressive cognitive impairments. Such approaches must not be confused with cognitive training, which typically involves guided practice on standardized tasks such as recall of items on word lists; this strategy is somewhat controversial as it fails to consider cognition within a real-life context and as there is no significant evidence that it is beneficial. Efforts to develop person-centered cognitive stimulation approaches have emerged within recent years (Yuill & Hollis, 2011).

Simulation Presences Therapy: Simulation presences therapy (SPT) was successful in alleviating 'problem behaviors' such as social isolation, verbal aggression or agitation. An example of nighttime assistive success was reported where one resident required antipsychotic medication every night for episodes of screaming. The need for medications was eliminated. ***Recreational therapy*** was studied by Lee et al. The study introduced ***gardening therapy***. Gardening could provide a sense of accomplishment, create no extra care-giving workload, be easily integrated into environment; and be enjoyable for both caregivers and people with dementia (Carswella, McCullagha, Augustoa, et al., 2009).

Craft therapy was explored for the benefits of crafts as memory triggers in reminiscence sessions with older women in residential care who had severe symptoms of dementia and had enjoyed crafting as a leisure activity during their lifetime. Three structured reminiscence sessions, involving different kinds of handicrafts, craft material, and craft tools, were used to trigger memories and offer multisensory stimuli. Multisensory triggers activated nonverbal and verbal reactions, sustaining attention and prompting interaction and nonverbal communication. The most interesting triggers stimulated recall of forgotten, pleasing craft experiences (Pöllänen, and Hirsimäki, 2014).

Doll Therapy (Fernandez, Arthur, & Fleming, 2013): Doll therapy is based on the ***attachment theory***. The impact of attachment experiences is evident from childhood through adult life. For people with dementia, attachment behavior can be observed at various stages of dementia. Searching for deceased relatives has been reported when attachment needs were not being met.

The use of dolls for therapeutic purposes involves giving a doll to a person with dementia to care for and is purported to assist in overcoming some of the attachment needs. For example, cuddling and caring behaviors towards the doll are said to be an expression of being needed, feeling useful and being able to care for others. In addition, hugging a transitional object such as a doll is representing security during a period of uncertainty. Doll therapy has been reported to reduce

agitation, aggression and behaviors of concern in people with BPSD. Doll therapy as a strategy in managing challenging behaviors in people with dementia has not yet been quantified in a manner to enable clinicians to make an informed decision about its benefits.

A motorized toy dog can effectively reduce wandering and agitation after dinner in people with dementia. The robot dog AIBO as well as a motorized toy dog proved to be effective in increasing patient activity and spontaneous speech during occupational therapy. The introduction of AIBO increased the number of utterances in people with dementia. These results indicate that socialization and social activity can increase in the presence of a toy dog and AIBO (Lauriks et al., 2010).

Cognitive Training by PC: Specialized software and commercial devices including the possibility of cognitive gaming has been placed into the market; most of them are based on neuropsychological models of cognitive aging, but few have been scientifically tested. Cognitive training includes specific stimulation regarding to concrete processes such as memory or language, as well as more general tasks based on broad constructs such as attention or speed of processing. The level of difficulty must be in accordance with capabilities: difficult enough to mean a challenge for the elder, but not so difficult that becomes frustrating. Little attention has been placed in this field on older adults' prospective memory stimulation, despite its importance on their daily living (Buiza et al., 2009).

Cogmed Working Memory Training is a home-based program to improve executive function by training working memory capacity. In brain injured patients after stroke, Cogmed Working Memory Training was found to have an effect on short-term memory tests, on a paced auditory serial-addition task (Buiza et al., 2009).

In mild and moderate stages of dementia, computerized cognitive training in combination with other cognitive stimulation programs has shown improved outcome scores in cognitive performance. ***Smart brain***'s efficacy with the cognitive stimulation in Alzheimer's disease has been demonstrated in a single blind randomized study. Patients receiving Smart brain training began at the lowest level of difficulty from 15 levels, increasing the level of difficulty automatically after three consecutive performances. After 12 weeks and also after 24 weeks, significant differences were found in standardized measures of cognitive function, but not in functional assessment nor in specific neuropsychological tests (Buiza et al., 2009).

Recreation Therapy: By the observations of people with dementia, meaningful activities are often lacking, by providing more stimuli and activities, such people's quality of life can be improved. In his list, most attention is paid to the active involvement of the person with dementia, first, to support and facilitate the person's memory, orientation, and other cognitive abilities;

second, to enable the person to carry out tasks and activities. Third, such active involvement is also necessary to facilitate meaningful occupation during the day, including leisure activities, and the maintenance of valued roles in the family and other social networks (Topo, 2009).

Many individuals with memory impairment seem to lose interest in their familiar hobbies or activities; they may appear apathetic or depressed about life. When questioned about what they might like to do, they cannot think of anything to suggest. Before assuming the person is really not interested in doing anything, consider that the memory impairment might be the culprit (Bourgeois, 2007).

The person may not recognize the words used to invite him or her to do something or may not understand them. Written and graphic memory supports can be very helpful for maintaining interest and engagement in preferred activities and hobbies. A visual prompt may be more effective than the verbal cue because objects and written words are permanent and static; in comparison, auditory information in the form of words, phrases, and sentences is transient, often disappearing into thin air. Life-long hobbies and interests will always attract more attention and interest than generic recreational activities designed for the older adult (Bourgeois, 2007).

The ***INDEPENDENT*** project, having ascertained from people with dementia and carers what they would most enjoy, developed several devices, most particularly a music player, designed to be easy to use for people with cognitive impairment. ***Talking Mats*** is a communication tool that uses a fabric mat and a series of cards to support people to express their views. They tested it with people with dementia and found that it was indeed effective (Bowes, Dawson, & Greasley-Adams, 2013).

Schikhof, De Lange, & Goumans (2012) targeted games for the iPad that can be played independently and individually by people with dementia. If playing games enables people with dementia to do meaningful activities on their own; activities that will give them pleasure and a sense of achievement. If this is the case, game-playing can be dually beneficial, i.e. for the people with dementia and for the caregivers. The Rotterdam University of Applied Sciences is developing a number of games. The outcome led to the following selection of themes for concept games: pets, the outdoors, hobbies, sports, and shopping. The first experiences of designing the new games and the new iPad cover shall be shared in the symposium (Schikhof, De Lange, Goumans, 2012).

Laughing Therapy: To evaluate the effect of laughter on cognition in elderly with mild cognitive impairment (MCI), the intervention was tried to watch a Japanese comedy routine Manzai (Yamamoto, Mizuno, Aota et al., 2012). Manzai is one of a traditional style of stand-up comedy in Japan, which usually involves two performers. The intervention led to significantly higher cognitive

scores in exercise, word memory, and animal name recollection domains, suggesting that interventions focused on laughter and simple exercise may improve cognition in elderly patients with MCI. A lot of data from previous study shows effects of cognitive function from diversional therapy. It is important to consider about cultural and individual contents for elderly people in each country.

HERMES-Cognitive Care and Guidance for Active Aging (Buiza, Feli, Facal et al., 2009): This project is co-funded by the European Commission. The main aims of the HERMES project are facilitation of episodic memory. HERMES captures user's daily life information through audio and video means as well as information on the context. HERMES also provides reminders through visual and audio patterns in order to strengthen prospective memory.

The first step in the HERMES project was to clearly identify the user's needs as well as their preferences about the new technologies. The results showed that most of the healthy older adults studied stated they would appreciate a device to play some cognitive games. Older adults want a device to remind them. The situations in which they feel most uncomfortable due to forgetfulness are buying something or doing any task; how to get somewhere, forget names; an important appointment and conversations. Technological external aids should be easier and simpler than the aids currently used. Most of the participants forgot from 5 to 7 events per week.

HERMES have the goal of encouraging autonomy and sense of independence by means of making use of information introduced into the system by HERMES users about their own daily life. This distinctive aspect will allow them to stimulate prospective memory directly addressed to daily events. Users' motivation has been taken into account, especially in order to promote user long-term motivation and adherence to daily gaming experience.

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Chapter 6 Reminiscence Therapy and ICT

6.1 Review of Reminiscence Therapy

Memories are our own private episodes, formed from an individual person's experiences in the past. Talking together on the pasts means exchanging a part of their egos. As a result, people are able to prompt mutual understanding. Therefore, memory has a role of building and maintaining human relationships. Reminiscence is "a process in which individuals attempt to accept negative events of the past, resolve past conflicts, reconcile the discrepancy between ideal and reality, identify a pattern of continuity between past and present and worth in life as it was lived" (Thompson, 2013).

Reminiscence intervention is one of the approaches suggested in order to increase feelings of positive self-esteem and psychosocial well-being, and to decrease behavioral disturbances (Yasuda, Kuwahara, Abe et al., 2009). The act of reminiscence is critical to successful aging, as it helps to form identity and build problem-solving skills (Thompson, 2013). Yamasaki, Izumi, & Nakatani (2012) provide a trigger for recollection by presenting social events and information similar to the lost memory.

Despite experiencing degeneration of short-term memory function, people with dementia can very often retain a facility for long term memory. Reminiscence therapy is a proven means of stimulating long-term memory to prompt communication in people with dementia (Gowans, Campbell, Alm et al., 2004).

Current practice often relies upon physical props, e.g. old photo-albums, audio tapes, CD/DVDs, videos etc. (Gowans, Campbell, Alm et al., 2004). Media content ranged from generic content to personal photographs; the predominant media type was music. Other content types were based on the era or region in which the individual with dementia grew up or were based on personal interest. The use of a "reminiscence kit" include a portable selection, such as old toys, smells, maps, and food, and technological triggers, such as slides or records. (Lazar, Hilaire Thompson et al., 2014).

Reminiscence Therapy and Life Review (Lazar, Hilaire Thompson et al., 2014): Reminiscence methods were introduced in dementia care over 20 years ago and have taken a variety of forms. Reminiscence Therapy involves the discussion of past activities and events with other persons, usually with the aid of tangible prompts such as photographs, daily life items, music and archived sound recordings. Life Review is another method for use in reminiscence processes that typically involves individual sessions, in which the

participants are guided chronologically through life experiences, encouraged to evaluate them, and possibly to produce a life story book.

Evaluations: Fletcher, & Eckberg (2014) explored the effects of creative reminiscence activities on the quality of life of clients. They showed significant increases in caregivers' perceptions of their loved ones' quality of life and decreases in the burdens during the intervention phase. The Cochrane review concluded that there are many promising indications of the effect of reminiscence work on quality of life and reduced depression, but due the small size and relatively low quality of the few studies done, it is difficult to make a robust conclusion yet.

Photo Using Reminiscence Therapy: The various studies on reminiscence therapy suggests the use of photographs such as scents, foods and music. Some interventions used songs and the sharing of photographs that correlated with the weekly "theme", and encouraged the family members of participants to join in. The use of props can be used to add structure to the group therapy session, as each member can take turns. This structure was taken to another level by limiting the group to photos pre-selected by the therapist, which may not have allowed participants to explore the memories important to them as individuals (Thompson, 2013).

The interest album is the collection of pictures with some large-print words about a single, favorite topic or activity can provide many hours of engagement. Interest albums can be made using magazine pictures, photographs of familiar and personal objects, and mementos and memorabilia, such as baseball or other sports, a doll collection, wine, fishing, music, theatre, reading, TV shows, movies/ actors, gardening, shopping birds, favorite trips, and so forth (Bourgeois, 2007).

Photographs hold a variety of types of information such as date and time, place, and events. People have a tendency to promote their bonding by confirming the shared experiences and photographs provide an opportunity to start a conversation about shared memories of the family (Yamasaki, Izumi, & Nakatani, 2012).

However, such photographs are often too small for senior citizens to see clearly. Typically, such photographs have been pasted into albums. The albums are usually bulky and heavy, and thus not easy to handle. In addition, individuals themselves or caregivers need to turn the pages to browse through the albums. If these photos were turned into a video slideshow, enlarged photos could be seen on a TV monitor without having to turn album pages (Yasuda, Kuwabara, Kuwahara et al., 2009).

Problems of Reminiscence Therapy: In contrast to the positive results of integrative and instrumental reminiscence, poor physical and mental health, lower life satisfaction and higher distress was found amongst older adults who participated in obsessive or escapist reminiscence, such as intimacy maintenance and bitterness revival. (Thompson, 2013). A potential area of discomfort that may arise from reminiscence therapy is the reaction to disturbing photographs, such as wartime photographs or of deceased loved ones (Lazar, Hilaire, Thompson et al., 2014).

Reminiscence Therapy by Utilizing Tools: People with dementia have few means of enjoyment. Picture gramophones have buttons with the names and/or symbols of songs which the person with dementia used to enjoy singing. Pressing the button starts the music (ENABLE, 2004). The ***Musical Memory Lane*** built in a 1930s radio cabinet and the "***Video Memory Lane***" housed in a 1950s television cabinet present nostalgic music and videos to people with Alzheimer's disease in an easy-to-access, push-button, picture format (Alzheimer's society, 2015).

6.2 Review of Reminiscence Therapy by Utilizing ICT

Reminiscence Therapy Supported by ICT: The use of multimedia in Reminiscence Systems (RS) was in the growth of research supported by ICT, and there are a significant number of research projects and publications highlighting such work. It is natural, perhaps that reminiscing work, which uses visual and hearing senses could be enriched with multimedia material encompassing photographs, videos, audio recordings, music as well as historical material from newspapers (Mulvenna, Zheng, & Wright, 2009).

Using multimedia, the RS can animate the material thus making it more attractive and attention holding than a paper-based scrapbook. However, since the process of creating a memory book is itself a process rich in reminiscing opportunities, care must be taken not to replace this type of work with a more mundane and less user-centered multimedia authoring process. Arguably the next opportunity in RS research and development is the potential for the Internet to create new ways for reminiscing to be supported (Mulvenna, Zheng, & Wright, 2009). Despite its effectiveness, regular reminiscence intervention is difficult to perform, especially at home, due to a shortage of human resources. Therefore, convenient, home-oriented reminiscence interventions are important (Yasuda, Kuwahara, Abe et al., 2009).

Subramaniam and Woods (2010) reviewed key issues in relation to reminiscence work with people with dementia and presents the findings of a systematic review of original studies on

information and communication technology reminiscence systems and dementia published since 2000. Most systems comprise primarily personalized biographical materials, and these could be seen as a replacement for a life story book. A few systems comprise more general material and would lend themselves as memory triggers to enhancing conversation in small groups, or in pairs with care workers.

Information and communication technologies (ICT) are potential venues for supporting the reminiscence therapy. Lazar, Thompson, & Demiris (2014) systematically examines the scientific literature on the use of ICT for facilitating RT to assess the current state of the evidence and identify future trends. ICT has the potential to be a practical way to support the delivery of RT, whether through permitting individuals to stay in their local communities while communicating with others at a distance.

Eight papers described systems that utilize ICT for reminiscence therapy but did not report any evaluation with the target population. The projects used diverse types of technology: to deliver reminiscence therapy remotely, to capture and display daily activities, to play multimedia, to monitor brainwaves of an individual during reminiscence therapy. Several of the projects used a touch screen interface to allow people with dementia to manipulate the reminiscence materials. One example is the Computer Interactive Reminiscence and Conversation Aid (CIRCA) group, who found that the touch screen interface encouraged users with dementia to use the system themselves with little prompting (Lazar, Thompson, & Demiris, 2014).

Two projects gathered materials from the users' daily activities using technology, such as GPS, cameras, and audio recorders, to compensate for memory deficits during reminiscence. The motivation for one design was to alleviate caregiver strain originating from repeatedly providing details to help someone with dementia recall facts about events during casual reminiscence. Yasuda, Kuwabara, Kuwahara, Abe et al., (2009) used photographs, background music, narration, panning, and zooming in its reminiscence video slideshows (Lazar, Thompson, & Demiris, 2014).

One study found that generic photographs prompted more storytelling from individuals with dementia (Astell, Ellis, Alm et al., 2010) and noted the potential for emotional distress when a person with dementia fails to recognize himself or herself or others in personal photographs. Another study found that people showed more interest and less distraction while viewing personalized photo-videos than while viewing TV shows (Yasuda et al., 2009). One explanation for the disparity in findings is that the first group of researchers had people with dementia involved in conversation, possibly resulting in the person with dementia struggling to remember specific details

about pictures from his or her past. The second study took place with a person with dementia alone in a room viewing photo-videos. By not requiring the participants to generate conversation with another party, the researchers might have enabled the participants to enjoy the personalized photo-videos. Another explanation is that the different findings are due to the higher score on the Mini- Mental State Examination (MMSE) of participants in the first study, possibly leading to more awareness of their difficulty in recalling information and subsequent discomfort (Lazar, Thompson, & Demiris, 2014).

Reminiscence therapy can be time-intensive and costly in terms of preparation and delivery. Technology can also bridge geographic distance and address transportation barriers. A potential area for technology to aid in the delivery of reminiscence therapy is in allowing the digital transfer of materials for reminiscence therapy to the therapist. A website-hosted reminiscence intervention was built that allowed family members to upload personal material to be viewed by their relative with dementia (Lazar, Hilaire Thompson, & Demiris, 2014).

The football reminiscence project consisted of four interventions in different locations that used digitized images from a historic football picture database for reminiscence therapy with older males with dementia. The set of papers dealing with ***networked reminiscence therapy*** describes a system focused on the delivery of therapy from afar. The system is designed to allow a caretaker or therapist to view videos and photos with an individual in another location. Evaluations of this system have found that most individuals find remote reminiscence therapy enjoyable, and some have had persisting benefits in terms of managing behavioral symptoms, such as anxiety, irritability, and restlessness (Kuwahara, Yasuda, Tetsutani et al., 2010; Yasuda, Kuwahara, Kuwabara et al., 2013; Yasuda, Kuwahara, & Morimoto, 2009). Yasuda et al., (2013) involved in networked reminiscence therapy addressed this concern by setting up the system in the participants' homes and remotely starting applications (Lazar, Thompson, & Demiris (2014).

Future studies should be more descriptive in how reminiscence therapy is delivered. Another issue is that results were rarely separated by dementia severity, despite the differences in people across the spectrum of disease. If researchers include individuals at different stages of dementia (Yasuda et al., 2013), they should separate results by stage or specify if there is no difference (Lazar, Thompson, & Demiris, 2014).

Despite their limitations, the papers included in this review yield some rich insights on benefits and challenges of using ICT during reminiscence therapy. Challenges include that many of the systems require technical expertise for setup or operation and may not be ready for independent use

by family caregivers. Benefits include the enjoyment derived by people with dementia from viewing reminiscing materials through various forms of multimedia, such as video and audio (Lazar, Thompson, & Demiris, 2014).

The purpose of Tuan and Ko (2014) is to design a talking life memories album. When each page in this album is turned, a recorded voice is broadcast that explains the individuals in the photo. With voice interaction technology, the elderly can leave recordings for future. Generations about nostalgic photos, and they can also record their memories in their own voice. Light-dependent resistor (LDR) is used as the switch to trigger voice-interaction on or off. When the LDR is triggered, it automatically searches the corresponding voice zone with microprocessors in real time. The elderly were greatly impressed by the voice-interaction concept. In addition, most of the test subjects were enthusiastic about the do-it-yourself capacity, which allows them to decide the content of the album themselves.

Talking photo albums have become popular gifts for seniors with and without memory challenges. Fried-Oken and Rowland (2008) asked whether adding one- to two-word spoken output to pictures and text would enhance language use and conversation. Results clearly demonstrated that AAC devices with digitized voice output depressed conversational performance and distracted participants with moderate AD as compared to similar devices without voice output. It could be argued that the very presence of voice output produces perceptual and attention problems that interfere with the use of an external device for conversation. For a number of participants, the novelty of the voice output caused them to stop conversing. Some clients who could verbally embellish a point found that the spoken cue interfered with conversation (Bourgeois et al., 2010).

Photographs are useful for recalling memories of happy past days and promoting bonding of family through communication of shared happiness. However, it is difficult for persons with dementia to recall a detailed memory just by looking the registered information of the photograph. Furthermore, the family caregiver may not always remember the event shown in the photograph. Therefore, as information to aid memory recollection, the system shows another photograph registered with similar information or associated social events. The content in the social events database stores effective information for recollection, such as social events which occurred during the same period or information associated with the dementia patient's hobby (Yamasaki, Izumi, & Nakatani, 2012)

Review of Lifelog: Many researchers are trying to address this concept by logging the life of

a person, recording daily activities and making them available in reminiscence processes later on. Aggregation of audiovisual media, and sensor data such as location and temperature, makes it possible to create an overview of the activities of a day. Utilizing aggregated data from a GPS logger and a digital camera can provide technological support for episodic memory to aid persons in storytelling and reminiscence activities. It features a personal memory organizer which uses images, sounds, and recorded text, to help recall names, faces, conversations and other important information. Studies have also been done to explore the feasibility of using images from the innovative SenseCam device in conjunction with sensor data as a life-logging approach (Hallberg, Kikhia, Bengtsson et al., 2010).

Hallberg, Kikhia, Bengtsson et al., (2010) aims to show the viability of a semi-automated tool for supporting reminiscence and at the same time building up a media-rich life-log, as a useful basis for integrated services for persons with dementia. It presents and discusses a reminiscence process which aim to build and maintain episodic memories of everyday life. This reminiscence process is part of a larger system, called **Memory Lane**, which will also provide real time support based on this life-log, using context reasoning and context correlation. A person with mild dementia can learn by rehearsing details about the day, and hence build lasting episodic memories. However, this remains to be properly tested. By helping persons with mild dementia build lasting episodic memory and by providing real time support through the MemoryLane mobile device we hope to promote independent living for persons suffering from mild dementia.

The typical approach for reminiscence processes in the studies mentioned above is to use wearable devices which can capture and collect data during the day of a person (mobile device, camera, GPS logger, etc). The data is then typically transferred to a local storage where it is aggregated and analyzed to form a life log (Hallberg, Kikhia, Bengtsson et al, 2010).

The Microsoft SenseCam, a device that takes photographs at intervals was wore by a person with early-stage dementia. A therapist then used the photographs during RT. The individual was not able to remember that he had been wearing the SenseCam and was confused about where the pictures had come from but was able to engage in richer conversation than without the photographs as prompts（Lazar, Thompson, & Demiris, 2014).

Privacy and Lifelog: There are important privacy issues related to the use of automatic recording devices in daily life. Hallberg, Kikhia, Bengtsson et al., (2010) intend to investigate this delicate ethical balance during field tests. Furthermore, users of life-logging systems must have the option to turn off recording temporarily, in sensitive situations. A key challenge is how to

make this explicit act easy enough to be remembered by users who usually have trouble remembering and performing procedures. Persons with more severe dementia will no longer be capable of using this option, leading to a strong requirement for ensuring confidentiality of recordings and other identifiable personal data.

6.3 Talking Video

For pleasant activities for Alzheimer's patients, almost all of them require caregiver supervision. Among pleasant activities, watching TV has many attractive features for individuals with dementia. It is convenient, readily available, and does not usually require caregiver supervision. However, not all TV programs effectively sustain patients' attention or provide enjoyment. Moreover, in the course of time, dementia is often accompanied by deterioration of language ability, making it difficult to comprehend the conversation on TV programs, as well as conversation in daily living (Yasuda, Kuwabara, Kuwahara et al., 2009).

As an alternative to TV programs, videos for people with dementia are currently available. Most of these videos include singing old songs and showing old customs, annual events, cooking, and so on. In a generic videotape series called "video respite", created for the use of individuals with dementia, video narrators talk in calm, friendly tones about activities such as gardening, family events, gatherings at Christmas, and singing old songs (Yasuda, Kuwabara, Kuwahara et al., 2009).

Therapeutic benefits of ***Video Respite*** let people with Alzheimer's disease enjoy the interaction. This highly engaging video series provides opportunities for singing, movement, and conversation for viewers in moderate to advanced stages of Alzheimer's disease and related disorders. These programs are proven to calm agitation and reduce self-limiting behaviors. Flexible enough to be used almost anywhere a television or videotape player is available, the videos are perfect for a variety of settings, including adult day centers, clinics, hospitals, support group meetings, long-term care facilities, and even home use (Lund et al., 1995). Yasuda et al. (2006a) created "Talk Video" for such individuals, in which a woman talks about such topics as hometowns and old customs and sings old songs. Yasuda et al. also developed a conversation-support system that consists of three electronic resources: a vocabulary data file, an encyclopedia, and Internet homepages (2007a). DVDs on the market can also be used as additional contents, such as short movies depicting traditional foods and events or social documentaries (Yasuda, 2006b). This system has been converted into a remote conversation system (Aye, 2008).

6.4 Reminiscence Video

Yasuda (2007) created two such generic videos. One problem with group reminiscence intervention or generic video use is that personal preference is often not considered. It is difficult to

predict which generic themes will engage a person in a reminiscence session. Furthermore, individuals with dementia develop semantic amnesia that causes an inability to recall generic memories such as public events, traditional practices, common knowledge, and so on (Yasuda, Kuwabara, Kuwahara, Abe, & Tetsutani, 2009).

Despite its effectiveness, regular reminiscence intervention is difficult to perform, especially at home, due to a shortage of human resources. Therefore, convenient, home-oriented reminiscence interventions are important. As individuals, we are inevitably more concerned with ourselves and our own autobiographies than generic episodes. Individuals with dementia also show a clear desire for items of personal relevance in reminiscence intervention (Alm et al., 2004). Their autobiographical memories, especially of younger times, are often preserved. Although individuals in advanced stages of dementia cannot voluntarily recall autobiographical memories, proper stimuli such as old photos and retold episodes may help them recall their "old days" (Yasuda et al., 2009). Technology would create a DVD that stores and plays the patient's biography (Willis & Price, 2014). Cohen (2000) developed ***video biographies*** that included interviews with family members, photographs and favorite stories. Cohen's research found that agitation was reduced in patients with Alzheimer's disease after viewing the video biography, because it filled the need for social contact, and that these feelings tended to carry over.

Personalized Reminiscence Photo Videos (Yasuda et al., 2009): Each video contains about two hundred personal photos and lasts nearly an hour. It is accompanied by songs and a short, welcoming commentary. They developed a video slideshow based solely on the old photographs of individuals (Kuwahara, Kuwabara, Abe et al., 2005; Yasuda, Nakamura, & Kuwabara, 2005). They call this video a ***personalized reminiscence photo video***" (photo video). To make the interaction more engaging, a pan/zoom effect was added to the photo video. Since old music and children's songs are effective for calming individuals with dementia (Yasuda et al., 2006a), such music is played in the background to increase the enjoyment of the individuals with dementia.

The narration was made by a female narrator in her 30s who was asked to speak slowly and gently in short sentences of less than about five words. Since individuals with dementia often lack correct autobiographical memories, in order to not induce stress from difficulty of recalling memories, open-ended questions were avoided, such as "Where was this photograph taken?", "Who is sitting next to you?". Instead, the narrator frequently praised the subjects in the photographs, saying for example, "You look beautiful", and "Your dress is very nice", or the narrator made confirmative descriptive statements, such as "They are eating a delicious meal", "You are

surrounded by many flowers".

Photo videos will help caregivers perform reminiscence intervention at patients' homes or institutions. It can also be viewed repeatedly with or without caregiver attendance. While individuals with dementia are enjoying the video, behavioral disturbances are not expected to occur, thus giving caregivers some respite.

Yasuda et al. (2005) and Kuwahara et al. (2005) performed preliminary studies on the effectiveness of the photo video. The effectiveness of photo vide was evaluated in comparison with two types of TV shows: a variety show and a news show.

These results confirmed that photo videos are effective in helping individuals with dementia focus their concentration for a substantial period of time. Moreover, the results suggest that the photo video may be effective for individuals, especially with moderate and severe dementia, whereas the TV news show seemed to be less effective for maintaining concentration for subjects with moderate and severe dementia, and the TV variety show, for subjects with severe dementia. Comparison of the concentration scores for the first photo video with that of the second photo video indicates that the mild group subjects showed poor concentration for the second photo video presentation. Our interpretation is that they remembered the photos in the first presentation and were bored by seeing the same photos 30 minutes later.

The moderate and severe group subjects showed concentration scores for the second photo video that were much higher than those shown by the mild group subjects. Probably this was because the moderate and severe group subjects did not remember the photos in the first presentation. The moderate group's distraction scores, compared to those of the mild group, increased for the TV news show but not for the variety show. This suggests that the TV variety show may be much easier for them to understand and enjoy than the news show.

The severe group subjects' distraction scores increased considerably for the TV variety show, compared to those of the mild and moderate group subjects. This suggests that these severe patients already have difficulty enjoying even the TV variety show (Lund et al., 1995). The photo video appears to be an appropriate method to attract the attention of these severe group subjects.

Three subjects were unable to finish watching the shows. Subjects 5 and 8 quit the experiment due to a sense of uneasiness and worry, and subject 10 showed little interest in his photo video.

Some individuals such as subjects 4 and 14 gave extensive oral responses to the narrations or photos. Their interactions seemed like real dialogue. In an earlier study (Kuwahara et al., 2005), it was shown that some children also enjoyed conversation with their dementia-afflicted parents while watching the photo video together. Thus, the video may work as a prompter of verbal

communication for some individuals.

Our photo video combined four factors: accessing preserved memory of a younger age through photos, playing background music of old tunes, narrating in an encouraging manner, and using pan/zoom visual effects. The multiple impacts of these factors can be summarized by a caregiver's comment (Kuwahara et al., 2005): "I showed her old photograph albums on several occasions. She did not look at the albums very long, but she enjoyed this photo video for several hours. This video met my expectations."

Recent Researches on Reminiscence Video (Thompson, 2013): Baecker, Marziali, Chatland et al. (2006) seek to impact psychosocially the entire ecosystem encompassing AD individual, family, and caregiver, and evaluate the intervention's impact over a period of six months after completion of the biography. Biographies are structured as a series of "acts" which typically represent major stages of one's life such as adolescence, a first marriage, or the birth and first years of a child. Within each act there are a number of "scenes". Still photos, video clips, music.

Regular viewings of a visual biography serve to stimulate memories and bring joy to the AD individual. The biographies provide benefits to family members such as better remembering. The biographies also seem to stimulate conversations between the AD individual and family members, and to enable third-party caregivers to better understand who is in their care and thereby approach caregiving with greater knowledge and empathy.

The multimedia biography tells the story of the life of an elderly person with a cognitive impairment. Using a production process in which they collaborated with family caregivers, Smith, Crete-Nishihata, Damianakis et al. (2009) share lessons learned from the multimedia biography research to assist practitioners, families, or researchers who wish to use similar technologies and processes for eliciting and sharing life stories.

Remote Reminiscence Therapy: Communication, especially verbal, is an easy, common, and enjoyable activity for most of us. Individuals with dementia, however, tend to be alone and poorly informed with few chances to talk. One of the most important interventions in ***networked interaction therapy*** is to provide them with conversation partners on the Internet, such as friends and family members living in remote locations. A simple interface enables individuals with dementia to talk with partners by video phone whenever they want.

It is important to verify that they can converse eagerly and sufficiently for certain durations by video phone and in face-to-face sessions. Yasuda, Kuwahara, Abe, and Tetsutani (Yasuda, 2006) revealed no differences in the total response time and in the eagerness observed between the two sessions, suggesting that video phone talking could potentially have the same effects as face-to-face

conversation. The researches discussed so far suggest that a combination of video phone and reminiscence interventions would be effective for psychological stability. Kuwahara et al. (2007) created a system to incorporate video phone and reminiscence photo sharing and conducted an experiment of this system's effectiveness in an institution for senior citizens (Kuwahara, Yasuda, Tetsutani et al., 2010).

Kuwahara et al. (2010) focused on the effect of reminiscence and previously proposed a networked interaction therapy to provide such communicative intervention as talking on video phones, offering private reminiscence contents, and managing daily schedules by TV monitors (Kuwahara et al., 2004). Based on this concept, they developed reminiscence systems that consist of reminiscence video and remote reminiscence conversation systems to calm individuals with dementia and to relieve the burden of family caregivers.

However, no reports exist using video phones to assist individuals with dementia living at home, because, compared with care facilities, providing such service to people with dementia at home is more difficult. The experimental was setup of the patients at home. As preparation for remote reminiscence conversations, the subjects and caregivers submitted old photos that were digitized on the terminal PC.

Remote reminiscence conversation was effective for Subjects 2 and 4 in terms of psychological stability. Since Subject 4 sometime became anxious in the evening, remote conversation in the evening stabilized her and provided a break for her caregiver. Our system might prevent such syndromes as wandering in the evening, agitation, etc. Furthermore, Subject 4 was even stable three hours after the conversation. This may be the most valuable finding of this experiment and for future research. For Subject 1, there was no difference in psychological stability between watching TV and remote conversation. Her dementia was mild, so she could still enjoy ordinary TV programs. This might explain why there was no difference in the psychological stability.

Despite its effectiveness, reminiscence therapy is difficult to perform at home because such sessions are usually conducted in a group led by experienced staff at institutions with such items as old tools, toys, photos, and paintings. The reminiscence conversation system might overcome such difficulties. Combining with our schedule prompter system will enhance the effectiveness of ICT utilization for supporting individuals with dementia and their family caregivers at home.

6.5 Simple Reminiscence Video

Since creating such personal reminiscence photo videos is very time-consuming (Yasuda, 2006b). Yasuda, Abe, and Kuwahara (2006b) developed a simple system for making photo videos by connecting a digital video camera to a TV set with an integrated VCR function. With this system,

the photo video can be made on the spot without needing to be edited. To further improve photo video production, Kuwahara et al. (2005) developed a computer-implemented authoring tool that semi-automatically creates a photo video with narration and music. By using these methods, the photo video can be made at a lower cost and with less labor. Moreover, this will allow many individuals with dementia to enjoy reminiscing about old videos in their home or institution setting.

6.6 Group Reminiscence Therapy

The personalized Monogram Booklet slideshow is presented via a laptop computer. Each of six slides has a personal photo, a short phrase starting with the first letter of the participant's name, and a voice recording of the short phrase. The Monogram Booklet slideshow is customized using personal photos, a familiar voice, and short phrases that bring together a meaningful moment via sight and sound. With the written and spoken photo explanation, a participant is more likely to get through the slideshow without interruption (Spivey, 2011).

Some research suggests that the reminiscence photo activities that include voice input can be distracting to participants, especially those with moderate Alzheimer's disease, when compared to reminiscence photo activities with no sound. The participant's focus becomes more fixated on the sound than the purpose of the activity as a whole. After each slideshow, if the group starts no conversation, the facilitator can begin with open-ended questions. For example: "Do these photos remind you of anything?" (Spivey, 2011)

Otake (2009) proposed novel method named ***coimagination***. Participants of the co-imagination program bring three images according to the topics of the session in order to share imagination and communicate with them. Each participant has five minutes for talk and five minutes for questions. Number of participants is six, so that one session lasts for one hour. Themes include "favorite things", "neighborhoods, hometown and travels", etc. Selecting photos stimulates planning abilities, and conversation about them develops communication skills.

A group reminiscence approach (GRA) with reality orientation (RO) is widely used as a psychosocial intervention for dementia. Akanuma, Meguro, Meguro et al. (2011) studied 24 patients with vascular dementia. Since glucose metabolism is associated with brain function, cerebral glucose metabolism was measured by positron emission tomography (PET). PET demonstrated that metabolism in the anterior cingulate was increased in the GRA-RO, whereas no significant changes were observed in the control. These results suggest that GRA-RO stimulates the anterior cingulate and has a positive effect on social interaction.

6.7 Summary

Reminiscence intervention is one of the approaches suggested in order to increase feelings of

positive self-esteem and psychosocial well-being, and to decrease behavioral disturbances. Reminiscence intervention exploits the fact that long-term memory is usually preserved even after short-term memory is impaired (Yasuda et al., 2009). Reminiscing requires prompts aimed at stimulating feelings and memories e.g. the use of audio and visual triggers to stimulate recall. Researches demonstrated how it was valuable and beneficial to person with dementia. Inconclusive evidence was found for the efficacy of reminiscence therapy for dementia in a Cochrane Review. Reminiscence in general, but especially life reviews are potentially effective methods for the enhancement of psychological wellbeing in older adults (Carswella et al., 2009).

There was no evidence that the use of general reminiscence materials was associated with psychosocial benefits. The use of life story books and multimedia alternatives, with or without an associated life review process, does appear to be worth pursuing from both clinical and research perspectives (Subramaniam, & Woods, 2012).

In terms of social media, existing social networking sites such as Facebook can support reminiscing interactions using specialized applications or "apps." There are also emerging social network sites that cater specifically to older people. It is unclear if they support specific reminiscing activities, but a part of their attraction is in bringing older people together in a social network and supporting their interactions. While not explicitly supporting reminiscing, some sites are a social networking application that is strongly orientated to linking family members in support of sharing experiences (Mulvenna, Doyle1, Wright et al., 2011).

We believe that there are three main modalities of use for reminiscence systems. Firstly, the use of a reminiscence system by an individual; secondly, more than one person sharing reminiscences in the same physical space; and thirdly, shared reminiscing where people are physically remote from each other but inter-connected by the Internet (Astell et al. 2010b).

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Chapter 7 Music Therapy and ICT

7.1 Review of Music Therapy

Music and Dementia: Music is a powerful medium. Its effects can calm us, excite and persuade us, inspire us, and lift our spirits especially when we are cognitively impaired or facing end of life. It may even be that in Alzheimer's disease and related dementias, musical memory is spared. Music has the capacity to be a means of connecting, communicating, companioning, and preserving the self along the long, dark journey (Foster, 2009). The use of music therapy allows a unique method of communication for individuals who have difficulties with language. The musical abilities of individuals with dementia remain intact for an extended period of time, despite cognitive deterioration（Ingram, 2012).

Music therapy is one of the methods known to alleviate BPSD. For this reason, caregivers will play music on an audio system on a daily basis. A music therapist may also come once in a while to the nursing home and perform music therapy. The music therapy has no particular form or content. In institutions, the patients often spend one- or two-hours singing songs, playing musical instruments, doing body exercises to the music, and so on, led by the music therapist. It is a pleasure for them to play musical instruments by themselves. In some cases, they talk about the past and talk about their past lives to the others after their music sessions (Oshima, Nakayama, Yasuda et al., 2010).

Definiton of Music Thrapy (MT): MT is one example of a non- pharmacological treatment that has been used to treat individuals with dementia. The World Federation of Music Therapy (2011) describes MT as the use of music and/or its musical elements by a qualified music therapist, on an individual or group basis, through a formally defined process. This process is designed to facilitate and promote communication, relationships, learning, mobilization, expression, organization and other relevant therapeutic goals. Two types of MT were distinguish: The first is referred to as ***receptive MT***, in which the music therapist provides music while individuals simply listen. The second is referred to as ***active MT***, in which individuals are expected to participate in the production of the music by playing instruments, singing, and/or dancing (Ingram, 2012).

Differentiating between ***music therapy*** and ***music activities*** studies is not straight forward. Music therapy requires clear theoretical and applicative bases along with methodological and scientific objectivity in research design. In addition, some empirical studies conducted by music therapists were music activity studies, and the concept of music therapy also differed

according to cultural contexts (McDermotto, Crellin, Rider, & Orrel, 2013).

The systematic reviews found evidence for short-term improvements in behavioral and psychological disturbance. The limited availability of high-quality studies and the lack of evidence for long-term benefits of music therapy also highlight the difficulty of finding appropriate outcome measures to evaluate a complex intervention for people with dementia (McDermotto, Crellin, Rider et al., 2013).

Review of Music Therapy: Dowse (1996) introduced the following personal episodes; *It was like switching on a light. As soon as the individual or group music sessions commenced, many of the residents "came alive", singing or whistling, shaking small hand-held percussion instruments, and moving hands and feet rhythmically. Whenever I visited the participants' dayroom, the residents were sitting in a state of total apathy, were asleep or in the case of one or two, muttering to themselves. The behavior observational data highlighted the marked contrast between the participants' behavior in the music session and the dayroom.*

In an investigation of the use of music to retrieve long-term memories, ix thirty-minute sessions were given to twelve residents of two nursing homes, diagnosed as having Alzheimer's disease. Two of the sessions used musically cued reminiscence; two sessions were spent in verbal reminiscence without music; two sessions consisted of familiar songs. The results for the musical activity were statistically significant (Dowse, 1996).

People with Alzheimer's dementia was examined for verbal recall, with and without music. the music encouraged responsive participation (singing, humming, and tapping) and those words in a musical context facilitated recall more than words without music (Dowse, 1996).

The use of drums was investigated with individuals in the advanced stages of dementia. Group drum playing helped to access their inherent sense of rhythm. The rhythms were varied over time, however their repetitive and predictability nature provided a stable base for a positive participatory activity (Dowse, 1996).

Music therapy sessions provided one of the only opportunities in which low-functioning patients could interact successfully with others. The effects of recorded music in decreasing occurrences of aggressive behavior were observed among the patients with dementia during bathing episodes. Caregivers reported improved affect and a general increase in cooperation with the bathing task in response to music. Several caregivers had successfully used music to calm individual agitated patients. However, uncontrolled sound could cause agitation in other patients and stress in the nursing staff (Oshima, Nakayama, Yasuda et al., 2010).

An experiment was conducted in which individuals with dementia listened to their preferred

music. The results showed that mean agitation levels were significantly lower during than before listening. The study of Nair et al. found that ambient Baroque music did not have a calming effect. Therefore, in order to achieve the desired behavioral effect, music may need to be tailored rather than generalized (Oshima et al., 2013).

Effectiveness of Music Therapy (McDermotto, Crellin, Rider et al., 2013): Literature reviews on music therapy in dementia conducted to date have found short-term reductions in behavioral disturbance and improved mood, but evidence for long-term benefits is lacking. conducted narrative synthesis (NS) systematic review of literature on music therapy in dementia.

Group music therapy may encourage social interaction between group members, thus reducing social isolation and assisting in communicating feelings and ideas. Fundamentally, music making is non-verbal, and this offers an alternative means for self-expression and communication when the conventional use of language becomes difficult. Music accessible medium for people with dementia. However, despite the wealth of music and music therapy literature in dementia care, there are no in-depth reviews exploring the mechanisms of music therapy interventions.

Short-term intervention was offered and found that it was still effective in reducing agitated behavior and pacing. However, this study had a particularly high number of participants excluded from analysis; therefore, the degree of evidence is questionable. Reduction in wandering behavior was also reported in studies, however, the studies' quality was too low to draw any conclusion.

A long-term effect of music therapy on agitation was investigated, but this could not be established because of the large variation between the treatment and control groups and fluctuating Cohen–Mansfield Agitation Inventory scores.

The small-group intervention focusing on reminiscence using familiar songs was effective in reducing depressive symptoms. There was a significant improvement in the Cornell Depression Scale scores; however, provision of daily music therapy is not a common practice in most clinical settings. Hence, the positive results might not have been typical.

Six studies were examined for hormonal and physiological changes observed following music therapy. Musically medicated stimulation of several neuro-hormonal and neurotransmitter systems is hypothesized to be able to accompany behavioral changes. Physiological changes related to music therapy were evident. Improvement in heart rate variability was reported and decreased heart rate was also documented. Increased melatonin

concentration was associated with a calmer mood amongst the patients, and reduction of stress hormone was observed.

Two before-and-after studies explored effects of music therapy on the relationships between family caregivers and their family members with dementia. The interventions consisted of a series of structured music activities, but theoretical explanations for the choice of these particular activities were not provided for either studies.

Providing music therapy during the day had a positive influence in increasing the cognitive ability of person with dementia the following morning. Another study analyzed the reaction either to live interactive music, passive pre-recorded music or silence for 30 minutes. The visual image of someone playing provokes a greater emotional response.

The influence of music therapy was investigated on people with moderate to severe levels of dementia. Results show increased communication in the group that received the therapy. Music appeared to have significant positive effects for people with cognitive impairments. Many of those with Alzheimer's disease, despite aphasia and memory loss, continued to remember and sing old songs and dance to old tunes. Music is an important source of social cohesion and social contact so supporting its inclusion within and outside the household provided a degree of empowerment for Person with dementia (Carswella, McCullagha, Augustoa et al., 2009).

A significant improvement was found on the language subscale of the MMSE in the MT group. There is suggestive evidence that MT has a positive impact on speech content, speech fluency and category fluency in adults with VD and DAT. Following MT, improvements have also been noted on the language subscale of the MMSE.

Systolic blood pressure increases with aging; the systolic blood pressure was significantly lower in participants who received music therapy. No significant differences in cortisol level in saliva or intelligence assessment score were observed (Takahashi,& Matsushita, 2006).

RCTs study and narrative study for Music Therapy (McDermott, Crellin, Ridder et al., 2013): Randomized controlled trials (RCTs) provide more reliable evidence in evaluating healthcare interventions. However, RCTs are not always the most suitable research design for psychosocial interventions because provisions of double blinding to treatment or placebo condition are not always practically possible or ethically suitable. Individual cases are explored in more detail in qualitative studies or in single-case studies, but these studies are automatically excluded from standardized quantitative meta-analysis.

Traditional narrative reviews may offer more flexibility to accommodate various study designs; however, these reviews can be seen as less trustworthy if review methods such as

inclusion and exclusion criteria or quality assessment of studies are not made explicit.

Various forms of narrative synthesis (NS) are widely used in systematic literature reviews. However, NS has been criticized because of the lack of consensus on its constituent elements. A guide was devised a guide to make the process of NS more systematic and to minimize bias. NS can still include the statistical analysis of the findings, but the key to this approach is not only to review what worked but also to investigate why and how an intervention might have worked.

One important limitation is the small sample size that was included in these studies. In addition, the Music therapy interventions described in each study took place over a short period of time and no long-term effects were reported. Another limitation of current Music therapy research is the loose clinical definition of Music therapy. As a result of this, there is very little consistency in experimental methodologies. In addition, the definition of Music therapy does not distinguish between active and receptive forms of the therapy.

A further limitation of the research included in this critical review is that participants had varying types of dementia (i.e., Vascular dementia or Alzheimer's dementia). As well, no information regarding the severity of the dementia was provided. A more random sampling to obtain participants would be necessary in order to increase the generalizability of the results.

Review of Music Therapy by applying ICT (Oshima et al., 2013): The ***Music Memory Lane*** system was constructed, which enables people with dementia to listen to and watch nostalgic music videos. This system had a positive impact in engaging people with dementia. ***Picture Gramophone*** are also systems that present old popular songs and display old video pictures. Alm, et al. constructed a hypermedia system ***CIRCA*** that allowed people with dementia to enjoy reminiscences using generic photographs and nostalgic music via interaction through a touch screen. When a patient with dementia touches a photograph on the screen of CIRCA, music suited to the photograph is presented. ***Express Play*** is a support system that patients with dementia compose music.

However, all of these systems are passive for the users. Topo, et al. described the ***Picture Gramophone*** when the user begins to sing along with the accompaniment, the lyrics appear on the screen and they are timed to scroll along with the music. ***ExPress Play*** promotes musical creativity in people with dementia, allowing them to create music actively. When the screen is touched, the user hears a chord play and sees circular shapes on the screen. People with mild to moderate dementia showed a positive engagement in the music activity. However, it is doubtful that they would enjoy this system on a daily basis.

Music Table system uses applications of augmented reality to the composition and learning of music for children. The children use cubes on the table, which are the input systems that start the

sound. Cubes are considered to be familiar toys for children, so they are apt to touch the cubes without any directions.

7.2 Behavioral Guidance by Music (Yasuda et al., 2006)

There have been no previous reports of daily home activities of individuals with dementia being guided by the combination of music and verbal messages. This study evaluated the effectiveness for three individuals of music and messages which were automatically output by an IC recorder. After music was presented, messages instructed them to go to a day care center, behave more peacefully and eat more at meals, respectively. These stimuli were highly effective for guiding the above activities. This study suggests that automatic output of music and messages has potential as a strategy for guiding individuals with dementia at their home.

Clinical literature has also demonstrated the positive effects of toys, such as dolls and stuffed animals, on the behavioral symptoms of individuals with dementia. If music and messages are given through a doll, the combination of these stimuli can assist in management of various behavioral disturbances in more severe dementia. The third experiment in this study employed music and messages presented through a doll.

Experiment 1: Case KS: KS is a 71-year-old man with Alzheimer's disease who enjoys listening to famous classical music. In April 2001 he was attending a day center four times a week. However, he began to refuse to go to the center. His wife, therefore, persuaded him to go out by saying "Let's go for a walk with the dog" (intending to go to the center). This was always a very stressful process for her.

We hypothesized that if songs expressing an admiration of nature or a desire for travel were presented to him, he would be motivated to go for a walk. Therefore, we played him songs in the morning before he came to the center. Messages advising him to go for a walk followed the songs. Once he was dressed and ready at his door the car from the center would arrive to pick him up.

Three popular songs were chosen based on the following guidelines: They were oldies from 1930s to 1940s which he knew well, they were rhythmic songs with bright tunes, and the lyrics of songs expressed an admiration for nature such as the mountains and the sea. The messages and three songs were output automatically by the IC recorder from 8:30 to 8:41 a.m. on days he attended the center. His wife put the IC recorder in the living room and took it to the door as he prepared to leave.

In the baseline phase, his wife felt severe stress in 2/7 days (28.5%), and moderate stress in 5/7 days (71.4%) related to persuading him to go out. In the intervention phase, his wife felt mild stress in 2/17 days (11.7%) and no stress in 15/17 days (88.2%).

Behavioral disturbances observed in the day care center: From the beginning of the intervention, several staff members at the center reported to his wife that recently he had behaved quietly there. The staff at the center was unaware of the beginning of this intervention. Before the intervention began, the following six behavioral disturbances were observed: “His speech becomes harsh at times”, “he was wandering around”, “he was restless all day” etc. After the intervention began, only one behavioral disturbance was observed: “He showed a stern expression at times”.

Caregiver’s (his wife) comments: Since the beginning of the intervention, he has obediently agreed to go out. Sometimes before the end of the songs, he would voluntarily stand up, and prepare to go out. As this was a very simple method which might apply to a child, I did not expect it would be so effective. I was very relieved by this intervention.

Discussion: In this experiment, the presentation of songs beforehand made the verbal messages effective for him. This appears to be due to his improved mood and increased motivation in response to the songs. Additionally, listening to the songs before coming to the day care center may have had a prolonged positive influence on his mood and resulted in a decrease in behavioral disturbances at the center.

Most music interventions, however, have been performed in hospitals or other in-patient facilities. It is quite difficult to perform at home because it adds to the work which must be done by caregivers. However, we postulated that the automatic output of music would not increase the caregiver’s workload. This study was the first attempt at bringing music intervention into the home utilizing the automatic output function of the IC recorder.

Experiment 2: Case TA: TA is a 68-year-old man with vascular dementia. Since the summer 2001, he had begun to repeat himself, to get excited easily, and to be verbally abusive to his wife. However, he complied with other’s instructions (e.g. nurses). After he hit his wife with his cane in July of 2002, a sedative was prescribed. However, he continued to verbally abuse his wife occasionally, which was very distressing to her. We hypothesized that the intermittent presentation of songs and messages would reduce his verbal abuse.

Ninety-six children's songs were prepared. These songs were evaluated by an amateur composer in regard to two factors: familiarity and non-excitement. In this manner 28 familiar and non-exciting songs were selected for the intervention. Four songs (about ten minute’s total) were grouped as a set. Ten sets (three sets were used twice) were output from 8:15 a.m. to 5:30 p.m. Each set was automatically played at one-hour intervals. At the beginning of each set, and at the pauses in a set, the first author’s messages were output. At the end of the set, the message asked him to behave quietly, peacefully, etc. (see Appendix 2).

In the baseline phase, there were six incidents of verbal abuse in 11 days (54.5%). After the intervention began on August 12, the frequency of verbal abuse was reduced to 3 times in 21 days (15%)

Caregiver's (his wife) comments: He has settled down since the intervention began. He would stop talking when the music started. One day we were quarrelling over trifles. Just in time, the music started automatically. As his attention turned to the songs, his anger quickly disappeared. After a set of four songs ended, he often requested more. I felt that music was more effective than the sedative in making him settle down.

Discussion: Verbal agitation is a common behavioral disturbance in dementia, including screaming, calling out, moaning etc. Since the intervention started, TA has become gentler and has almost ceased verbally abusing his wife. This was accomplished by the presentation of music once an hour. To our knowledge, automatic intermittent presentation of music has not been previously tried.

Casby and Holm (1994) examined the effect of classical music and favorite music on the repetitive disruptive vocalizations of three individuals with Alzheimer's disease. In their study music significantly decreased the number of vocalizations for two of three individuals. Several other researchers have also noted the effect of music on verbal agitation in dementia. The results of experiments 1 and 2 in this study are consistent with these reports.

Experiment 3: Case SI: SI is a 75-year-old homemaker with Alzheimer's and vascular dementia. Since the second infarction, her meal intake had been decreasing. In April 2002, the average amount was 20-30 percent of the meal served.

In the speech therapist's room, she was able to listen to children's songs for 30 minutes or more. We had also showed her a doll, whose head she would stroke gently, saying "you are pretty." We hypothesized that music and messages played through a doll would be an effective way of encouraging her to increase her intake at meals.

The Sony IC recorder was stored in a pocket set on the back of the doll's clothing. Thirty-eight minutes of songs and messages which encouraged her to eat were recorded on the IC recorder. The tape consisted of 6 repetitions of a female piano teacher singing a children's song. The original lyrics of the song were replaced with new ones, which recommended that SI eat more. About two minutes of silence were inserted between repetitions. The same melody without the lyrics was also played 6 times, each repetition separated by two minutes of silence. At the beginning and end of every song or melody were messages spoken by the piano teacher encouraging SI to eat.

The average amount of intake was 26% in the baseline phase. In the intervention phase, it

increased to 54% on average.

Caregivers' (her husband and son) comments: She answered the messages from the doll. For example, in responding the message "This rice is newly harvested." she answered "Is it true? I am very glad." and to the message" You were scolded when you hadn't eaten every grain of rice in your childhood," she replied "That is true." She spoke to the doll more than to us. She became happier when she listened to these stimuli.

Discussion: Ragneskog et al.(1996) has investigated the influence of dinner music on food intake by individuals with dementia. They found that individuals ate more in total during music periods. In our experiment, messages were added to the music, and were provided through a doll. This intervention also succeeded in increasing the amount of the meal consumed.

This individual's decreased appetite was considered to be mainly the result of her depressed mood and advanced dementia (Ragneskog et al., 1996). As for the effects of dolls or toys on depression, Francis and Baly (1986) found statistically significant improvements occurred on most variables including depression, mental status, positive emotion, and social interest when plush animals were provided. Furthermore, four individuals with Alzheimer's disease produced more information units when dolls and stuffed animals were present (Hopper, Bayles, & Tomoeda, 1998).

When messages were output through the doll, SI responded to the "speaking doll" as if she were a real conversational partner. Just like joyful conversation over a meal, the artificial conversation with the doll improved her appetite.

General Discussion: Although music has been suggested as a means for directing people with dementia (Casby & Holm, 1994; Gerdner & Swanson, 1993; Goddaer & Abraham, 1994), music therapy has been applied primarily for the purpose of group recreation in skilled nursing facilities (Bright, 1987). To our knowledge, this is the first investigation to use the automatic output of songs and messages for directing individuals in their homes. There are many people with dementia who refuse to go to their day care centers, do not eat enough at meals, or are easily agitated. The results of this study indicate that the automatic output of music and messages is a highly successful method for guiding people with behavioral disturbances. In practical terms, this method holds great promise, since it can easily be applied to other activities of daily life, such as bathing, toileting, etc.

Music appears to alter the abnormal or disruptive behavior of people with dementia (Casby & Holm, 1994). It is important to select music that coincides with patient's preferences if one expects treatment to be effective (Cook, 1981).

This study suggests that music can have a strong effect on mental stability. Bright (1987) has suggested that the behavior of individuals with dementia was not only "better" during the music

session but continued to be “better” for a time afterward, indicating some carryover effect. In this study the stabilized mental state brought to our three cases by the intervention seemed to continue for hours.

It is known that some individuals with dementia show the “doll phenomenon”. That is, they cherish dolls as if they were genuine babies. As a result, a doll is likely to be effective as a messenger or a conversational partner.

Interventions should be directly focused on situations of daily living (Adam et al., 2000), especially in their home. Because the methods used in this study were focused on daily activity, our individuals and caregivers received immediate benefit.

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Chapter 8 Therapy for Communication and ICT

8.1 Dementia and Communication

The traditional term ‘‘communication’’ is used for exchange of information between people and exchange of information between a user and a system (Borg, Lantz, & Gulliksen, 2004). Conversation is a very high-level cognitive activity and involves large brain areas, language understanding, language production, and so on. It is believed that keeping engaging in conversation can activate brain activities. (Huang, Matsushita, & Yasuda, 2014).

The first symptoms of dementia are typically word-finding problems, comprehension deficits for abstract and complex conversation, and short-term memory problems that often interfere with conversational interactions (Bourgeois et al., 2010). As the disease progresses, these memory deficits intensify and create related problems such as repetitive questions and limited verbal output, characterized as "empty speech." Over time spoken output is further eroded to echolalic, perseverative, and paraphasic speech, then to incoherent vocalizations, and finally to mutism. Areas of preserved ability-such as reading, writing, and pragmatic skills that remain functional until the later stages of the disease (Bourgeois et al., 2010).

A clinician assesses the communication environment and identifies barriers and facilitators that interact with a client's communication needs and abilities (Beukelman &Mirenda, 2005). Instead of expecting the client to recall personal information when presented with minimal verbal cues, the clinician might expect the client to read aloud personal information and point to the correct photograph when presented with a memory book with sentence-length captions (Bourgeois et al., 2010).

Communication, especially verbal conversation, is an easy, common, and enjoyable activity for most of us. Dementia sufferers, however, tend to be alone and poorly informed, with few chances to converse. A simple interface would thus enable individuals with dementia to talk with various partners on the video phone whenever they want (Yasuda, Kuwahara, Kuwabara et al., 2013).

Aphasia is a cognitive disorder, usually acquired as a result of damage to the language centers of the brain due to a stroke, or other brain disease such as dementia. The symptoms generally include disturbances in naming, reading out load and/or comprehension of speech. There are different multidimensional classifications schemes fall into the categories of fluent, non fluent and other aphasias. (Aye, Ito, Hattori et al., 2008).

Applying Technology for people with cognitive Disabilities: For people with aphasia, language deficits can create a significant barrier to technology use. Difficulty understanding spoken and written language would impede an individual’s ability to understand and apply

spoken and written instructions (Brandenburg, Worrall, Rodriguez et al., 2013). The review of Borg. Lantz, & Gulliksen (2004) was to identify and synthesize measures for accessibility to electronic communication for people with cognitive disabilities.

People with cognitive disabilities may experience difficulties in electronic communication due to reduced capacity in mental functions, such as orientation, attention, memory, abstraction, organization and planning, experience and management of time, problem solving, language, and calculation. Medium, ATM, cash machine, communication system, cellphone, cloud, computer, digital, electronic communication, electronic device, ICT, information system, information tech, information and communication tech, interface, internet, iPad, iPod, laptop, mediated com, messaging, mobile phone, on-line, pad, palmtop, PC, phone, player, portable, reader, smart card, smartcard, smartphone, SNS, social media, social medium, surf pad, tele-communication, telephone, TV, terminal, text message, texting, ticket machine, ticket purchasing point, vending machine, video, web (Borg. Lantz, & Gulliksen, 2004).

Nevertheless, a small number of high-tech devices have been developed specifically for people with more severe forms of aphasia. The ***Talksbac*** system, developed with input from people with aphasia and their carers, generated some useful information on features that may maximize usability, which included less information on the screen, removal of prediction algorithms etc. Simple design, a static interface and use of different modes such as symbols/pictures may be important when designing technology for people with aphasia.

PhotoTalk is a mobile app for small mobile computers to assist people with aphasia to independently organize their photographs with the aim of supporting conversation. Participants were able to use the app independently and were using it most days of the month-long study (Brandenburg, Worrall, Rodriguez et al., 2013).

There are also apps which utilize video stimuli, which uses real-life video stimuli. Video stimulus may also be useful as stimulus for verbs, adjectives, sentences and longer stories. A particular advantage of using mobile technology is that there is an opportunity for people with aphasia to use the camera to take their own pictures and videos to create personally relevant and contextualized therapy materials. Behavior tracking **Trackers** are apps used by the client or carer in everyday life to track behaviors. Use of handheld computers for tracking behavior has the advantage of mobility and easy accessibility (Brandenburg, Worrall, Rodriguez et al., 2013).

8.2 Vocabulary Data File (Yasuda, Nemoto, Takenaka et al., 2007)

Regular conversations may significantly reduce the frequency of the behavioral and psychological symptoms of dementia and enhance psychological stability, and this would in turn reduce the burden borne by caregivers (Yasuda, 2007).

Proper names are of practical importance for verbal communication. For instance, they are indispensable for transmission of autobiographical information concerning a person. Proper names are neuro-psychologically and anatomically processed in a manner which differs from the processing of common nouns. Peoples' names in proper names were sufficiently comprehended by globally aphasic patients. Curiously enough, they are the most difficult words even for non-brain damaged people to retrieve. This is because proper names are associated with one person arbitrarily. (Yasuda, Nakamura, & Beckman, 2000).

In order to assist people with aphasia, Yasuda et al. (2007) developed a vocabulary data file ***Rakuraku Jiyu Kaiwa*** (Easy, Natural Conversation). The patients would like to make daily conversation with their family members, relatives or friends beyond their basic needs and wants. Enjoying conversation itself would be a basic requirements or necessary condition of anyone's happiness to maintain their QOL. In this system, called "Rakuraku Jiyu Kaiwa", the topic list taken from the vocabulary file is shown on a PC monitor. By pointing at the word on a PC monitor, aphasic patients enjoy daily communication with their partners.

Vocabulary data file, named Rakuraku Jiyu Kaiwa contains approximately 50,000 words, of which 70% are proper names. These words have been collected from catalogues, magazines, newspapers, etc., and can function as keywords in conversations. Most words are written in kanji letters. Words are displayed using a 20-point font to make them more easily readable to older people without glasses.

A typical scenario of the system goes like this: A person with aphasia and his or her communication partner sit in front of a PC. First, they decide on a topic of a conversation, for example, "Sports". The partner clicks the category ''Sports'' on the first level page, and then a list of keywords of various sport names appear on the screen such as "Baseball", "Soccer", "Tennis" and "Judo". If the person points the word "Baseball" that he/she likes, the partner clicks on this word to make the names of baseball team appear. If the person points at the "Boston Red Sox" from the third level page, the partner opens that page to display the names of players of this team. The partner asks the aphasic's favorite or most interesting player's name. If the person points to "Daisuke Matsuzaka", the partner might complete the conversation by saying "he is a famous baseball player in Japan". In this way, a conversation continues until it reaches the lowest level of category (Aye, Ito, Hattori, Kuwabara, & Yasuda, 2008).

More words have been continually added to the vocabulary books (Yasuda & Nakamura, 1998) since the first edition. To simplify the process, the books were converted into HTML files and published on the Internet in 2003 as a vocabulary data file. In order to collaboratively use, the vocabulary data file, the encyclopedia, and the homepages are includedas a conversation-support system.

In this study Yasuda et al tried to establish which, if any, resource is most effective in eliciting information within a reasonably limited timeframe. The results demonstrated that only the data file succeeded in eliciting more information from participants, as indicated by the increase in the number of points with convinced marks in the use condition when compared with the non-use condition. The increased points were gained mostly by participants pointing to proper names. This increase was not observed in the other two resources.

By incorporating proper names into the data file, the range of conversational topics has been widely extended. For example, the names of favorite musicians, painters, movies, cars, towns, or restaurants can be conveyed to partners. These kinds of topics have not been considered conversation themes in traditional AAC systems. Hence, it was difficult to talk about these kinds of themes in using the traditional AAC systems. To our knowledge, our vocabulary data file is the first AAC system in which proper names are exploited to such an extent for communication with moderate-to-severe aphasia people.

However, the encyclopedias and homepages have their own specific merits. The range of their topics is very wide. Moreover, the quantity of information is enormous and continually expanding. They are often useful for talking about specific or professional topics. Furthermore, the encyclopedia and homepages have enormous archives of auditory and visual images. These images may facilitate conversation with people with profound aphasia (Elman, 2001), who are unable to comprehend even words or proper names

Progress of Vocabulary Data File: Aye, Ito, Hattori et al., (2008) have extended the concept of vocabulary data file Rakuraku Jiyu Kaiwa to facilitate remote conversation over the network. They presented the overall framework of remote conversation support for people with aphasia along with preliminary experimental results. In this system, they created a topic list based on the categories that would be included in conversation. The same topic list is displayed on both PC monitors. The word/icon that is currently being talked about is highlighted on the list of both displays.

To solve the problem of insufficient topic words in the Rakuraku Jiyu Kaiwa, Yamane, Ishida, Hattori et al., (2010) used the Japanese version of Wikipedia. The freshness of its information is

another merit, because they are constantly edited and updated. Articles can be retrieved not only by keyword search but also by navigating categories. Each category has a number of subcategories and links to articles that belong in that category.

Using ***WikIE***, the Wikipedia data analyzing tool, all category names and the titles of all articles are extracted as topic word candidates. Parent and child relationships between category names and between category names and article titles are also extracted. For each category, its subcategories are listed on the left and article titles that belong to the category are listed on the right. About 1,030,000 words were extracted. The proposed method not only resolved the problem of insufficient topic words but also the rigid structure of Raku-raku Jiyu Kaiwa's topic lists. Experimental results show that with the proposed tools, people with language disorders can enjoy conversations. Moreover, the proposed methods eliminated the requirement to make and maintain topic lists by volunteers.

Kuwabara, Hayashi, Uesato et al., (2009) have constructed an initial prototype using Skype for video chat and the RemoteX plug-in for screen sharing over a network. Homan, Morita, Yamaguchi et al., (2012) described the construction of a topic database for conversation support for people with cognitive handicaps. Kuwabara (2012) proposed an agent-based approach to customizing a remote conversation support system for cognitively handicapped people. The system of Morita, Kuwabara (2014) is built from 'gadgets', each of which implements a particular conversation support function. Since the need for conversation support varies from person to person, such a system needs to be customized to suit the requirements of multiple users who conduct the conversation. The proposed approach introduces a user agent that corresponds to a human user.

8.3 Conversation Advantage of Videophone

Boman, Lundberg, Starkhammar et al., (2014) argued that being able to use the telephone can be very important for many purposes such as maintaining social networks, getting stimulation, and for reaching help when needed. Persons with dementia might not only have difficulty handling an ordinary telephone; they might also have difficulty visualising the person they wish to talk to when she or he is not present as well as to hear, interpret, and understand what is said in the conversation. Moreover, talking on the telephone might be experienced as an abstract action that makes it difficult to relate to the person spoken to. Therefore, a videophone might be an appropriate communication tool for persons with dementia to help them demonstrate their ideas and to understand what is said in a conversation with gestures, signs and body language, and to feel safe and secure while they interpret the other person's message.

Videophone is considered as one of the best assistive communication tool for these people since video communication is not only a tool to break an isolation caused by the disease, but also a powerful way to help people demonstrate their ideas and understand what is said in a conversation with pictures, signs and body language (Wan, 2010).

One of the most important interventions in the networked interaction therapy is to provide them with talking partners on the Internet, such as friends, partners, and family members living in remote locations. A simple interface would thus enable individuals with dementia to talk with partners on the video phone whenever they want. However, there were no studies on how long and how eagerly individuals with dementia could talk with a partner on the video phone, in comparison with the face to face settings. Yasuda et al. (2006) have conducted an experiment in which nine individuals with dementia talked with a partner on a video phone and in a face-to-face session. The results revealed that there was no difference in the total response time and in the eagerness observed between the two sessions. This suggested that the video phone talking could potentially have the same effects as face-to-face talking (Yasuda et al., 2006).

One caregiver-patient dyad received the educational material face-to-face, the other received it via videophone. Both were equally satisfied. Curiously, the investigators noticed an increase in the number of verbal interactions between hospice staff and caregivers in the dyad when a videophone was used. In another study, how useful videophones were compared in delivering psychoeducational material with face-to-face sessions. No differences were found between face-to-face and videophone results when 24 geriatric patients were evaluated using the Geriatric Depression Scale and Hamilton Depression Rating Scale. Videophones have also been used successfully to provide access and "virtual visits" to nursing home residents from distant family members in an effort to prevent isolation and depression. This visual access provided enough "social presence" to allow family members to "visit" with a nursing home resident and alleviate some of the isolation these residents often experience (Nieves, Briscoe, Edwards et al., 2015).

Applying Videophone for Generic Use: Nakamura, Takano et al., (1999) installed Integrated Services Digital Network (ISDN) in individual homes of clients and service providers. An intervention group of home healthcare cases were provided with videophones, and it was compared to a control group of regular healthcare cases. The effectiveness of the videophones in home healthcare service was found to be significant. This evidence supports the use of videophones in home healthcare to improve the quality of service.

Problem-solving therapy (PST) has been found effective when delivered to informal caregivers

of patients with various conditions. The purpose of Demiris, Oliver, Wittenberg-Lyles et al., (2012) was to compare the effectiveness of a PST intervention delivered face-to-face with one delivered via videophone to hospice primary caregivers. PST delivered via video was not inferior to face-to-face delivery. Caregiver quality of life improved and state anxiety decreased under both conditions. The delivery of PST via videophone was not inferior to face-to-face. Audio-visual feedback captured by technology may be sufficient, providing a solution to the geographic barriers that often inhibit the delivery of these types of interventions to older adults in hospice.

The innovation project was conducted in two new apartment buildings for older persons (Goumans, Bussmann, Hupkens et al., 2012). In all apartments the videophone is standard equipment. The independently living older persons did not accept the videophone. The older persons, who were mostly active, did express that at this moment in their life they did not see the value of an extra opportunity for communication to relatives or a care giver. The research will come up with concrete recommendations for improvements in the implementation and valuing process of ICT in home settings.

The delivery of mental health care via electronic devices-also called telemental health has gradually become an established alternative to improve access to mental health services. Telemental health services routinely include psychotherapy, psychological testing, medication management, and evaluations. Videophones could serve as an adjunctive means to mental health services for special populations, such as the severely mentally ill or those living in rural areas. In another study, dignity psychotherapy was delivered via videophone to terminally ill patients in an effort to prevent depression (Nieves, Briscoe, Edwards et al., 2015).

Videophones are an ideal telehealth alternative for delivering patient-center care. They are affordable, portable, and durable and can be used to provide an array of adjunct care services to patients with barriers to treatment-whether geographical, functional, or otherwise. Video conferencing equipment, on the other hand, is more expensive, requires dedicated space, and is not mobile; also, it requires technical support and incurs infrastructure expenses (Nieves, Briscoe, Edwards et al., 2015).

Users found it helped them deal with feelings of isolation, family members were able to assess their well-being using visual clues as well as spoken words and carers felt the system aided them in their daily role and reduced their stress levels. Despite the fact that the project has now ended, some users continue to use the system and it is interesting to note that video telephony appears to continue to be considered a key element of AT/ tele health (Bonner & Idris, 2012).

Videophone Conversation for people with Dementia: ***Televisits*** contact between elderly

people living in a nursing home and their family via a videophone was demonstrated to promote social contact. In a similar study, Sävenstedt et al. (2003) showed that a videophone as a means of communication between patient and family reduced feelings of guilt in family members, allowed more frequent visits than was possible with face-to-face visits and let family members see the physical and emotional state of the patient on a daily basis. In some cases, the conversations were more focused and of better quality than during face-to-face visits.

In most cases, however, more emphasis was placed on the family member to direct and lead the conversations which was seen by many as demanding. The relationship between staff and family members improved as a side effect of staff helping the patient use the videophone. Two studies showed that by using videophone technology, the quantity and quality of conversations between the person with dementia and others would be enhanced (Lauriks et al., 2010).

Newcastle Social Services Video conferencing was a core driver for another innovative initiative implemented, known as ***Connect for Care***. Essentially, they harnessed the power of video telephony to help those with dementia of age 75 upwards to connect with relatives, carers and friends. The basic hardware was a touch-screen PC with a simplified software menu to explain the technology and to encourage use (Bonner & Idris, 2012).

A broader use of videophone for people with dementia, their family and professional carers is reported in an earlier study (Lee et al., 2000). They utilized the video phone for assessment, diagnosis, counselling and staff education etc. The education provided through the videophone was over traditional face-to-face education and the interactions between clinicians and patients were well accepted by their patients. The results of assessment of their severity of dementia obtained via the videophone link and from resident specialist were identical. A neuropsychological tests via video phone technology and traditional face-to-face methods was also administered and highly similar test scores were obtained for persons with MCI and mild- moderate Alzheimer's disease (Cullum, Weiner, Gehrmann et al., 2006).

Wan（2010）designed a graphical user interface (GUI) for an easy-to-use videophone for people with mild dementia. The videophone should be introduced in an early stage of the disease, and should be introduced as a product which is a pleasure to use (Boman, Nygård, & Rosenberg, 2013).

As for the daily assistance by the video phone, Smith, Lunde, Hathaway et al., (2007), and Wade, Izzo, & Hamlyn (2008) assessed the delivering daily medication management by videophone for elderly clients with dementia and other clients. The medication management was delivered safely, and the service was time and cost-efficient compared to a home visit by a field nurse (Wade, Izzo, & Hamlyn, 2008).

A total 12 cognitive intervention sessions such as attention, memory, calculation and language were conducted over six weeks via either videophone or face-to-face (Poon, et al., 2005). Both groups improved significantly in most of areas. Most of the videophone group members were satisfied with the system. Elderly adults including three patients with dementia increased the number of words by videophone conversation (Mochizuki-Kawai, Tanaka, Suzukji et al., 2008). The effect of videophone communication between patients with dementia, their cares, and nurses were clarified (Hori, Kubota, Kinoshita, 2008; Hori, Kubota, Ando et al., 2009). For a period of several weeks, a patient-caregiver pair communicated with a nurse via computer for 30 minutes once a week. The result showed a significant improvement in hours of sleeping, signs of improvement on an neuropsychological test (Kubota, Ando, Kihara et al., 2009; Hori, Furuya, Kubota et al.,2011. Demiris, Oliver, Wittenberg-Lyles et al., (2012) compared the effectiveness of a problem-solving therapy intervention delivered face-to-face with one delivered via videophone to hospice primary caregivers. These literatures suggest that videophone conversation is a feasible and acceptable means of providing cognitive support to older people with dementia.

The purpose of Wade, Izzo, & Hamlyn (2008) was to assess the practicality, suitability, safety and cost-effectiveness of delivering daily medication management by videophone. Over a period of 6 months, 9 clients had broadband and IP Videophones installed in their homes. Clients with mild to moderate cognitive impairment, multiple medical problems and who lived alone were able to use the service. The clients and Call Centre staff viewed the videophone service positively, medication management was delivered safely, and the service was time and cost-efficient compared to a home visit by a field nurse.

Videoconferencing (VC) based diagnostic interviewing has shown good agreement with conventional face-to-face diagnosis of dementia in several investigations, but extension of this technology to neurocognitive assessment has received little attention. To this end, Cullum, Weiner, Gehrmann et al., (2006) administered a brief battery of common neuropsychological tests via VC technology and traditional face-to-face methods to 14 older persons with mild cognitive impairment (MCI) and 19 persons with mild to moderate Alzheimer's disease (AD). Highly similar test scores were obtained when participants were tested in-person or via VC. Telecognitive assessment appears to be a valid means to conduct neuropsychological evaluation of older adults with cognitive impairment.

One article reports that users with mild-to-moderate Alzheimer's disease were able to follow instructions and respond to Yes/No questions by an avatar on a TV. The avatar had a realistic voice and its lip movements were synchronized with its speech (Borg, Lantz, & Gulliksen, 2004).

Remote Reminiscence Conversation Experiment 1 (Kuwahara, Yasuda, Abe eta al., 2006): In this study, they intended to evaluate the effectiveness of a networked reminiscence session. The senior care-home company provided two of its care facilities for this experiment and recruited dementia sufferers living in each facility as subjects. The severity of subjects' dementia ranged from mild to severe. Seven subjects (all female) and six talking volunteers (two male and four female) took part in this experiment. During the first few weeks, volunteers conducted face-to-face reminiscence sessions and selected photos to be used in networked reminiscence sessions. Selected photos were stored in the Community Platform and were used to produce reminiscence videos that were also used in this experiment. The results indicate that even for the subject with very severe dementia, the networked reminiscence session served in a way comparable to the face-to-face reminiscence session. "Field Trial of Networked Reminiscence Therapy," networked reminiscence therapy seems to work well even for people with very severe dementia.

Remote Reminiscence Conversation Experiment 2 (Kuwahara, Yasuda, Tetsutani et al., 2010). Kuwahara et al. (2004) focused on the effect of reminiscence therapy to provide such communicative intervention as talking on video phones, offering private reminiscence contents, and managing daily schedules by TV monitors. Based on this concept, they developed reminiscence systems that consist of reminiscence video and remote reminiscence conversation systems to calm individuals with dementia and to relieve the burden of family caregivers.

The researches discussed so far suggest that a combination of video phone and reminiscence interventions would be effective for psychological stability. Kuwahara et al. (2007) created a system to incorporate video phone and reminiscence photo sharing and conducted an experiment of this system's effectiveness in an institution for senior citizens.

There have been no reports about using video phones to assist individuals with dementia living at home. They conducted experiments to evaluate the above remote reminiscence conversation and schedule prompter systems. Compared to our previous experiments in care homes, this field experiment's technical and social aspects were much more challenging. Finding family caregivers to participate in our field experiment was especially difficult. Few such families used PCs with broadband connections; they also hesitated to buy PCs and subscribe to the Internet. Therefore, during the experiment we rented PCs or Internet connections for family caregivers who didn't have them so they could participate in the field experiment.

Remote reminiscence conversation system: Remote reminiscence conversation was effective for Subjects 2 and 4 in terms of psychological stability. Since Subject 4 sometime became anxious in the evening, remote conversation in the evening stabilized her and provided a break for her

caregiver. Our system might prevent such syndromes as wandering in the evening, agitation, etc. Furthermore, Subject 4 was even stable three hours after the conversation. This may be the most valuable finding of this experiment and for future research. Since Subject 4's family caregiver had its own PC and Internet connection, she wanted to continue the remote reminiscence talk after the field experiment. It has continued for more than a year, and the above effectiveness is still being achieved. For Subject 1, there was no difference in psychological stability between watching TV and remote conversation. Her dementia was mild, so she could still enjoy ordinary TV programs. This might explain why there was no difference in the psychological stability. According to Subject 3's daughter, her skeptical attitude continued. She wondered why a "stranger" was asking personal questions.

Remote Reminiscence Conversation Experiment 3 (Yasuda, Kuwahara, Kuwabara et al., 2013): A remote reminiscence conversation system was created that incorporates a video phone with reminiscence photo sharing. This system was activated remotely by a conversation partner and in terms of psychological stability, it was effective for individuals living at home. Interestingly, one patient remained stable for more than 3 h after the conversation session ended. This sustained psychological effect of conversation had not been reported previously. If this effect is confirmed in other patients, remote conversation in advance may prevent behavioral disturbances from arising.

The results of this experiment revealed that remote conversation was effective in one out of four subjects. The mean psychological stability of subject 3, as evaluated using the GBS scale, was more explicit while conversing remotely than while watching TV programs. According to the caregiver, she had difficulty in watching TV programs and often exhibited restless behavior in the evening. However, she seemed to enjoy the remote conversation with the partner, leading to dramatic increases in psychological stability. Furthermore, the increased stability of subject 3 was statistically significant in the delayed evaluation, which was performed 3 h after the remote conversation ended.

Sustained psychological effects of music and video biographies in individuals with dementia have been reported. Communicating with a partner may have reduced the stress of subject 3, and this stress-reduced state may have persisted for 3 h. This result agrees with the hypotheses that behavioral disturbances arise from a lack of social contact[3] and that reminiscence interventions decrease these disturbances.

Although subject 3 was the second case to exhibit this phenomenon, it is suggested that the conversation itself has the potential to prevent individuals with dementia from showing anticipated behavioral disturbances such as "evening syndrome." However, it is very difficult for individuals

with dementia to engage in frequent and regular face-to-face conversations. In contrast, remote conversation with volunteers via video phone may be easier. This stability may ease the burden of the caregiver.

The caregivers of subjects 1 and 2 observed that they enjoyed talking with the partner. They also enjoyed watching TV programs, which explains why remote conversation had no significant effect on their psychological stability. Regarding the effectiveness of this system, further studies should focus on subjects who exhibit restless behaviors but are able to enjoy the conversation.

Remote Reminiscence Conversation Experiment 4 (Yasuda, Kuwahara, Kuwabara et al., 2019): A remote reminiscence conversation system was created to provide opportunities for individuals with dementia (Kuwahara et al., 2010, Yasuda et al., 2013). This system incorporates a videophone with reminiscence photo sharing enabling individuals with dementia to remain stable during and after conversing with talking partners. Furthermore, it was very interesting to note that some individuals were even stable for more than 3 h after the conversation session ended. This sustained psychological effect of conversation has not been reported. As the third experiment, they investigated whether psychological stability was again observed in other individuals while conversing with talking partners on the videophone than while watching TV programs. In this experiment, the remote photo sharing on the screen was not performed in order to understand the single effect of conversation.

Methods: Six outpatients with dementia participated in this experiment. Their mean age was 75.8. Their mean MMSE score was 22.1. Furthermore, three males and three females of the same ages participated as talking partners. ABAB design was applied to investigate the effects of the conversation. In session A, the talking partner remotely booted Skype™ on the individual's computer (videophone) and asked the individual to have a 30–40 min conversation. In session B, the individuals were requested to watch their favourite TV programs. The total period of sessions A and B lasted for two or three weeks. The talking partner for each individual was same in this period.

The 'different symptoms common in dementia' section of the Gottfries-Brane-Steen (GBS) scale was used to evaluate psychological stability while they were talking with the partner or while they were watching TV programs (concomitant evaluation). The caregiver graded the psychological stability on the GBS scale of 0–6 every day in sessions A and B. The overall psychological stability was also evaluated 3 h after each session (delayed evaluation). These scales were converted to the corresponding scores.

Results: The average A score (conversing on the videophone) of the GBS scale was 0.6 in the concomitant evaluation and 0.42 in the delayed evaluation. The average B score (watching TV) was

0.93 and 0.86, respectively. In this scale, lower scores denote more psychological stability.

Discussion: In both evaluations, individuals with dementia demonstrated more psychological stability while they were conversing on the video phone than while watching the TV programs. The stability was more apparent 3 h after the conversation ended, supporting our previous two experiments. Sufficient conversations in advance may prevent behavioural disturbances, such as evening syndromes. Remote conversation is a promising intervention for assisting individuals with dementia and for reducing caregivers' burden in their daily lives.

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Chapter 9 Daily Assistance by High Tech Interventions

9.1 Review of High tech interventions: Various Projects

Clever Project: The mission of the Cognitive Lever (Clever) project since 1999 is to provide computationally enhanced environments to assist people with a wide range of cognitive disabilities and their support community (Carmien & Gorman, 2004).

INDEPENDENT: The aim of the Investigating Enabling Domestic Environments for People with Dementia (INDEPENDENT; 2003) project is to develop technology and design solutions to help enable people with dementia to live independently, to empower them and to improve their quality of life wherever they live. In order to avoid institutional care and facilitate early hospital discharge, the project help people within residential care settings to retain independence and autonomy and maintain contact with the outside community; increase opportunities for older people with dementia to experience enjoyment, pleasurable activities and social interaction.

Assisted Cognition: The goal of the Assisted Cognition project combines computer science research in artificial intelligence and ubiquitous computing with clinical research on patient care. Assisted Cognition systems are proactive memory and problem-solving aids that help an individual perform the tasks of day-to-day life. They are Sense aspects of an individual's location and environment, both outdoors and at home, relying on a wide range of sensors such as GPS, active badges, motion detectors, and other ubiquitous computing infrastructure. Learn to interpret patterns of everyday behavior, and recognize signs of distress, disorientation, or confusion, using techniques from state estimation, plan recognition, and machine learning. Offer help to patients through various kinds of verbal and physical interventions, and alert human caregivers in case of danger (Kautz, 2004).

Lifeline: A tool for caregivers to monitor and support clients with wireless prompting systems. This tool is closely linked to the Mobility for All and MAPS projects and it gives caregivers the ability to track and support clients who are performing activities in remote locations. Lifeline seeks to give clients greater autonomyin home, work, and travel activities and to give care givers the tools they need to assist their clients.The aim is provide clients with opportunities they might not otherwise have because of limited caregiver resources. The emphases is to harnessing caregiver support instead of replacing it with technology.

MAPS: Memory Aiding Prompting System (MAPS) is a system for providing support to persons with cognitive disabilities by guiding them through prompted tasks. The MAPS system is multimodal and uses wireless networking to adaptively respond to changes in the environment. MAPS provide adaptive prompting on a PDA platform and appropriate and useable tools for creating, maintaining, and sharing prompting scripts, with an aim to create a collaborative community around its use.

MAPS use a PDA platform to display verbal and pictorial prompts in a sequence that comprises a script. The PDA provides error correction functionality via dynamic, situated scripting and ‘panic button’ functionality. As a script is played the events and context are logged, providing information for script refinement and analysis as well as immediate alternate prompts for breakdown situations. A PC based application provides tools for script creation, modification and sharing with other users via a web-based repository of scripts. MAPS and the Lifeline project are integrated to

support wireless context awareness and panic button functionality; caregivers can be notified of problems via cell phone.

CIRCA project: The CIRCA project set a goal of producing an innovatively designed reminiscence experience based on interactive multimedia and aiding communication between people with dementia and their caregivers (Alm et al., 2004). Alm et al. (2003) suggest that with the use of multimedia as a source of reminiscence, patients exhibit more control of the direction of the conversation. They developed a touch screen display to convey photographs, video or music and compared it to traditional reminiscence methods. By tapping into long-term memory to elicit communication we can come to understand that people with dementia are individuals who have life histories and personalities, they have knowledge, wisdom and humor. Reminiscence sessions enable older people to socialize, to share 'past competencies and failures' and encourage people to 'value their lives (Gowans, Campbell, Alm et al., 2004).

Without an effective working memory, ordinary conversation becomes impossible. Long-term memory, however, can remain relatively well-preserved, if long term memories can be prompted. Their system, called CIRCA, stimulates long term memories with a touchscreen-based hypermedia presentation of material from the past: photos, music, video clips, graphics and text. In evaluations the system was acceptable, and positively received by both staff and people with dementia, and people with dementia were able to take more control of the interaction than they could in reminiscence sessions run in the traditional way (Alm, Astell, Gowans et al., 2009).

Evaluation of three initial virtual reality environments by a group of dementia care professionals and a group of people with a diagnosis of dementia was positive. The system captured attention and provided an engaging experience. The users with a diagnosis of dementia were able to imagine themselves in the environments, for example sitting on a bench in the botanic garden or having a pint of beer in the pub environment. We then developed a wide range of virtual activities to try out with potential users: Short video clip presentations of activities, e.g. playing with a dog; Exploring environments, e.g. the Botanical Gardens; Creative activities, e.g. painting a virtual pot; Sport activities, e.g. bowling; Fairground activities, e.g. coconut shy; Amusement arcade type games, e.g. pinball.

Music is produced by the user dragging their finger around the touch screen. Visual feedback is provided instantly during music play to help individuals with severe short-term memory loss to remain engaged while using the system.

One stated goal of CIRCA was to provide a facility to customize the system to allow users to input their own personal images e.g. family photographs. One argument against personalization relates to privacy of information, e.g. would individual personal images need to be protected in care institutions. A significant number of our subjects in tests using personal photographs often fail to recognize close relatives e.g. siblings, spouses and offspring. On many occasions they will fail to recognize themselves e.g. in their wedding photographs. This can cause great emotional upset for both the person with dementia and their close relatives (Gowans et al., 2004)

Progress of CIRCA: The combination of interactivity and the ability to provide a high-fidelity 3D visualization of places and objects offers a unique experience for users. For instance, virtual world could be used as aids in reminiscence activities, allowing users to interact with objects which are hard to obtain in the physical world (e.g. a retro car) or to provide an experience of a place which is no longer possible to access (such as a historic street

from the past). The interactivity of the virtual environments could allow older people to not only be passive viewers of the objects and scenes, but also engage actively in a more playful and creative experience of reminiscence. It has also been used to provide relaxation to trigger positive emotions among older people and to provide a representation of a place from the past (e.g. a bar).

Siriaraya and Ang (2014) focus on creating a lively real time rendered 3D environment, instead of more "static" visualization such as 360 Degree Panorama. This would potentially enhance the feeling of "presence", thus enhancing the benefit of use. Secondly, they make use of gesture-based technology (i.e. Kinect) to enhance the interaction and empower older people to interact with the system in a more natural manner. Thirdly, their design puts an emphasis on creating a virtual space for use in social interaction.

The Microsoft Kinect sensor was used to detect the user's gestures and motions and the ZDK (Zigfu development Kit) was used as a middleware to facilitate the development of the gesture controlled system through Unity3D. A projector was used to display the virtual world. Kinect was used to map the users' interaction to the avatars. More than 10 joints (e.g. Head, Torso, Waist, etc.) were detected and their movements mapped onto the avatar. In the second mode (seated mode), the avatar was seated in front of a table with virtual objects (a book, a magazine, a radio and a lamp) placed in front of the user. Kinect detected the movements of the upper body and the user would remain seated in the physical world. The user could pick up items on the table by moving their hands to touch the object.

In the second version, two virtual worlds were created. In the river tour, the participant was taken through a virtual river trip. The environment was created to resemble a tropical forest, with vegetation, plants and animated animals (such as elephants, rhinoceros, etc.). The user would tour around the river by doing a "rowing" motion with their arms, which would propel the boat forward along the path.

An Android-based tablet computer was used to allow the caregiver/residents to select the vegetation to plant in the virtual garden. The participant would "walk" to the empty lot using Kinect. As they came close to an empty lot, a text would be displayed on the screen, asking the participant to select the plant. Overall, almost all residents were able to see the projected screen as a place they were situated in and perceive themselves as actually performing the activity. In one case, the resident mistook the virtual environment as being the "real world".

They are also not advocating replacing physical activities with only virtual activities. Instead, virtual world can provide interactive experiences to promote a continuing selfhood which may have been lost due to dementia and/or moving to long-term care facilities. Negative memories could be mitigated by playful design. Virtual world could also be a "place" that allows staff and residents to foster personal relationship and trust, which may improve care.

Networked Interaction Therapy: To relieve the stress of people with memory impairment and their family members, the concept of Networked Interaction Therapy was proposed for their psychological and behavioral stability in their daily life (Kuwahara, Kuwabara, Utsumi et al., 2004; Kuwahara, kuwabara, Tetsutani et al., 2005). By providing videophone intervention with multi-component stimuli, broader cognitive assistance would be possible. The stimuli include not only verbal conversation/instructions, but also photos, music, video, vibration, aroma etc. at any time of the day or night via internet. When, people are unable to relax and stay calm, the system

provides them with useful instructions, together with favorite pictures and pieces of music, and enables them to talk to volunteers or family members. This project is also developing a system whereby they can receive above information, contents, and chance to talk even if they do not know how to use a computer.

When, for example, people are unable to relax and stay calm, the system provides them with useful instructions *via* the Internet, together with favorite pictures and pieces of music, and enables them to talk to volunteers or family members who are not physically present. However, at the present time, the difficulty of using a computer is seriously hampering access to these services for virtually everyone with a memory disorder. This is why we are developing a system whereby they can receive verbal instructions, pictures and music, and talk to volunteers over the Internet even if they do not know how to use a computer (Yasuda, 2007).

Since the conversation is conducted over the network using a video phone. The web contents such as old personal photos and videos (mostly a slideshow video made from the old photos) are used (Kuwabara, Kuwahara, Yasuda et al., 2006). Since a dementia patient may have difficulty in handling the browser function in the terminal, a remote controlling mechanism is included so that a conversation partner can specify which photo or video should be shown in the patient's terminal. The remote control is realized by remote execution of a JavaScript program. Photo or video is displayed in the terminal so that the same photo is shown on the two terminals.

However, the patient and his/her family caregiver may need assistance to operate content sharing because they are usually elderly, they might not be familiar with the concept of content sharing over the network, and it is very likely that they will encounter difficulties. Therefore, remote assistance from the therapist's terminal to operate contents is necessary, which is why we have developed a protocol between Web browsers so they can share contents with each other and operate contents from a remote Web browser (Kuwahara , Yasuda, Abe et al., 2006)..

Touching is a very intuitive sense for enabling the talking partner to recognize the patient's interest. They provide the patients with a way to inform therapists of their interest by simply touching the object or person in the photo (5). These features are listed below In the design of the networked reminiscence system.

Reminiscence Video*:* We use reminiscence videos as video contents because the effect of the reminiscence video on dementia patients to bring them peace of mind is experimentally proven.

Remote Terminal Operation Assistance by using Web Technology*:* The photo-and video-sharing function is implemented with Web technology. There already exist some photo-sharing sites on the Internet managed by famous provider, however, these sites are designed for unimpaired people who are able to use Web browsers without the support of a remote talking partner, nor for interactive photo sharing between remote users. To implement the remote support for using a Web browser and interactive photo and video sharing, we have developed a messaging mechanism between remote Web browsers over HTTPS. Using this mechanism enables a therapist can support a patient in sharing photos and videos by sending messages on how to operate the remote Web browser on the patient's terminal.

Multi-Modal Interface for Communication*:* Patients are required to touch the photo on the terminal display. The touched position on the photo is recorded and the corresponding position in the photo on the remote terminal is highlighted. The therapist operates the photo on the patient's terminal remotely, for example, panning and zooming in on the object or person in question.

Panning and zooming in on the specific object or person in the photo were very effective for making patients feel much more involved when they were watching the reminiscence video. These remote content operations are also based on the messaging mechanism between remote Web browsers.

Utsumi, Kawato, & Abe (2005) discussed a system that estimates user attention to displayed content signals with temporal analysis of their exhibited behavior. In the proposed system, user behavior, including facial movements and body motions, is detected with vision-based methods. User attention to the displayed content is then estimated based on the on/off facial orientation from a display system and body motions synchronous to auditory signals. This attention monitoring mechanism design is derived from observations of actual patients. Estimated attention level can be used for content control to attract more attention of the viewers to the display system. Experimental results suggest that the content switching mechanism effectively attracts user interest.

The posture-detection system using IR cameras and IR pattern projectors detects the user's state as the 3-D appearance (posture) of him or her. In the system, human behavior is modeled as a distribution of 3-D appearances, and the results of this behavior detection are used to determine instructions to be given to the user. They address a method to display video content to people with dementia. In the method, user behavior, including facial movements and body motions, is detected with vision-based methods (Utsumi, Kanbara, Kawato et al., 2006). User attention to the displayed content is then estimated based on body motions synchronized to auditory signals. Estimated attention levels can be used for content control to attract deeper attention of viewers to the display system. Experimental results suggest that the proposed method effectively extracts user attention to musical signals (Ohara, Utsumi, Yamazoe et al., 2007).

COGKNOW: The objective of COGKNOW was to achieve a breakthrough in the development of a successful, user-validated cognitive prosthetic device with associated services for people with dementia (Final Evaluation Report, Version 3, 2009). COGKNOW uses commercial off-the-shelf stationary and mobile devices, and commercial technologies for automatic sensing and for controlling the home environment, which keeps investments and operating costs reasonably low. The ability to adjust configurations and service settings remotely enables family and professional carers to offer support also remotely which complements and extends physical presence.

The COGKNOW Day Navigator prototype consists of a touch screen in a home environment imbued with sensors and computer-mediated controls, and a mobile device for the person with dementia to bring along when going outside of their house. Both devices offer easy-to- use functions: memory support, support to manage activities of daily life. 10 persons with dementia used the prototype independently for several weeks while 32 used it for one or more days. The COGKNOW Day Navigator is perceived as useful and user-friendly by the users, with a potential to maintain more autonomy in several areas of daily living and to improve their quality of life..

The final COGKNOW Day Navigator (CDN) prototype consists of the COGKNOW Home Hub (CHH), the COGKNOW Cognitive Assistant (CCA), the COGKNOW Sensitized Home (CSH), and the COGKNOW Server (CS). Functionalities in the final prototype as follows.

Support in Reminding: Date & weekday & time indication: analogue or digital, 24-hour or am/pm.

Pop-up reminders: remotely configurable, one-time or daily, user-defined

text/image/audio/repetition, Agenda & Quarter Hour Clock, Appointment Reminders, Find Mobile Device, Item Locator site tested, Forgotten Keys Warning.

Support social contact: Picture Dialing, priority, photos, landline prefix, using existing phone or voice modem with handset, Internet-based telephony (SIP).

Support daily activities: Radio/lamp control using Tynetec actuators, Radio/lamp control using X.10 actuators
Music/story player, Selectable music.

Activity assistant: stepwise video or image + voice instructions for daily activities, Automatic music during lunch.

Enhance feelings of safety: Help/emergency: personalized contact/help icon, Pop-up safety warnings, doors, household appliances, Sensitized night light, Navigation when outdoors, we-centric navigation when outdoors mockup.

Reminding functionality: The reminding function was overall judged positively during the three field tests. Comments during the first field test concerned the wish for more personalization and configuration of reminders and the way of attracting attention to the reminders on the screen.

Social contact functionality: As for the picture dialing function, the majority considered it useful for keeping in touch with family and friends. After comments in the first field test, the icon for making a telephone call was removed from the screen so that the number of steps needed for performing a phone call was reduced. However, some problems with the picture-phone function remained, such as: hearing problems related to the quality of the sound of the handset and delay of the hang up function.

Summary: The technical development suffered from two main challenges, one of which was related to the technical complexity of creating a system with a highly intricate set of functionalities and secondly from the logistical complexities of the physical geography and technical/clinical communication differences.

An increased amount of effort was directed towards working in closer collaboration with non-technical partners. Although this process was not fully refined,

An increased amount of effort was directed towards addressing the logistical issues surrounding geographically distributed technical development along with increasing the testing both in the lab and at each of the sites prior to deployment within the person with dementia's homes. The process of transferring knowledge from the development environment to the technical installation environment was not perfect.

Reliable and secure home area networking systems encompassing user devices and sensors should be studied, aiming for long range, security and auto-configuration. Ideally such a new home communication infrastructure should support positioning at room resolution, and fast proximity detection. Such home networking systems should work with communication systems found in mainstream user devices like WiFi and long-range Bluetooth.

9.2 Scheduling Assistance

Assistance by Videophone (Kuwahara, Yasuda, Tetsutani et al., 2010): The schedule prompter system automatically informs patients when to start the remote reminiscence conversation. They used this schedule prompter system for managing not only remote reminiscence conversation but also the routine core of the patient's daily life at home.

Due to anterograde amnesia, individuals with dementia often forget scheduled tasks. This causes

trouble, irritation, and instability. When individuals with dementia cannot remember their schedules, even using such tools as memos, diaries, and alarm-attached equipment, caregivers must constantly remind them of scheduled tasks. This places a great burden on both parties. To cope with these problems, the automatic output of scheduling contents may be useful (Yasuda et al., 2009b).

An individual with dementia, caregivers, and a memory clinic therapist determined the schedule contents to be output and a timetable, and then an engineer or a volunteer input them on the schedule prompter system. The server delivers video content by PC in which a memory clinic therapist explains and reminds patients to perform scheduled tasks (2). They prepared more than ten kinds of schedule prompter video contents (schedule contents), such as taking medicine, preparing meals, taking a bath, and so on. The length of the schedule contents was about one minute. In the initial 20 seconds, beautiful pictures and soothing/nostalgic music are output to get the attention of the individuals with dementia, to relax them, or to lure them to the PC monitor. In the remaining 40 seconds, the same explanation was repeated three times to increase the odds that the subjects had understood the task.

A five-minute automatic recording system was also installed. Since such scheduled tasks as taking medicine are crucial, the 'medicine' video content requests an individual to take her/his medicine in front of the PC. After the video presentation, the system shoots video for five minutes with the web camera to gather evidence that the individual obeyed. Then this video is sent to the server (3), so that the caregiver (who is out of the home) can check it (4). If the individual does not take her/his medicine, the caregiver or the volunteer can call the individual by IP video phone or cellular phone.

Four subjects with moderate and mild dementia participated the experiment. Several tasks were carried out every day, such as taking medicine, or output several days a week. To evaluate the effects of this video content, the caregiver was required to check whether the subject successfully fulfilled the task in periods A and B. The task completion rate afforded by the schedule prompter system, which displays a video reminder series automatically, was 52% in the study (Kuwahara et al., 2010).

The scheduling prompter was effective for subjects 1 and 3, and less effective for subjects 2 and 4. One possible explanation for the discrepancy is that both of the first two subjects were living alone, and the video contents of the schedule prompter may have eased their loneliness. In fact, subject 3 enjoyed seeing her daughter on the monitor. On the other hand, subjects 2 and 4 were living with wives or family. Since the instructions were usually given by their caregivers, the effect from the video content was less than those of subjects 1 and 3. The scheduling prompter was completely ineffective for subject 4, although, she was fascinated by the video content. She may have regarded the video content as TV commercials. Another explanation could be the difference in the severity of the dementia. The reminders worked best in the group with mild dementia, and conversation worked best in the more severe group.

Assistance by Videophone (Yasuda, Kuwahara, Kuwabara et al., 2013): The task completion rate by the schedule prompter system was 52% in Kuwahara et al. (2010). In the present study, motivational prompter videos were added to enhance the original schedule prompter system.

Individuals with Alzheimer's disease present cognitive, psychiatric, and behavioral disturbances such as agitation, poor insight, poor motivation, and depressed mood. The use of a personalized reminiscence photo video improved the concentration of individuals with dementia. The automatic

output of old music improved their behavior. In addition, psychomotor exercises have also been suggested to change their mood and behavior. If these interventions are utilized, the motivation of individuals with dementia may also be sufficiently increased to accomplish scheduled tasks. Therefore, we incorporated a personalized reminiscent photo, old music, and motor exercise videos as motivational prompter videos to augment the original schedule prompter system (Kuwahara et al., 2010).

Four outpatients of the memory clinic participated in this experiment. The revised schedule prompter system included the following video reminders: navigational prompter (navigational), motivational prompter (motivational), and schedule prompter (scheduler) videos.

The navigational video was 20 s in duration and featured beautiful pictures and soothing/nostalgic music. This video was designed to capture the attention of the subject and prompt the subject to move to the PC. Three types of motivational videos were newly developed (each type of video was approximately 5 min in length): (1) old music video (three sets), (2) motor exercise video (one set), and (3) reminiscence photo videos of each subject (three sets). One type of video was randomly and evenly chosen from the three types of motivational videos. Furthermore, one set was also chosen from three sets of the old music videos and reminiscence photo videos in the same way. These motivational videos were used to inspire the subject to perform household tasks as directed by the subsequent scheduler videos.

The subjects, caregivers, and memory clinic therapist selected household tasks to be performed and their schedule. Consequently, scheduler videos for each household task were also prepared. The length of each scheduler video was approximately 30 s. In this video, a memory clinic therapist (or a family member for subject 4) explained the scheduled tasks and reminded the subject to complete them.

The server automatically delivered the following two-video reminder series. The original video series (original series) consisted of the navigational and the scheduler videos. The revised video series (revised series) consisted of the navigational, motivational, and scheduler videos.

The caregiver was required to determine whether the subject completed the scheduled tasks successfully. The subject received 1 point if the tasks were performed without any additional instructions from the caregiver, 0.5 points if additional instructions were required for the completion of the tasks, and 0 points if the task was not completed, even after additional instructions.

Compared with the average percentages of the scores obtained in session A1 (caregiver instructions), the scores of all subjects increased in session B1 (instructions given by the two-video reminder series). The average percentage of completed tasks for the four subjects was 62.6% in the two A sessions and 82.9% in the two B sessions.

Caregiver observations of the effects of the schedule prompter system: The caregivers provided information regarding the effects of the schedule prompter system on subject behavior, as follows. ***Subject 1:*** She did not write her diary. Although she had been advised to write it and knew its importance, it was difficult for her to follow the caregiver's advice. However, the advice of the therapist in the video was stronger. She began to write the tasks in her diary immediately after she performed each task. However, writing in her diary did not persist when the video was not shown (in the B sessions). ***Subject 2:*** The PC was set in her bedroom. However, she was often in the kitchen, so the voices from the video were not heard. The timing of video output sometimes did not match

her actual activities. ***Subject 3:*** When the output of the videos started, she complained about feeling as if someone was ordering her to do the task. Nevertheless, she performed the tasks as advised by the videos. Gradually, she accomplished the tasks before the videos instructed her to do so and looked forward to the start of the videos. She even became eager to complete the caregiver's household tasks. After the videos were stopped, she felt lonely because she could not see the videos anymore. Her completion rate of household tasks decreased. ***Subject 4:*** She was very glad to see her great-grandson appear on the screen and comfortably accepted his advice to "stay home", because she sometimes lost her way. After the video stopped, she left her home.

Discussion*:* In this study, motivational prompter videos were added to the original schedule prompter system. The average percentage of completed tasks for the four subjects was 82.9% (instructions provided by the revised system), compared with 52% observed in the Kuwahara et al. (2010). Although the subjects were different from those who participated in the previous study, the revised schedule prompter system may have improved their concentration, behavior, and mood and may have succeeded in motivating subjects to accomplish the scheduled household tasks.

Furthermore, the attitude of maintaining social relationships was usually preserved in individuals with mild or moderate dementia. Therefore, they tended to obey instructions from "social resources" such as therapists and doctors more frequently than they obeyed those of the caregivers. The superiority of the effect of the videos in the two B sessions can also be explained by this hypothesis, as well as the increased motivations discussed above.

Review of Other Studies on Scheduling Assistance: Skillen, Chen, Nugent et al., (2012) introduces a novel approach for providing personalized, context-aware assistance services for users in mobile environments. Central to the approach is the use of ontological user profile modeling which captures various characteristics of a user in order to create a unique set of profile information. In addition, user profiles can adapt to changing user behavior, thus enabling services to respond to evolving user needs and preferences.

This study proposes a personalized architecture with embedded user profile modeling capabilities to support person with dementia undertaking activities of daily living (ADLs) as they move from one environment to another. Current applications include the use of GPS to track users and determine their location to provide outdoor navigation support back home again (iWander). Mobile solutions have been used to deliver reminders to users to engage with various activities at scheduled times.

iWander focuses on tracking a user's location if they have wandered outside of their 'safe zone' and thereafter alerting a carer to assist the user if they are lost. This approach, however, only focuses on the aspect of a user becoming lost and does not include other personalized services such as shopping trip reminders or context-aware guidance. A novel approach to improving outdoor mobility of person with dementia through the use of a smart-phone application is proposed in this study. The solution will not only track a user when they venture outdoors, but will also aim to provide context-aware, personalized services adapted to that user at any time.

Case application scenario*: Jane is a retired, 68-year-old woman who lives by herself and has a mild form of Dementia. Due to her condition, Jane leaves the house and forgets how to find her way to the store resulting in her wandering off in the wrong direction. The phone detects this and offers navigational support to Jane to her destination through*

the use of GPS technology. When Jane arrives at her local supermarket, her smart phone uses the underlying user profile ontology to determine what she may want and/or need from her trip. She is presented with food items and can select if these are required or not. In the background, the personalization components will create a shopping list based on her food preferences and shopping history.

9.3 Review of Life Logging Assistance

There are recent researches on logging the life of persons and recording it in a digital format. Furthermore, many applications have been developed in the field of smart environments especially for elderly persons and persons with mild dementia to improve their quality of life. Researchers in **Lifestyle Assistan**t aim to build a context-aware system that can be used by elderly persons and persons with mild dementia. Implementing such systems inside the home of a person will convert it into an intelligent space that observes the user and assists with daily activities. For instance, the system will remind the user to do daily activities, and it will send warning signals if necessary (forgetting the food on the stove, forgetting the door open, etc) (Kikhia, Hallberg, Synnes et al., 2009).

The ***Memex*** vision was described as "a device in which an individual stores all his books, records, and communications. This vision has already been realized, by the ***MyLifeBits*** project. Aggregation of audiovisual media, and sensor data such as location and temperature, makes it possible to create an overview of the activities of a day. The ***Context-Coded Memories*** project aims at providing technological support for episodic memory to aid persons in reminiscence activities by utilizing aggregated data from a GPS logger and a digital camera. ***PENSIEVE*** is a project which utilizes lifelogging to help persons remember key facts of their life. Uses images, sounds, and recorded text, to help recall names, faces, conversations and other important information. Studies have also been using images from the innovative SenseCam device in conjunction with sensor data (Hallberg, Kikhia, Bengtsson et al., 2010).

Aiding persons with dementia generate more challenges for reminiscence processes since they often find technology difficult to understand and use. The aim of ***HERMES*** is to develop a user-friendly system that will support elderly persons. The key services are reminding the user of what happened in the recent past, helping users to manage their daily schedule, and offering a series of exercises to strengthen the user's memory. (Hallberg, Kikhia, Bengtsson et al., 2010).

A ***digital photo diary*** was developed to capture information about events in daily life. The device consisted of a wearable digital camera, smart phone with Global Positioning System (GPS) and a home memory station with computer for uploading the photographs and touch screen. The aim of this study was to describe professional caregiver's perceptions on how persons with mild dementia might experience the usage of this digital photo diary from both a situation when wearing the camera and a situation when viewing the uploaded photos (Harrefors, Sävenstedt, Lundquist et al., 2012).

Memory Lane is a context-aware life-logging system for persons with mild dementia, which offers real time support (navigation, nearby person identification, current location identification, activity guide, etc) and possibilities to review previous activities and to organize future ones. It is important to collect enough data to provide sufficient material for reviewing the activities at the end of the day. This may be problematic outside the home since the system has to rely on data collected by equipment carried by the person with mild dementia. However, inside the home the

system can collect data from the sensitized environment (Kikhia, Hallberg, Synnes et al., 2009).

Lisa is on her way to the medical center for her medical check-up and she is following the navigation instructions given to her by the mobile device, which is running the Memory Lane mobile client, to get there. She is grateful for this device because it helps her remember past activities, places, and name of persons. Today she is meeting with Dr. Stefan, and as she sits down in the waiting room she is reminded of his name by the mobile device that has detected the doctor's presence. While she is waiting she takes the opportunity to review and recall past activities where Dr. Stefan has been present.

At the end of the day, the data from the portable devices is uploaded to the home station and they can start reviewing. Together they select a number of images that represent the different activities: a few images of the clinic, an image from the laundry room from when Lisa was doing her laundry, and images from the dinner Lisa had with her friends. The names of known persons which were present during the activities are automatically added by the system to reduce the effort.

Detecting the presence of known persons nearby is based on the Bluetooth ID, and the interface displays images of up to four persons if there is more than one known person nearby. Clicking on the persons' image will show the images of all nearby known persons separately as a list, making it easier for the person with mild dementia to choose any person to recall information about (Kikhia, Hallberg, Synnes et al., 2009).

Hallberg, Kikhia, Bengtsson et al., (2010) described the main features of the ***Review Client*** and will show an early design of the user interface. The Review Client guides the person with dementia and the carer through the steps of organizing the preceding time period into activities with a described purpose for each, annotating visited Places and present Persons, and making representative selections of recorded media for each Activity

The reminiscence therapy method was introduced over 20 years ago. It is also based on the idea of letting the person with dementia review the activities of the day together with a carer. This was deemed effective for building durable episodic memories. The theory is that a person with mild dementia can learn by rehearsing details about the day, and hence build lasting episodic memories. However, this remains to be properly tested. (Hallberg, Kikhia, Bengtsson et al., 2010).

Wearing Assist system for recording and searching daily behavior: Information technologies to record daily behavior by wearing Video Recorder have been studied. Yasuda (2010) made a prototype system to assist recoding and searching of one-day behavior of vest-wearer on which two IC recorders and a portable video recorder are equipped. Vest-wearer records on IC recorder the key words and the time of occurrence for events which will be searched in the future. The recorded information is analyzed by a speech recognition software on personal computer. Then, by using these literally-converted information, vest- wearer can search for the specific visual scene on the video record. The operating procedures for these tools were visually presented by a note pad on the vest, and also verbally and automatically presented by another IC recorder. A patient with mild cognitive impairment wore the vest with these tools, operated them, and succeeded to record his daily behavior for 12 hours in a day. These researches suggest that various IT tools are effective to manage various symptoms of peoples with dementia. IC Recorder as automatic voice output navigator can prompt the patient's daily activities, including reminders not to leave the house.

Huang, Matsushita, Kawagoe, and Yasuda (2014) are developing a memory vest which is

equipped with portable devices including an Android smartphone, two IC audio recorders, and a digital video recorder to log the daily life of the patient. The gathered activity history database can then be used to enrich the dialogue ability of the agent and for helping the user to recall his / her own memory. It is essential to make the agent memorize not only past interactions but also the daily life of the patients, to allow them to feel that the agent is together with them. They proposed a set of recording devices (digital video recorder and an IC audio recorder) which are put in a wearable way and are operated by the patient himself / herself, the memory vest. This is used to log the user's daily activity for memory recall of both the user and the agent after then.

They are then developing the integration with an Android smartphone into the memory vest. The current prototype recognizes the user's moving status (walking, running, bicycle, car, or train) and location when she/he is outside home and periodically updates the user's latest status to a server hosting the activity history database of the user. After the development of the technique to transform the log data to appropriate memory and knowledge presentation, They plan to integrate the database as the back end of the listener agent and thus allow it to engage the dialog involving the context of the user's daily life.

They are now developing methodologies to automatically identifying remarkable events and the denotes that the user was moving by a train while red means a bus browsing interface of video log. Our next step is to extend the companion agent interface to the smartphone.

Crete-Nishihata, Baecker, Massimi et al., (2012) designed a home-based ambient display that allowed a man with AD to similarly review his past life, in combination with recent photos automatically captured by a life-logging device called SenseCam. Reviewing SenseCam images improved episodic recall for personal events depicted in the images for 4 of the 5 participants.

Two other studies followed: one utilizing life logging and semi structured interviews, and the other taking photographs from the life logging. Life logging, the recording of everything that is seen or done, includes the use of the SenseCam . The SenseCam is a wide lens wearable camera that automatically captures images based on changes in the persons' environment.

Crete-Nishihata (2012) found that the slideshows did not improve memory, it did allow the opening of conversation about memories, and story-sharing. It aided in creating identity. They were more able to attribute emotions and memories to them, rather than if they had taken the picture themselves. There is room for expansion in this field, and the results thus far seem promising (Thompson, 2013)

Behavioral Assistance in Night: At nighttime, People with dementia (PwD) can experience aggression, restlessness and Sun downing in the forms of vocalization and shouting, physically threatening behavior, wandering, and overreaction to situations. The causes range from misunderstanding of time, irregular and excessive daytime sleeping, feeling frightened, frustration in being unable to comprehend situations, erosion of self-control and judgment through inhibitions and decreased awareness of rules about appropriate behavior. The consequences equate to higher rates of falls, propensity to other accidents and dangers, sadness and depression.

A therapy session can have a positive impact on mood as well as performance of activities for PwD during both the day and nighttime. Those therapy sessions can be influenced by carers providing information such as family pictures and appropriate music (Carswella et al, 2009).

Nighttime activity levels may be lower but this is potentially a more vulnerable period for PwD. AT has been used to assist with the regulation of sleep patterns, as excessive daytime sleeping, and

Sundown syndrome contribute to the night-time problems. Sundown syndrome (sun downing) is a term that describes the onset of confusion and agitation that generally affects PwD or cognitive impairment and strikes in the late afternoon or early evening. A closely related syndrome is that of day-night reversal where PwD experience longer periods awake at night than they do during the day. This provides significant additional burden to the carer. Technology can assist people in the hours of darkness as well as during the day. While night-time specific studies identified very few papers (Carswella et al, 2009).

Monitoring: A monitoring system was presented for PwD using an expert system. The system tracked people and monitored their activities through use of low-cost positioning sensors. The system recorded and learned the person's movements and their whereabouts. The following data were recorded: number of times he/she got up, went back to bed, visited the toilet, and left the bedroom, and the distance covered during the night. Such analysis could give nurses warning of an increased risk of fall or a decrease in mobility and assist them in making decisions on prescribing medication or whether additional surveillance was needed (Carswella et al., 2009).

Lighting and guidance: At nighttime darkness and disorientation is a hazard. Therefore, lighting for guidance is a very important aspect of safety. Lighting can guide PwD to destinations or make them aware of other hazards. ***INDEPENDENT*** suggested that lighting significantly assisted navigation by ensuring that different areas were visually distinct and providing orientating views. Effective lighting improved recognition of spatial awareness and visual orientation (Carswella et al., 2009).

Education and treatment: A sleep education program was introduced for people with dementia to try and improve sleep patterns at home. Their program introduced the combination of sleep education, daily walking, and light exposure intervention over three weekly treatment sessions. Treatment sessions included a 30 minute daily walking exercise and a program for increasing daily light exposure via a "Sun-Ray light box", within a 3 hour window of bed time. After 6 months participants had significantly fewer awakenings per hour and were awake for less time at each awakening.

The ***Vigil system*** comprised a bed exit sensor positioned under each resident's bed sheet, and bathroom and bedroom exit monitors. Vigil alerted caregivers via a silent pager when a 'high-risk' resident exited his or her bed, bedroom, or bathroom. It was expected that the presence of an automated sensing system would reduce the number of times that nurses would have to check residents' nocturnal status. Staff commitment actually increased on average 6 minutes more per person per month, but there was a significant difference in affective disorder, with the intervention group showing improved affect.

Using an infrared sensor system 1.5m above the residents' beds, their activity along with their presence or absence from their bed was recorded over a 3 month period. The sensor system performed accurately by analyzing it against video recordings of night activity during the experiment. Thus infrared sensors have potential as an ambient technology.

Wandering is the major concern of all carers for person with dementia. Results showed subjects were less active at night, e.g. lying, sleeping and in their own rooms. Excessive wandering behavior appears to be related to activities in the environment, e.g. a quiet environment leads to less agitation and therefore less wandering.

Technology for tracking movements of individuals in residential care was discussed in using

‘tagged’ slippers and electric pressure mats. Six of the eight subjects were detected to have moved during the night-time period, showing various movement patterns. Understanding the pattern of movement at night time may improve the safety of PwD who are at risk of falling. Nighttime assistive success was reported where one resident required antipsychotic medication every night for episodes of screaming, when an simulation presences audiotape was used for 1 hour every evening.

Passive Infra-Red (PIR) Night Light: Two PIR dusk to dawn lights were used. One was plugged into an existing plug socket by the bed and the other was plugged into an existing plug socket in the hallway near to the toilet door. Both lights were switched to the PIR function so that they only came on when activated by movement. The lights stayed on for approximately one minute when activated. This enabled the person to see to find their way from the bedroom to the hallway and then to locate the toilet. A simple plug in light with PIR reduce falls at night, assist orientation, reduce anxiety (Cash, 2004).

The effects of exposure to high-intensity bluish and yellowish light was assessed on behavior and circadian rhythmicity of institutionalized older person with dementia. When light intervention was used, a more normal circadian rhythm was established. Most lighting studies have been used to produce a positive impact on circadian rhythms. Person with dementia are more likely to experience disjointed patterns in their sleep and wakening patterns. By trying to regulate these patterns into a fixed normal pattern of a day/night cycle, The associated night time problems and their potential hazards could be significantly decreased. A randomized controlled trial was undertaken to determine whether the progression of cognitive and non-cognitive symptoms may be ameliorated by bright light and increased release of melatonin. Lighting, of course, is of greater relevance at nighttime, as it can assist with guidance and hence reduce the potential hazards in the dark. (Carswella et al., 2009).

Telling system in night: During the night, for example, a lighting system was activated if a patient had left the bed. On returning to bed the lights would fade off after a few minutes. However, failure to return to bed after a predefined period of time would result in the communication system telling the patient that it is nighttime, and they should go to bed. Furthermore, the system communicated to the patients when they approached an exit during the night and verbally reminded the patient to return to bed (Lauriks et al., 2010).

Electronic display board for use at night: Some people panic when they wake up during the night, unable to remember where they are, why they are there, or what time it is. One solution is to place an electronic display board on the wall, the ceiling or at the foot of the bed, so that the person will see it when he or she wakes up. It can be used to display information such as, *"I have come to spend a few days with my daughter"*. We have tested this system on several people with dementia and it seems that success depends on the way in which the messages are phrased (Yasuda, 2007).

9.4 Assistance for Procedural Behaviors

Dressing Assistance: The goal of the study (Mahoney, Lczano, Ravishanka et al., 2014) is to develop a 'smart dresser' for in-home use by people with moderate memory loss. This device is designed to provide individualized audio and visual task prompting and enables people to dress while giving a respite to their caregivers. There has been insufficient attention to the stressors associated with dementia-related dressing issues. The ***DRESS*** system uniquely combines interactive context aware/skeletal movement, wrist-affective emotion sensing and fabric tag components to assess and respond to users in real time. Caregivers validated the need for tangible dressing

assistance to reduce frustration from time spent in repetitive cueing and from struggles over dressing. They contributed six changes that influenced the smart dresser's conceptual stage prototype development, most notably adding a dresser top iPad to mimic a familiar “TV screen” for the audio and visual cueing.

Cooking Assistance: Forgetting to turn off the cooker can cause a fire. The control turns off the gas when the food being cooked reaches a certain temperature (ENABLE, 2004). In the early stages you could use signs to say, “remember to turn the cooker off”’. However, if this intervention failed, the cooker would be switched off. This included the use of smoke alarms, fire blankets, cooker guards and safer forms of heating such as storage heaters and oil filled radiators (At Home with AT, 2004).

Cooking is one of the most fundamental activities of humankind (CEA2015). It is not only connected with the joy of eating but also deeply affects various aspects of human life such as health, art, entertainment, and human communication. Cooking at home requires experience and knowledge. They may also need support for food-logging and menu planning for their family health. Needless to say, support for a good and enjoyable meal would improve the quality of life. Systematic cooking/eating support for elderly or physically challenged people is also significantly important. Since a cooking activity requires people to manipulate foods, watch their conditions, listen to the sounds, smell the aromas, and taste it, a cooking assistive system should also be capable of multiple sensitivities. CEA has been aiming to provide an opportunity for such research groups to discover each other, introduce their trials, and discuss their status and where they should go. Even if limiting to computer science, there are related works in multimedia, human-computer interaction, natural language processing, and artificial intelligence.

Two cognitive aids have been developed to assist aphasic users in the execution of cooking tasks. ***VERA***, which provides individually tailored visual cooking instructions, has been tested with four aphasic subjects. The most severely aphasic subjects performed best with the system, whereas those who were less impaired performed best with text-based -instructions. In contrast, ***Cook’s Collage*** is a video-based reminder system that displays the previous six steps completed in the cooking task to reorient the individual to the remainder of the activity (Bharucha et al., 2008). A cooking monitor service was developed to detect problems and potential dangers during the cooking process. During evaluations the cooker monitor worked well. However, it caused some irritation to users when the cooker was turned off under false positive situations (Lauriks et al., 2010).
Among daily-living activities, kitchen tasks may profit most for ICT-based, elderly-assistive solutions: for safety; for complex and cognitively-demanding tasks; and since most home technology is found in kitchen appliances. The FOOD (Framework for optimizing the process of feeding) project, is based upon these premises, and aims at building a 'smart' kitchen environment, providing older adults with services supporting safety, motivation and fun in the kitchen, and a healthy lifestyle. FOOD utilizes a networked kitchen, in which appliances and environmental sensors communicate, both at the local and the remote level (Grossi, Bianchi, Matrella et al., 2014).

The kitchen network is also relevant to energy management and to maintenance purposes. Services could be as simple as basic safety monitoring tasks. For instance, a recipe database can be accessed through nutritional and medical 'filters'; step-by-step guidance is provided for selected recipes; automatic set-up of the cooking appliances can be connected to the desired recipe. The data stream coming from the kitchen network is also exploited for profiling the user's habits and for early

detection of behavioral changes (connected to feeding and possibly suggesting health issues).

Cooking Support System (Sano, 2014): Sano (2014) have focused on cooking behaviors which are vital to living and which draw on all five senses, as a powerful means of cognitive rehabilitation with respect to people with higher brain dysfunction. In order to help people with higher brain dysfunction prepare food and cook on their own, he proposed a cooking navigation system that is tailored to the mental and physical disabilities of the patients based on multimedia cooking recipes.

The flow of a cooking rehabilitation program. Step1: The patient plans a meal, determines the dishes to create, and shops for them. Step2: The patient prepares the food, based on the cooking support system. Step3: Once the cooking is complete, the patient eats the meal while communicating with others. Step4: The patient reflects on the rehabilitation with the therapist, including shopping and cooking behaviors.

The cooking navigation system consists of multimedia cooking recipes configured of combinations of static and dynamic media, which have been converted to basic short sentences. The patients perform tasks in accordance with the recipes written into the cooking rehabilitation system. During the cooking process, a number of tasks are generally done simultaneously. For example, the boiling of water and the cutting of ingredients can occur simultaneously.

For the top-down attention behavior model, we configured it as a flow model in which a number of cooking steps are done in parallel. We show the steps for a simmered meat-and-potatoes dish, the steps for miso “soup”, and the attention flow. When putting together the meat-and-potatoes dish while making the miso soup, for example, the cook starts the process for miso soup once the process for the meat-and-potatoes dish has more-or-less ended. During that time, the cook must watch the actions at hand in order to follow the miso soup step, but at the same time it is also necessary to pay attention to other things such as whether the meat-and-potatoes pan is boiling over.

For evaluating whether proposed attention indices can work well, we prepared a recipe of meat-and-potatoes dish and that of miso soup. For obtaining attention behavior evaluation index, an ideal attention allocation pattern is required. Each allocation rate (%) is normalized as the sum of the simultaneous events becomes 100%. The attention allocation rate of hands and pan is high, because the cutting and heating operations have some dangerous factors.

There is a total of 20 nodes for the meat-and-potatoes and the miso soup recipe. We arranged a video screen with rehabilitation activities at left side and located an evaluation score and comment each step at right side. When a user clicks on the step to reflect, a video is played according to the specified step. The comment was described as “You worked well!” And you watched a pan of meat-and-potatoes dish beyond necessity. You have to glance at a pan of miso soup.”

We conducted cognitive rehabilitation experiments to two higher brain dysfunction patients for one month. The patient A could perform a cooking using cooking navigation system smoothly. Because improvement was seen in how to handle kitchen knives and the way of measurement of the seasoning, this support system was effective for the patient A. As for the patient B, his awareness and aspirational utterance increased gradually. He said, “I wanted to continue this rehabilitation and I will use this system at his home”.

Washing Hand Assistance: People with dementia often have difficulty completing activities

of daily living (ADL). Forgetting steps in tasks such as using the toilet can become aggravating and embarrassing. Caregivers often guide patients to complete the task by giving step-by-step prompts. The development of automated prompting systems may help to alleviate some of the strain experienced by caregivers.

Mihailidis and Turgeon (2005) have had some early success with these automated prompting systems. Up to three different verbal cues were issued to the subject before a caregiver was called upon for assistance. The subjects were able to complete without assistance from a caregiver as well as a decrease in the overall number of interactions required with the caregiver when the device was introduced.

COACH: Using a video camera, hand-tracking bracelets, and machine learning algorithms, COACH monitors the progress of the hand washing activity, determines the context, and provides prerecorded verbal prompts if and when it detects a problem in task execution (e.g., forgetting to wash hands after using the soap). In a clinical trial of 10 subjects with moderate to severe dementia, COACH increased by 25% the number of hand washing steps that were correctly completed without caregiver assistance. The investigators are currently refining COACH with a new color vision hand and object tracking system that obviates the need to wear tracking bracelets, and machine learning algorithms that are capable of handling uncertainty more robustly. Moreover, a visual prompting capability is being tested in comparison with the previously developed verbal feedback methods (Bharucha et al., 2008).

Toilet Assistance System: Utsumi, Yamazoe, Abe et. (2006)'s posture-detection system using IR cameras and invisible IR pattern projectors detects the user's state as his/her 3D appearance. Human behavior is modeled as a distribution of 3D appearances using kernel density functions, and the results of this behavior detection are used to determine the instructions to be given to the user. They show a sample implementation of the system for a toilet task with voice- and CG-animation-based instructions to users.

Caregivers bear a great burden of toileting assistance for those patients with dementia. Yasuda, Okazaki, Utsumi et al. (2008) proposed a system that can help the patients to relieve themselves in the toilet activities by giving cognitive support through an appropriate voice and visual guidance, in line with their task progress. The system observes 3-D user appearances and recognizes the task progress based on his/her position and postures. They performed an evaluation experiment with 7 subjects with dementia in simulation environment.

The result showed that 5 patients had successfully fulfilled their required task in the simulated toilet activities, partly with the help of voice guidance by an experimenter from the monitor room. The cause of the failure is that their eye gazes and attentions did not correctly move from the PC screen to the target objects in the environment. In order to overcome this problem, Yasuda, Imai, Kuwahara et al. (2009) introduced an arrow and eyeball animations to direct the patient’s gaze and attention. With this refinement, seven out of eight patients with mild and moderate dementia smoothly performed the required tasks. The arrow animation seemed to be more effective for eye gaze direction.

Bathing Assistance System: Onishi and Hirai (2008) had a research project of a bathroom as a ubiquitous computing environment. In order to measure bathing activities, they have studied availability of RFID equipped into bath items in a bathroom with water. From some experiments, we confirmed to be able to detect primitive actions of bathing person by picking up or putting bath

items and their positions. However, meta-level bathing activities, for instance washing body or hair, are more useful than primitive actions for various applications. This paper describes three trial estimations of meta-level bathing activities from primitive activities using Hidden Markov Model (HMM). This paper also describes data of bathing activities for HMM, and a simulation using actual bath items equipped RFID.

9.5 Smart Home

Low Tech devises: Several nursing homes use environmental/spatial cues to increase functional independence in room finding for the elderly. Spatial cues can be considered as salient reference points which can help the patient to discriminate among similar places and recognize specific areas, such as corridors, stairs, room entrances. Ten persons suffering from mild to severe AD were involved, which compared the effectiveness of significant (familiar and beloved) and non-significant (unfamiliar and neutral) objects displayed outside the participants' bedroom. Some in the moderate stage relied more frequently and successfully on significant cues. The patient with an advanced stage of the disease failed drastically to use any type of orientation cues.

Another impact was evaluated for placing two external memory aids outside the bedrooms of three persons with AD. A portrait-type photograph of each participant from early childhood and a large print sign with the resident's name were both placed outside each participant's room. Results showed that there was over a 50% mean increase in participants' ability to accurately locate their own room following the intervention (Caffo, Hoogeveen, Groenendaal et al., 2013).

AT programs for reducing spatial orientation disorders have been profitably employed with persons with intellectual and visual disabilities: for example, auditory cues repeated at regular intervals to call the person toward a specific target destination were used with persons with visual impairments. Similarly, a visual orientation system based on a portable device to be worn by the participant and on light sources that marked the routes to the various destinations was employed for promoting independent indoor traveling in persons with profound developmental disabilities (Caffo, Hoogeveen, Groenendaal et al., 2013).

Recently, an AT orientation program based on verbal messages has been successfully implemented with three persons with AD. The orientation system (a) included a sound source at each of the destinations (b) provided brief verbal messages from the destinations the person was expected to reach. The verbal messages consisted of short sentences encouraging the patient to walk and find the destination. The three participants involved in the study learned to use effectively the orientation technology to reach different room destinations. In a more recent effort, the effectiveness of two AT orientation systems was compared, one involving auditory cues (i.e. verbal messages automatically presented from the destinations. There was over a 65–70% mean increase in patients' ability to travel and locate the target rooms.

High Tech Devises: The ***Gloucester Smart House*** project aimed to develop the following functions. ***Locator*** is a device to help people locate lost items such as their purse, glasses, pension book, or keys. ***Bath Monitor*** is to help stop people filling the bath to overflowing. ***Cooker Monitor*** is a device that monitors the cooker and acts to prevent dangerous situation occurring. ***Night-time Guidance*** guides the resident of a house to the toilet with gentle lighting in the middle of the night.

Helal et al., (2003) propose ***Smart House*** in which computation is embedded into physical objects (such as walls, floors, doorways, clothes, etc). The Smart House should be able to proactively change its environment to provide services that promote an independent lifestyle for the

elderly. They have created a Smart Robot called ***Matilda***, which will function as a factitious AD elder. Matilda's Smart House is equipped with various sensors and devices. This environment includes J2ME smart phones as user devices, ultrasonic location sensor, X-10 controlled devices (door, mailbox, curtain, lamp, and radio), and networked devices (microwave, fridge, LCD displays on the wall, and cameras). They have developed several applications for Matilda's Smart House.

Mobile Patient Care Giver Assistant (***mPCA***) is a smart phone that interacts with a set of sensors in a smart space, in which most of the computation, decisions, and events take place. This is an attention-capturing application to help patients with moderate AD by means of reminders, orientation, and context-sensitive teaching, and monitoring. It first, attempts to capture the elder's attention. Once attention is captured, the system delivers the task to be done by the elder (e.g. the elder needs to drink water to be hydrated). The task is delivered in a form of a video clip played in one of the four flat panel monitors. The initial phase simply calls the elder's name (message played in the phone) requesting the elder to respond in a certain way (e.g. say "yes"). If attention is not secured, richer audio is attempted by playing special songs and sounds and then repeat the name calling and confirmation request. If this fails, the system actuates the vibrator on the smart phone and outputs the name calling using pre-recorded sounds of relatives and significant others (Helal et al., 2003).

General Reminder System (GRS) reminds the elder to perform critical tasks such as medication intake and doctor appointments. This application will play an audio message on the elder's smart phone whenever a medicine is due. Then the patient should use the mobile scanner attached to the phone to check if it is the right medication or not. The smart phone will send the data read by the scanner to the server, which will check how much medicine is available to order a refill whenever the quantity goes below a certain level (Helal et al., 2003).

Augmented Awareness System (AAS) is to enhance the level of awareness of the occupants by notifying them when certain events happen (mail delivery, someone at the door, water leak, etc), and also reduce the level of efforts by automating tasks (e.g. controlling appliances, lighting and doors). They have chosen voice interface to reduce the level of attention of the elder to control the environment. Appliances, lights, door latches, mailbox sensors, leak sensors, and window sensors are attached to X-10 components. Whenever mail is delivered, an event is sent in the framework. The framework delivers a voice message to the smart phone of the elder. (Helal et al., 2003).

In addition to instrumenting the home with various motion detection devices and a small wireless network consisting of three RF receivers, the person at risk for dementia and his or her caregiver wore an RF transmitting wristwatch to record the movement trajectory. the Proactive Activity Tool kit (***PROACT***) investigators also used RF technology to determine the performance characteristics of PROACT in automatically recognizing the activity of daily living (ADL) (Bharucha et al., 2008).

Intelligent sensors were described which may be used to form a monitoring and alarm system. The sensors included magnetic switches on doors for monitoring movement from room to room, thermostats which measured room temperature, appliance temperature or body temperature. Accelerometers measured loss of balance and falling. Radio Frequency Identification (RFID) tags were placed on commonly misplaced objects for retrieval while infrared motion sensors tracked presence and motion throughout the home. Microphone arrays were used to facilitate communication with the resident or to detect abnormal noises or calls for help. Grab bars were placed to aid

people's transfer on and off toilets, in and out of doors and entry and exit of baths and showers. The physical pressures exerted on grab bars could be used to identify improvement or decline in strength and balance. Pressure sensitive mats were installed under bed mattresses to monitor the rest dynamics. An array of pressure sensors, measured the positioning and posture while lying down and lying to rising transitions. Identifying these changes could lead to preventing falls injuries (Carswella, McCullagha, Augustoa et al., 2009).

The use of electronic noses can be used to recognize changes from normal smells to identify things from personal hygiene to burning food. These are very important aspects of nighttime associated care. A bathroom monitoring system was produced to provide statistical usage of bathroom appliances from showering, bathing, cleaning teeth and washing hands. However to date, evidence is not consistent as to the benefit. A Cochrane review reported a lack of empirical evidence to support or refute the use of smart home technologies within health and social care (Carswella et al., 2009).

Willow Housing and Care Beechwood Court Extra-Care scheme appears to be built specifically with dementia clients in mind, creating an environment which incorporates very helpful features. It opened in January 2012, a team Leader explains: "We have included a higher level of security at the scheme than previously; we also have flood detectors in kitchens and bathrooms and smoke detectors linked to the community alarm. We have 'memory boards' on individual doors and are alerted if a resident leaves their flat. Flooring is differently colored in different areas to aid way finding (Bonner & Idris, 2012).

Manor Gardens, Bolton Places for People developed this extra-care scheme in2009. Every flat has fused spurs to enable rapid installation of automatic door and window openers and motorized curtain tracks. The scheme has strengthened walls/ceilings in the bathrooms to accommodate grab rails and tracking hoists. As well as the modern call alarm system with full tele-care/tele-health capabilities, the scheme has Digital Signage and Interactive Notice boards, touch-screen video ('Skype') facilities and an IT Suite plus full on-site Broad band access allowing wired and wireless internet connections for each resident. Those who don't need any assistive equipment haven't been left with grab rails or automated mechanisms, but they can be fitted easily if they require them at a later stage (Bonner & Idris, 2012). 'YouTube' sessions in our IT suite were invaluable for reminiscence purposes as there are so many clips online from their earlier life. Also, our video box (which utilizes Skype), helped connect people with loved ones from around the world and this was a great source of comfort and pleasure" (Bonner & Idris, 2012).

Monitoring System in Residential Homes: Sugihara, Nakagawa, Liu et al., (2009) installed a camera system into a group home to investigate how such a device may help caregivers in responding to the behaviors of the persons with dementia. They studied how their behaviors have changed by introducing the system into the home through video recording and a series of interviews. They found that the system enables caregivers to optimize their responses to the persons with dementia depending on their degree of mobility.

Schikhop and Cordia (2012) evaluated the implementation of a new monitoring system in residential homes for people with dementia. The system supports the care professionals in their work and helps to prevent nightly incidents. The network IP-cameras were connected to a variety of sensors that respond to presence, activity, and sounds. When the sensors are activated by an event, live images and sound are sent by WiFi to the mobile Personal Digital Assistant (PDA) of the care

professional on duty. The camera in the bedroom of the resident can then be steered by the carer using the PDA touch screen if necessary. Thus, the care professional can make an assessment if the resident needs immediate assistance. The care professionals said they saw only advantages to using the monitoring system. They positively evaluated working with the new system despite the fact that, when introduced to the technology, they thought it would be intimidating to work with a PDA.

9.6 Other Assistance

Almost every Alzheimer association offers a website where people with dementia and their carers can join forums, post messages or chat with fellow sufferers. Many Alzheimer associations also have a 24-h telephone support service for emotional support and information on regional support services like Alzheimer café's and meeting centers. An Internet-based application called Alzheimer's Carer Internet Support System (**ACISS**), designed to provide carers with clinical, decision-making and emotional support, was evaluated in a 6-month field trial of 42 carer/patient dyads. Preliminary results showed the system to be beneficial to carers of people with dementia (Lauriks et al., 2010).

Cognitive intervention can be presented utilizing video conference, computer based, or Internet-based systems. In comparing cognitive intervention via a video conference system with face to-face intervention, telemedicine was feasible, effective on memory, language and attention and highly accepted in people with dementia. An interactive computer -based program was performed to train people with dementia to use a touch screen and showed improved performance in computer-program tasks. To determine the usefulness of an Interactive ***Multimedia Internet-based System*** (IMIS) in people with suspected Alzheimer's disease, IMIS was compared in combination with an ***Integrated Psycho-stimulation Program*** (IPP) and pharmacological treatment to IPP combined with pharmacological treatment and pharmacological treatment alone. They found both IMIS and IPP to improve cognition and the IMIS program to provide improvement above that seen with IPP alone (Lauriks et al., 2010).

Formal and informal carers in a number of European and North-American countries utilize forms of telemedicine such as video conferencing, tele monitoring and tele care to create more capacity by reducing travel time and increase quality of care by allowing more frequent contact and quick referrals to a specialist. Several projects aimed to develop tele-care home services that enable persons with dementia to live independently and offer support to their informal carers. The European Fourth Framework Program (FP4) project ***ACTION*** (Assisting Carers using Telematics Interventions to meet Older persons Needs) focused on the empowerment of family carers to help maintain autonomy, independence and quality of life in frail elderly. Familiar electronic equipment like TV and telephone was combined with modern ICT to improve carers' coping skills in daily care and emergency interventions and to offer financial information and emotional support. A Swedish contribution to the project comprised a videophone to facilitate communication between health care providers and patients and their families. Families were quicker to request information, education and support from professional carers and valued the informal support network of family carers to share experiences (Lauriks et al., 2010).

The FP5 project ***TeleCARE*** aimed to design and develop a flexible infrastructure of remote supervision and assistance services to facilitate independent lifestyles and to improve quality of life, confidence, well-being and safety in elderly people, including people with dementia. Partial validation was achieved with field assessments involving four classes of potential users including

elderly and their relatives and health care providers. However, field tests for fine tuning and acceptance of the technology still need to be carried out. Another tele care project is the "Tunstall tele-care system", which can be tailored to suit the needs of people with dementia and protect them from dangers such as wandering, fires and floods (www.tunstalltown.com) (Lauriks et al., 2010).

Within the ***Safe-at-home*** project conducted a large-scale study into the effect of different items of assistive and tele care technology. An intervention group of people with dementia was compared to a matched control group. After intervention the two groups differed significantly in the number of services received, visits and contact hours per week, resulting in lower costs in the intervention group. The technology was found reliable and a majority of carers reported reduced feelings of concern for a person's safety. Almost half of the carers felt the project had improved the confidence of the user in their ability to look after themselves safely (Lauriks et al., 2010).

The experiences of 19 informal carers with a web-based home monitoring system, consisting of broadband Internet access, an Ethernet card, the Xanboo Smart Home Management system and a cell phone with text messaging were explored by in the ***SAFE house*** project. Carers received training on how to use the system prior to installation and were able to use the system during the intervention period of 24 weeks. Researchers reported reduced carer burden. Cellphone alerts facilitated keeping track of loved ones and as relatives called more often, relationships improved (Lauriks et al., 2010).

How to cope with them and where to find support can be found on websites of Alzheimer societies. Alzheimer Nederland also offers a 24-h telephone service for information, support and advice. The Dutch site www.hulpgids.nl offers psychiatric consultation, forum discussions and fellow patient contact. On www.vraagwijzer.nl one can get help clarifying a health care demand, get advice on adequate care and support in how to receive the desired type of care (Lauriks et al., 2010).

The Geriatric Research, Education and Clinical Centre (GRECC) of the Minneapolis Department of Veteran Affairs Medical Centre offers practical online information on a number of topics related to caring for a patient with dementia (e.g. how to handle a loved one's decline, how to cope with bowel and urinary incontinence). The US website www.alzonline.net provides Internet- and telephone-based support and education for people with Alzheimer's disease and other dementias as well as support for their carers. Utilizing training videos and downloadable information, the site offers classes to address a wide range of topics related to dementia care (e.g. medication management, dealing with the stress of caring and performing daily tasks). An initial program evaluation showed reasonable effectiveness of ***AlzOnline's Positive Caregiving Classes***. Carer self-efficacy improved and subjective carer burden was reduced but positive dimensions of the care giving experience and perceptions of time burden in providing care were unaltered. The efficacy of ***Care-giver's Friend***, an Internet-based multimedia support program designed to support family carers employed in the workforce in participants using a pre-test/post-test design. Results showed significant benefits on carer depression and anxiety and improvements in perceived stress, strain and positive aspects of care giving (Lauriks et al., 2010).

Information and emotional support for carers in coping with dementia symptoms furthermore is available through web forums and chat rooms, video training and telephone services. Though web-based interventions seem promising especially to help meeting the various needs of people with dementia and carers in an effective and less time-consuming way, instrumental ICT support for coping with behavioral and psychological changes in dementia is, however, relatively disregarded as yet. People with dementia and their carers have access to online information, support, education,

and advice on coping with behavioral and psychological changes (Lauriks et al., 2010).

Until dementias can be prevented or cured, interventions that maintain or maximize cognitive and functional abilities will remain critical for healthcare and research priorities. Best practice guidelines suggest that individualized exercise programs may improve fitness, cognition, and function for people with mild to moderate dementia. Increasingly, telehealth is being used to improve the delivery and availability of healthcare services for individuals living in rural areas, including exercise. This article describes the feasibility of a telehealth-delivered exercise intervention for rural, community-dwelling individuals diagnosed with dementia and their caregivers. Participating in an exercise intervention with persons who were in similar situations was deemed beneficial. Although there are barriers to overcome, the development and evaluation of telehealth-delivered exercise interventions is a timely and important research activity that has the potential to facilitate improved healthcare services for individuals with dementia and their caregivers (Bello-Haas, O'Connell, Morgan, & Crossley, 2014).

Recently, walking exercise is becoming popular. People are able to exercise with enjoying the surrounding environment changes and the strolling around wherever they like. We believe that these enjoyments, are called wandering, are essential elements of the walking exercise. On the other hand, there are also many people exercising with a walking machine in the indoors, such as a sports gym. However, the exercise with a treadmill is tedious for users because of lack of the wandering. Takase, Yoshida, Dohi, Nakano, Sakai, & Yasuda (2016) proposed a novel support system for walking exercise with the wandering experience by using google street view. In addition, we introduce a companion agent to act as a route guide and improve the enjoyments of walking. As a result, users can stroll around the world or visit wherever they want with the agent during exercising. By means of the system, users will be able to exercise in the indoors with the similar wandering experience in case of walking in the outdoors.

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Chapter 10 Daily Assistance by Virtual Agents and Robots

10.1 Support by Agents System

Necessity of Conversation: Conversation is a very high-level cognitive activity and involves large brain areas, language understanding, language production, and so on (Huang, Matsushita, Kawagoe et al., 2014). A conversation is a common and enjoyable activity for most people. Individuals with dementia, however, tend to be isolated with few opportunities to converse, particularly for individuals living alone at home (Yasuda, 2009). Therefore, one of the most important interventions for them is to provide them with opportunities to converse with people. However, provision of such conversation opportunities requires human resources. As one of the interventions to resolve this problem, a remote conversation have been proposed, which connect an individual with dementia and a conversation partner by using a telephone or a video phone.

Since the number of individuals with dementia is rapidly increasing, it is getting difficult to find enough conversation partners, even with remote conversations. In the last decades, many talking dolls and toys for the elderly have been available in markets. However, the number of categories and topics to be spoken by dolls and toys are narrow and limited. The conversation with them is simple and fragmentary so that a reminiscent or theme-oriented conversation such as life review is difficult to perform. This limitation may frustrate individuals, especially with mild and moderate dementia. Recently, several talking robots have been developed.

Necessity of Agents: Aiming to reduce the caregiver's physical and mental burden and help the patients to keep their mental stability, several researchers proposed a conversational agent for people with Dementia. While some recent studies used conversational humanoid in caring elderly people and using in healthcare, little has been studied in conversational agent for people with Dementia (Sakai, Nonaka, Yasuda et al., 2011).

People are increasingly interacting with computerized agents. Examples include autonomous and tele-presence robots in homes, healthcare, or search and rescue, virtual characters in the expanding gaming industry or for serious games, and agents representing other people through on-line social and interactive meeting places. HAI will gather researchers from fields spanning engineering, computer science, psychology and sociology, and will cover diverse topics, including: human-robot interaction, affective computing, computer-supported collaborative work, gaming and serious games, artificial intelligence, and more (HAI, 2015).

Required Functions for Agents: Only humans communicate using language and carry on conversations with one another. And the skills of conversation have developed in humans in such a way as to exploit all of the unique affordances of the human body. We make complex

representational gestures with our hands, gaze away and towards one another out of the corners of our centrally set eyes, and use the pitch and melody of our voices to emphasize and clarify what we are saying (Cassell, McNeill, & McCullough 1999).

Cassell et al. (1999) propose a model of conversational function. In this framework, four features of conversation are proposed as key to the design of embodied conversational agents: the use of several conversational modalities, such as speech, hand gestures, facial expression, the importance of timing among conversational behaviors, the distinction between conversational behaviors (such as eyebrow raises) and conversational functions (such as turn taking).

Review of Various Researches on Agents: The development of embodied conversational agents as ***Companions*** brings several challenges for both affective and conversational dialogue. These include challenges in generating appropriate affective responses, selecting the overall shape of the dialogue, providing prompt system response times and handling interruptions. Smith, Crook, Boye et al., (2010) presented the implementation of a companion integrating all the above aspects into a single prototype.

The Companion presents itself as an embodied conversational agent with which the user can engage in a free conversation, albeit on a select set of topics. They opted for a scenario in which the user, a typical office worker, returns home and talks about the day's events. They refer to this as the "How was your day?" scenario. The system currently supports over 40 work-based conversational topics. Conversational flow in natural dialogues tends to be quite fluid, with partners frequently interrupting each other rather than observing the strict turn-by-turn structure of most current spoken language dialogue systems. The system has been extensively tested in the lab, in excess of a thousand sessions, and has demonstrated a regular ability to withstand meaningful dialogues of more than 10 minutes.

Conversation Agent for the Elderly: Heerink, Krose, Evers et al., (2006) focused on the acceptance of a relational agent appearing on a computer screen and functioning as a health advisor for older adults. People with cognitive impairments have problems organizing their daily life autonomously. A virtual agent as daily calendar assistant could provide valuable support, but this requires that these special user groups accept such a system and can interact with it successfully. Yaghoubzadeh, Kramer, Pitsch et al., (2013) presented studies to elucidate these questions for elderly users as well as cognitively impaired users. Acceptance can be increased by way of a participatory design method. Actual interaction studies with a prototype demonstrate the feasibility of spoken-language interaction and reveal strategies to mitigate understanding problems.

Previous studies on the acceptance of such an agent by elderly people reported that it is

important for the agent to display social signals, like smiling and head nods; this enables the agent to gain the patient's trust and enhances intimacy (Huang et al., 2014). Kanoh et al. (2011) investigated user acceptance of a robot in recreational use inside health care facilities for elderly people. Although the participants showed positive reactions to the robot, the interaction between the participants and the robot was seldom observed. The effects of verbal and non-verbal empathic behaviors of a 2D graphic agent was investigated and found that the subjects did rate the agent more caring if it shows those behaviors. Leite et al. (2010) investigated a robot cat showing empathic behaviors on the players of chess game. Smith et al. (2010) proposed the integration of affective dialogue with a deliberative architecture. These studies showed that the display of empathic behaviors can usually make the conversational artifacts better accepted by users, which is a requirement of artificial companions.

However, other studies try to model episodic memory which is essential to maintain the dialogue with users in long-term relationship. Sieber and Krenn (2010) proposed a W3C RDF based presentation of past interaction and user preferences. In order to achieve higher efficiency and more realistic dialogue, Lim, Aylett, Ho et al., (2009) integrated "forgetting" feature into their episodic memory model (Huang et al., 2014).

Acceptance of virtual agents by patients: To accomplish research goal, we should confirm that people with dementia accept a conversational agent and recognize it as a communication partner. For this purpose, as the first step, Sakai, Nonaka, Yasuda et al., (2011) set up a Wizard-of-Oz experiment to investigate whether people with dementia are willing to communicate with a virtual character. All were female subjects. The average age was 79.8 years, and the mean MMSE was 12.2. The conversation was successfully carried out. All the subjects were satisfied with the conversation with the agent, and the agent's capability of returning feedback such as nod and acknowledgment seemed effective in facilitating the conversations. The subjects were happy to communicate with the agent.

Conversational Agents for Interacting with Patients with Dementia (Sakai, Nonaka, Yasuda et al., 2011): Sakai, Nonaka, Yasuda et al., (2011) proposed a conversational agent for people with dementia. In a preliminary analysis, the subjects did not ask any questions to the agent. Thus, the agent's asking questions in proper timing may be more effective than just waiting for the user's input. Therefore, it may be necessary to monitor the end of the subject's speech to avoid utterance overlaps. They implemented the system which need to be able to automatically detect the subject's speech ends, and start speaking after the user finishes up her/his utterance. All the patients replied and were satisfied with the conversation with the agent. However, when the

agent's questions overlapped with the patient's speech, they quitted their utterance. Therefore, the waiting time between the end of speech and the agent's next question was found to be very important.

Grandchild agent (Yasuda, Aoe, & Fuketa, 2013): Sakai et al. (2012) developed a computer agent system that could serve as a conversation partner for hospitalized patients with dementia in clinical setting. At any rate, above agent systems cannot perform the long conversations such as 30 minutes reminiscence talk or life review. The short conversation is not enough to satisfy with and stabilize individuals with dementia. In order to perform the long conversation, we have developed another computer agent system for individuals with dementia which shows an animated face of a child. 180 reminiscent questions (450 questions in 2020 version) were prepared for general settings such as homes and institutions, not limited to hospitals. The system can also automatically detect the end of an individual's reply to a question. We investigated the effectiveness of this agent conversation system.

Methods: The computer screen showed an animated face of the child agent which resembled "a five-year-old grandchild." When the subject speaks, the agent reacts to them with generating nods, mouth movement, and acknowledgement automatically. We prepared 12 sets of 15 (total 180) reminiscent questions such as parents, home town, school life and so on. These were spoken by the synthesized voice of the agent.

The continual questioning by the agent may in the preliminary study yield an atmosphere like "a police interrogation". In order to improve this atmosphere, each question was composed with two parts. First part was introductory comments by the agent. The agent introduced his own reminiscent experiences. e.g. "I used to eat watermelon in the summer". The second part was the question for subjects. e.g. "what kind fruits do you like?" The pause between the comments and questions was fixed for one second. The introductory comments and questions were also shown in written form at the lower part of the screen for the visual confirmation of questions and compensation for hearing difficulty.

On the analysis of Sakai et al. [2012] and our preliminary trials, the waiting time was fixed to 3.5 second in this investigation. If following speech sounds were not detected during the 3.5 second's waiting time, the agent moved to the next question, or spoke "do you have any other experiences?"

Eight subjects with mild Alzheimer disease participated in this evaluation experiment; the average age was 78.5 years old and the mean Mini-Mental State Examination (Folstein et al., 1975) score was 22.2. To evaluate the effectiveness of this system, subjects replied to the questions by the

agent (agent condition) and a human conversation partner (human condition). The human partner was a speech therapist whom all subjects were acquainted with. In both conditions, the almost same 15 questions were asked, although some introductory comments were slightly modified in human condition. Each conversation took about 20 minutes.

Results: All the subjects uttered 5494 (74%) syllables in the agent condition, compared with 7406 (100%) syllables in the human condition. This system was sometimes disturbed smooth transfer to the next question by the agent by picking up non-speech uttering such as, sigh, cough of subjects, and environmental noise(door's closing, footsteps in the corridor and so on). After the experiment, a simple interview was conducted to ask the impression for this conversation system. Most of subjects had a favorable impression for the agent. A woman was moved to tears while conversing with the agent, because it's too enjoyable. A man with early onset dementia said "When I talk with normal people, I am always worrying about the difficult question which I cannot reply, or the repetition of answers which I already made. But, in this system, I can talk freely with this agent without above hesitation or anxiety.

Discussion: The system could succeed to elicit 74% utterances from the individuals with dementia. This system may be practical and valuable to introduce as an alternative way of a conversation when no human conversation partner exists. Nonetheless, all of subjects could accomplish 20minuute' conversations with the agent. Much longer conversation with this system is easy to perform. This kind of artificial talking system is needed for such individuals to provide enough talking chances without any hesitation and worries.

In this study, the waiting time was fixed to 3.5 seconds. Needless to say, the appropriate waiting time is different from each subject. The future study will reveal the effectiveness on the elicitation of speeches from subjects when the waiting time is adjusted to the subjects.

Recently, several robots and smart phones are installing a speech recognition system to converse with people such as "speaking concierge". However, its robustness for speech recognition is still unstable. Furthermore, the subjects do not always clearly pronounce. Since the robustness is definitely important for the practical use of this system, they employed the sound recognition system as same as Sakai et al. [2012] which was simple but more stable ways. As might to be expected, this system was forced to pick up non-speech uttering such as sigh, cough of the subjects, and environmental noises. However, this system could work well under quiet circumstances.

The repetitive questionings by the agent will work for maintaining or reminding various memories of individuals with dementia. It will be a more natural way of measuring the cognitive status, when the agent system can assess the individual's cognitive status through conversations

(Wang, 2009). If this system can be integrated with these functions, the agent will become a "remote concierge" system for a subject. If these devices are stored in to dolls, and robots, the individuals can converse with the agents through them.

YASUDA, FUKETA, & AOE (2014) observed a multi-party conversation between the agent and two participants with dementia or mild cognitive impairment. Their average age was 75.9 years and the mean MMSE score was 24. Five participant pairs conversed with this agent, or without the agent. We evaluated the influence of the agent on their conversation using original psychological five-scale ratings. For the experiment, two participants conversed well with this agent.

Further application of Grandchild agent (Yasuda, Fuketa, Morita et al., 2016): Videophone conversation was effective in increasing psychological stability of individuals with dementia. We also developed an anime agent system to serve as a conversation partner for individuals with dementia. The computer screen showed an animated face resembling "a 5-year-old grandchild." The agent was programmed to ask any of 120 pre-set reminiscence questions, automatically detect the ends of replies, and follow with new questions. In the third experiment, the remote multi-party conversation system Skype™ was integrated with the agent system. The agent participated as a presenter of conversation topics for the multi-party interaction. Three pairs conversed under two conditions: conversation of two subjects and a chairperson (human condition) and conversation in which the agent participated as a topic presenter to the above groups (agent condition). The quality of the conversation was scored by three evaluators. The average score of the evaluation was 3.9 (78%) in the agent condition and 4.9 (100%) in the human condition.

Discussion: The number of individuals with dementia is rapidly increasing; it is very difficult for them to engage in conversation at all times. Frequent and regular videophone conversation is becoming difficult to perform. As a possible resolution of these situations, we incorporated an agent as topic presenter in the videophone conversation. Although a prototype has been proposed, this is the first clinical trial of the participation of an agent in a videophone conversation.

We observed a multi-party conversation with an agent (agent condition) and without an agent (human condition). The time required to conduct these conversations was almost the same. Although operational procedures prevent intrinsic comparison on the quality of conversations between two conditions, all average scores of the quality of conversations were better in the human conditions. However, the percentage of the scores

was 72% for the agent condition compared with 100% for the human condition. We consider that this percentage means it is worth applying this system in supporting group conversations via a videophone.

From the number of encouragements, conversations in the agent conditions seemed to need more prompts, particularly encouragements for another subject to talk, than those in the human conditions. In the agent conditions, some subjects may have felt hesitation from speaking at will. In future revisions, encouraging words should be used to prompt more reserved participants to talk, such as “how about another person?” as well as “please explain in detail.”

Direct conversation between subjects occurred naturally in the human condition of pair C. To compensate the technical insufficiency of the agent system, direct talking between participating subjects should be augmented by prompts such as “Let’s talk to each other.” Furthermore, to increase the benefit of the agent system or of ICT interventions, use of various internet resources such as pictures, music, and short movies will be greatly beneficial. Future revision will incorporate the above prompts and functions in the agent system to increase the usability of this system.

Most individuals with mild or moderate dementia still have the ability to talk to each other. They also say that “I would like to make a social contribution, even though I have dementia.” Talking volunteers are one of the few remaining employments for them. Indeed, they are even more suited to be talking volunteers for other individuals with dementia. They easily forget what has been already said; therefore, they are not annoyed by repetition by other individuals with dementia. However, it is often difficult to recollect topics because of their degraded recall abilities. This agent system can work as a topic-providing system for them.

Most families in advanced nations have computers and access to the internet. Younger seniors with dementia who are accustomed with the operation of PCs and smart phone are increasing. The operation of Skype™ will not be difficult for such individuals. An anime agent participated in multi-party videophone conversations as a conversation topic presenter. Although further improvements are required, this agent system may become a promising intervention for assisted conversation of individuals with dementia (Yasuda, Fuketa, Morita et al., 2016).

Morita, Fuketa, Aoe, & Yasuda (2015) presented a dialogue communication system for individuals with dementia by using cloud-based approaches. The presented method proposes a

dialogue-controlling algorithm that can break communication if individuals with dementia go into a hyper excitable state. Videos with school songs are utilized to mitigate the impacts caused by hyper excitable state. In the cloud systems, a text mining module is combined in order to analyze personal orientation from communicated utterances of individuals with dementia. From experimental results for a total of roughly 327 individuals with dementia, it turns out that the presented method can make conversations smooth in comparison with the previous approaches.

Jaana, Imabuchi, Prima, Ito, & Yasuda (2015) developed an interactive conversational agent software to ameliorate the symptom of dementia patients. This software works as a speech therapy tool, which acts as a conversation partner to a patient. They defined three sets of reminiscent questions into the software. Each set contains 15 questions. The software utilizes constrained local model (CLM) and voice detections to determine the utterances of patients. Once the CLM recognizes a patient's facial landmarks, it starts to ask him using the pre-defined questions. The software will continue to ask using subsequent questions when it doesn't detect utterances from either distance changes between mouth landmarks or changes of voice of the patient. The voice detection solely enables utterance detections in a low environmental noise while the CLM succeeds to detect utterances regardless of the environmental noise.

Home living support agent: To support the individuals with dementia, a wide variety of reminder services are provided. However, existing reminder service has following three problems, lack flexibility, only providing the robotic interaction and difficulty adjusting to the individuals with dementia. Hence, to cope with the above problems, the new system architecture for real-time personalized Memory-Aid Agent Service for people with dementia was started.

The proposed architecture provides the real-time positioning detection, rich VA interaction and personalized reminder service for the users. To achieve above architecture, three services were integrated based (Tokunaga, Horiuchi, Saiki et al., 2015; Horiuchi, Tokunaga, Saiki et al., 2015). The memory aids service based on time and location for people with dementia. The service consists of three services, location detection service, forget-things registry service and agent service. This service aims to assist the individual based on individual's context (i.e. schedule and current location). Moreover, this service could interact with a conversation for example if the person goes to the hospital the service assists that "Do you have proof of insurance?" and so on. This service obtains the rough individual's location information using some electronic device, so as to detect where the dementia people are in the house.

Secondly, forget-things registry service which stores the usual schedule for the people with dementia. So, the caregivers or families could register the schedule such as daycare. Moreover, they

register the information when the dementia people go out. Based on the registered information, the service reminds not only notify the schedule, but also could prevent from wandering around in the midnight. Finally, agent service enables people with both voice and text interaction that enables to easily understand and confirm to prevent forget-things. Concretely speaking, when the individual goes to hospital, the service displays the list of forget-things (e.g. insurance, wallet) on the screen and also confirms to the individual with a voice.

Review of Other Agent Researches: Wiratanaya, Lyons et al., (2007) described the design and implementation of an interactive character animation interface. The system ***iMime*** analyzed the attentive state and aspects of the affective behavior of a viewer using input from a video camera and uses this to control the behavior of a cartoon-like animated character. Using the interaction metaphor of a mime artist, they designed the system to encourage viewer attention and interaction, with adaptation using an online reinforcement learning based on the viewer's attentive state.

It is essential to make the agent memorize not only past interactions but also the daily life of the patients, to allow them to feel that the agent is together with them. Huang et al. (2014) then propose a set of recording devices (digital video recorder and an IC audio recorder) which are put in a wearable way and are operated by the patient himself / herself, the memory vest. This is used to log the user's daily activity for memory recall of both the user and the agent after then. We are then developing the integration with an Android smartphone into the memory vest. The current prototype recognizes the user's moving status (walking, running, bicycle, car, or train) and location when she/he is outside home and periodically updates the user's latest status to a server hosting the activity history database of the user. After the development of the technique to transform the log data to appropriate memory and knowledge presentation, they plan to integrate the database as the back end of the listener agent and thus allow it to engage the dialog involving the context of the user's daily life. In addition to the listener agent as the front end to the patient, we also plan to integrate the front end for medical institutions and the relatives of the user to monitor the user's recent condition or to input instructions from remote.

During a meal, families have the chance to catch up on what is happening in each other's lives and to strengthen the bonds of the family. Therefore, Yuasa et al. (2013) proposed a table-talk agent that can enjoy talking and eating with others and create a pleasant atmosphere. The purpose of the research is to investigate understandable and appropriate nonverbal behavior and its timing in order to develop table-talk agents and robots. They developed embodied agents that can use a synthetic voice, hand gestures, and chopsticks using the TVML tool kit. Cameras set around a display allow the system to detect the head orientation, and the height of the human's hand is

detected using a colored marker attached to a finger or chopstick. The system can be arranged such that when a participant puts up his/her chopstick, the agent also puts up his chopstick and starts to speak.

Walking, Agent and wandering prevention: Recently, walking exercise is becoming popular. People are able to exercise with enjoying the surrounding environment changes and the strolling around wherever they like. Takase, Yoshida, Doi, Nakano, Sakai, & Yasuda (2016) believed that these enjoyments, are called wandering, are essential elements of the walking exercise. On the other hand, there are also many people exercising with a walking machine int the indoors, such as a sports gym. However, the exercise with a treadmill is tedious for users. In this study, they proposed a novel support system for walking exercise with the wandering experience by using google street view. In addition, we introduce a companion agent to act as a route guide and improve the enjoyments of walking. As a result, users can stroll around the world or visit wherever they want with the agent during exercising. By means of the system, users will be able to exercise in the indoors with the similar wandering experience in case of walking in the outdoors.

10.2 Robots

Robots and Aging Society: In the coming decennia, the industrialized countries face a dramatic growth in the elderly population combined with labor shortages in the healthcare sector. This has inspired a number of researchers to explore the applicability of intelligent systems in general and robotic products in particular to be used in assisted-living environments. For robots, the functionalities are related to supporting independent living by supporting basic activities (eating, bathing, toileting, getting dressed) and mobility, providing household maintenance, monitoring of those who need continuous attention and maintaining safety. Recent studies on interaction with robots stress the importance of social intelligence even more so in a health- and eldercare environment (Heerink, Krose, Evers et al., 2006).

The main issues facing older people are physical decline, cognitive decline, health management, and psychosocial issues. To reduce barriers to acceptance, robots designed to provide physical and healthcare assistance should have a serious appearance. On the other hand animal-like robots can address psychosocial issues and function like pets. However more focus could be placed on developing preventative interventions, multifunctional robots, greater educational content and motivational aspects of appearance and interaction style (Robinson, MacDonald, & Broadbent, 2014).

Review of Robots for Elderly Assistance: Since there are many problems associated with pets for the elderly, Robot Assisted Activity (***RAA***) has recently been attempted using a pet robot,

not an animal. A robot has much less possibility than an animal of hurting an elderly person requiring long-term care or causing infectious diseases, and it does not need to be taken care of, either. In addition, anyone can use the robot at any time in the same way without any need of breeding or training it (Kanoh, Oida, Nomura et al., 2011).

Research involving explicit tests of robots or agents with elderly users has been carried out. These studies concerned a seal shaped robot named ***Paro*** that was positioned in a group of elders where they could interact with it, mainly by caressing and talking to it. Another experiment that took place in an eldercare institution concerned a robot named ***Pearl*** by several researchers. The experiments with Paro and Pearl both registered a high level of positive excitement on the side of elders. However, it is not clear what aspects of the robot interface caused the users' positive attitude and whether such a robotic aid would ensure actual use on a longer-term basis (Heerink, Krose, Evers et al., 2006).

At present, some robots can communicate with people and alert them when it is time to take their medication. ***Palro*** is a small, autonomous humanoid robot which can have an intelligent conversation and walk on two legs. ***Pepper*** is a humanoid robot that can converse with a person, recognize and react to their emotions, and move and live autonomously. ***Emopa*** is a smartphone service that talks a user of this smartphone like family or friends (Oshima, Yasuda, Machishima et al., 2015). ***iCat*** was tested in a Wizard of Oz experiment where the robot was controlled remotely by an experimenter. The participants were asked to program a DVD-recorder and to participate in an online auction, by using the iCat interface. The extravert iCat was indeed perceived to be more socially intelligent.

It seems that research on robot can be subdivided into two areas: acceptance of the robot in terms of usefulness and ease of use (functional acceptance) and acceptance of the robot as a conversational partner with which a human or pet like relationship is possible (social acceptance). The experiments with Paro were more focused on social acceptance while the experiments with Pearl and iCat focused more on the acceptance of the robot regarding its functionalities (Heerink et al., 2006).

The Future of Assistive Technologies for Dementia: Borka and SARAH are examples of robotic technologies that perform tasks while providing companionship. The LIREC group is also striving to make robots more companion-like by observing canine behaviors. Robots will be able to detect human expressions (facial and body language), adapt accordingly and even mimic them

through the interface. Feelix Growing is working towards this direction (Peterson, Prasad, & Prasad, 2012).

Tamura et al. (2004) used ***AIBO-R*** and a battery powered toy dog for occupational therapy sessions. AIBO is a robot pet simulator that can walk, respond to commands, and sense its environment through touch, sight and hearing. The battery-powered dog was covered in a plush fabric, could wag its tail and sit, but did not respond to commands. The residents with dementia responded with interest to AIBO but they responded more readily to the battery-powered toy dog. Residents were reluctant to touch AIBO, even when it was dressed in furry "clothes".

The responses of nursing home residents was compared to a robotic cat ***NeCoRo-R*** and a plush toy cat. Both cats showed a significant effect on some behaviors. The robotic cat evoked a significant increase in pleasure and interest. However, few residents held the robot cat, although it had a furry outer covering, while most held the plush cat. There was a correlation between increasing dementia and decreasing engagement with both cat substitutes.

Heerink et al. (2006) examined the influence of social abilities of a robot on elderly user's attitude towards and acceptance of the robot ***iCat***. Experiments were set up in a Wizard of Oz experiment. Participants who were confronted with the more socially communicative version of the robot felt more comfortable and were more expressive in communicating with it. The more socially communicative condition would be more likely to be accepted as a conversational partner. The socially communicative condition exhibited: it listened more attentively (by looking at the participant and nodding while the participant was speaking), it smiled during the interaction, it remembered and used the name of the participant during the interaction, it was showing more facial expressions and it would apologize for making a mistake.

Kanoh, Oida, Nomura et al., (2009) have developed a Robot Assisted Activity (***RAA***) program for recreational use in health care facilities for elderly people. The program applies a standard classroom model, starting with homeroom and including lessons in the Japanese language, music, gymnastics, arithmetic, and other subjects. All participants have a favorable impression of the robot and nearly all have a positive opinion of the RAA program. However, in spite of the overall success of the RAA program, we seldom observe interaction between participants and the robot.

Kanoh et al., (2011) uses a YORISOI ***Ifbot*** robot with the conversation communication function to attempt the development of an RAA program to be available as an activity in facilities for the elderly. It has a height of 44.5 cm, which can remind them of their past. This can lead to the

expectation of the effect of reminiscence therapy. First, the Ifbot directs an utterance to the participants. If the participants answer the question, the assistant tells the Ifbot the answers. As the scenario progresses, the Ifbot produces facial expressions appropriate to the content of the utterance.

Almost all participants were accompanied by care providers. All participants except one out of 10 participants positively participated in riddles, did arithmetic, and sang songs. Additionally, participants were not often observed talking with each other during the progress of the RAA, but the results of the FGI have shown links between participants. This RAA program will serve to provide topics for conversations between participants outside the activity, thus increasing their socialization. When a robot talks to a person and asks for a hug or other physical contact, it increases familiarity, and the average distance between the robot and the person gradually decreases.

Care-O-bot3 Robots are started to be developed for aged care populations and some of these have been made into commercial products that have been well received.

Older people were invited to use a prototype robot with healthcare functions. The cognitions older people hold about robots may influence their decisions to use robots (Stafford, MacDonald, Jayawardena et al., 2013).

Teleoperated androids, which are robots with humanlike appearances, are being produced as new media of human relationships. The potential of humanoid robots how they affect people when they are employed to express a telecommunication presence and a sense of `being there'. ***Telenoid*** was used, a teleoperated android, to see how the elderly with dementia respond to it. Telenoid elicited positive images and interactive reactions from the elderly with mild dementia, even from those with severe cognitive impairment. They showed strong attachment to its child-like huggable design and became willing to converse with it (Yamazaki, Nishio, Ogawa et al., 2012). The elderly assumed positive attitudes toward Telenoid, and their positivity and strong attachment to its huggable minimalistic human design were cross-culturally shared in Denmark and Japan (Yamazaki, Nishio, Ishiguro et al., 2012).

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Chapter 11 Assisting Dog for People with Dementia

11.1 Animal Assisting Therapy

People frequently communicate with one another using nonverbal forms of communication, such as gestures and facial expressions. Many behaviors can occur to interactions between individuals and pets. For example, typical social behaviors of people interacting with dogs include talking, non-verbal expressions, and touching that engage the dog in a social way. Dogs have long been touted to be “man’s best friend,” with anecdotal evidence suggesting that dogs provide numerous benefits to their owners and those they encounter throughout their lives. Among the proposed benefits are reduced levels of stress, and improved physical health (McLellan, 2012).

Human–animal interactions are becoming a focus of research in an attempt to document claims that animals make humans feel better and serve as aids to communication. Dogs have evolved with humans for more than 10,000 years and feature prominently in animal-assisted therapy (***AAT***) practice and research. Animal-assisted therapy (AAT) is gaining popularity as part of therapy programs in residential aged care facilities. Humans and pet dogs respond to quiet interaction with a lowering of blood pressure and an increase in neurochemicals associated with relaxation and bonding. These effects may be of benefit in ameliorating behavioral and psychological symptoms of dementia (BPSD). Several small studies suggest that the presence of a dog reduces aggression and agitation, as well as promoting social behavior in people with dementia. (Filan & Llewellyn-Jones, 2006).

AAT most commonly involves interaction between a client and a trained animal, facilitated by a human handler, with a therapeutic goal such as providing relaxation and pleasure, or incorporating activities into physical therapy or rehabilitation. The therapeutic possibilities of companion animals have been described by Baun and McCabe (2003) with reference to the stage of dementia and the positive effect on caregivers.

There is preliminary evidence that robotic pets may provide pleasure and interest to people with dementia. However, real pets look and feel very different to currently available robots and toys. Real pets also show genuine affection and pleasure during interactions, which, in turn, bring pleasure to the human involved. Behavioral and psychological symptoms of dementia (BPSD) are common (Patterson & Bolger, 1994), are a major source of informal caregiver ill health (Burns & Rabins, 2000) and cause significant distress to residential care staff (Wood et al., 1999).

The non-verbal communications of dogs were reportedly more friendly, non-judgmental, and conducive to sociable behaviors than those of the best-intentioned staff members. It has been suggested that animals communicate better than humans with people with dementia who may have

impaired language skills, because animals rely more on body language (Perkins, Bartlett, Travers, & Rand, 2008).

Dog-Assisted Activity and Dog-Assisted Therapy: Broadly, two methods have been used to provide dog contact: dog-assisted activity and dog-assisted therapy. Dog-assisted activity has been defined as unstructured, informal, without specific therapeutic goals or recording of outcomes, and conducted by someone without special skills or training and possibly using an uncertified animal. By contrast, dog-assisted therapy is described as structured, one-on-one or in small groups, conducted by suitably trained professionals with specifically certified animals, and requiring active participation with specific therapeutic goals and outcomes recorded (Perkins, Bartlett, Travers, & Rand, 2008).

Relation Between Dog and Human: Animals influence the interrelationship between patient with dementia and therapist on the level of psychotherapy during and after the therapy session. Thus, they are perfectly adequate to be utilized as a 'door opener', while also reducing any anxiety a patient may be experiencing. The mere presence of a companion animal increases the number of spontaneous social initiations from strangers to individuals with disabilities. An intense bond with a pet often brings about a similar increase in personal self-esteem. Targeted animal assisted therapy is then able to promote redevelopment of self-awareness, self-esteem and personal trust in dementia sufferers (Vogt, 2013).

It is difficult to create congruence between digital and analogue communication. Thus, it is possible to digitally reproduce a current emotional state, whereas gestures and facial expressions may convey quite a different impression on one's counterpart. Animals have the ability to transfer orders and words into action. It can be assumed that within limits animals can also recognize aspects of digital communication. It is however important that a vast amount of animal communication is allocated on the analogue level. Animals react sensitively to analogue stimulation while it is insignificant whether a person transmits it knowingly or not (Vogt, 2013).

11.2 ICT-Wearing Dogs for Dog's Minds (Zeagler, Valentin, Martin et al., 2013)

Dogs currently work in many ways: guide dogs serve people with visual impairments; service dogs aid people with physical disabilities; hearing dogs alert people with auditory disabilities to sounds; Search and Rescue dogs can locate people who are lost. These highly trained canines perform critical, even life-saving tasks. The main goal of the ***FIDO*** project is to research fundamental aspects of wearable technologies to support communication from working dogs to their handlers. The scenarios below are just a sampling of the many ways which could use wearable electronics to communicate with humans.

Melissa and her guide dog Roman are walking along a familiar sidewalk when Roman suddenly stops. Roman tugs a tab on his harness and the message "go around" sounds in Melissa's earbuds. Roman finds a safe route off of the sidewalk, avoiding the wet cement in their path.

Charles is engrossed in a movie when his hearing dog, Schubert, alerts. Schubert touches one of the four buttons on his vest with his nose. A message appears on Charles' head-mounted display. "Tornado siren? Oh my!"

This paper describes a pilot study of four different on-body sensors that allow dogs to give information to their handlers. They integrated electronics into dog clothing to create canine user interfaces. They tested these interfaces with three assistance-trained dogs to evaluate ease of interaction, error rate, and false positive rate.

The results of this pilot study are extremely encouraging; they demonstrated that it is possible to create wearable electronics that dogs can reliably activate to communicate with their handlers. There is a vast amount of work yet to be done. The sensors need to be smaller and more robust and require less power.

Along with the sensor placement study they need to discover the best ways to train the dogs to differentiate multiple sensors on their bodies, and to activate them on different environmental triggers. They plan to explore other sensors, such as "Touch-points", which are areas embroidered with conductive thread that could be activated with a simple nose or paw touch. They also plan to stress-test the designs with dogs at speed on an obstacle course, which could simulate a rugged outdoor environment. This technology could easily be adapted to other canine professionals, for Police work and Military Working Dogs who could communicate the location and type of Improvised Explosive Devices (IEDs). Providing dogs with the ability to communicate clearly to humans opens a myriad of possibilities.

11.3 ICT-Wearing Dogs for Dementia Suppot (Yasuda, Kuwahara, Nakamura et al., 2012)

Traditionally, dogs also have been trained for various purposes that take advantage of their acute sense of smell, hearing, and mobility, such as police dogs, detection dogs, hunting dogs, rescue dogs, etc. Furthermore, dogs have also been used to successfully help individuals with disabilities, including visual, hearing, and physical impairments.

Guide dogs, for example, assist blind people so they can avoid various physical obstacles. A hearing dog can alert their owner to important sounds, such as doorbells, alarm clocks, ringing telephones, etc. They also work outside the home, alerting people to sounds, such as sirens, approaching cars, and to let them know if someone is calling their name. Service dogs are taught to pick up dropped items, open doors, turn on lights, and pull wheelchairs for physically handicapped

owners. They can carry oxygen tanks for breath support. Some dogs also help individuals with mental disabilities, including depression and autism. Other dogs are even used to help with early detection of seizures and diabetes. These dogs are called assistance dogs.

However, except for animal assisted therapy, use of assistance dogs has not been reported for individuals with dementia. Although details are not known, several anecdotal episodes have been found on the Internet. For instance, for a individual with dementia, the utterance of the phrase "home" will help the dog navigate to the person's home from wherever they are, even if they've lost their way. A dog may teach individuals the parking spot of car.

Not limited to forgetting their way, parking spots etc., individuals with dementia also show other forgetful behaviors, such as forgetting to execute daily tasks, forgetting where items are located, etc. Additionally, various BPSD often appear. However, no comprehensive supporting ideas for these symptoms have been proposed utilizing assistance dogs.

As one of the interventions for assisting individuals with dementia, assistive technology or information communication technologies (ICT) have been utilized. IC recorders were effective as an automatic output of messages for individuals with memory impairment and dementia. The IC recorder also attempted to treat other BPSDs, such as eating few meals and getting angered easily by the sound of music. Additionally, the reminiscence photo video was a slideshow video of individual's photos with narration, background music etc. Kuwahara et al., (2009) have created remote reminiscence talking and scheduling prompter systems using video phones. For two out of four individuals, these interventions were effective for their psychological stability and schedule performances.

Yasuda et al., (2010) developed a wearable system to record one day's behavior, using a small video recorder and IC recorders. The recorded utterances were analyzed by speech recognition software on a personal computer (PC). Recently, Sakai et al. (2011) developed a free-talking system in which an anime agent on a PC monitor asked individuals' questions; other questions followed after the agent recognized the finish of an individual's reply to each question. The research described above suggests that various ICT devices and content are effective in coping with various symptoms of individuals with dementia. The best way to help individuals with dementia is to provide them with appropriate information via ICT devices.

However, individuals with dementia often forget to possess their ICT devices, so they cannot hear the messages from the devices outside of their home. Also, they often dislike or refuse to wear the devices. Furthermore, due to lack of motivation, or lack of the psychological interaction with the devices, some individuals do not perform the daily tasks instructed by the devices.

A lot of pet robots have also been created as images of pet animals. Some individuals even treat these artificial machines as actual pets. Engineers are also developing various assistance robots, such as communication robots and care giving robot. Although a robot can move, they are slow in going up stairs or walking on rugged roads or fields. These robots also need complicated software and are too expensive to be used in a normal home. In addition, engineers are also studying smart homes. However, such smart homes are also too expensive to build. This system also does not work outside of the home.

Consequently, we came up with an idea that if dogs were mounted with ICT devices, such as sensors, computers, other electronic appliances, then various tasks would become possible. This ICT- augmented- assistance dog can help individuals with dementia relax, initiate actions, and more easily execute daily tasks, which the traditional assistance dogs or ICT devices cannot realize, respectively. Related ideas have not been found, except one in the military literature, in which camera and radio transmitter systems were built in the armored vest of a scouting dog.

In regard to using assistance dogs in this manner, we can hire professional trainers to breed and train dogs, and then adapt the trained dogs to individuals with dementia.

What we are proposing now may be called the Human-Computer-Animal Interface (HCAI), incorporating various fields, such medical, welfare, engineering, and dog training. We would like to describe the details of this idea. Anticipated effects on the quality of living of individuals with dementia are also discussed.

Comparison of Functional Abilities Between Dogs and ICT Devices: If the abilities of a dog and ICT devices were integrated, a more efficient and unprecedented assistance system can be created, while eliminating their demerits simultaneously.

Devices for Mounting: The owing devices may be efficient when they are mounted on to dogs. Non-electronic devices, such as medicine, pencils, memo pads, etc., are also needed. They are classified into the following five categories: Sensors (sound, smelling, lighting, temperatureetc.), Media for recording and sending information (USB, blue tooth, mobile Wi-Fi etc.), Electronic appliances (IC recorder, video recorder etc. wide angle camera, GPS, batteries, etc.), Computers (smart phones, tablet PC, etc.), Non-electronic devices (medicine, diary, glasses, bait for dog, etc.).

These devices are stored in special bags on the back and sides of the dog's trunk. Devices to be mounted on to a dog should be selected for an owner's specific needs, a dog's capability, and to meet specific circumstances. Dogs may be trained to sleep near remote charger systems so that devices can charge while dogs are sleeping.

Various Supporting Plans: Various kinds of support will be possible using assistance dogs who

are mounted with the above devices. We, therefore, classified support plans into the following categories. Additionally, most individuals with dementia cannot manipulate these devices, so the booting of the devices needs to be automatic. Therefore, volunteers or caregivers should set the time schedule for booting.

Healing and relaxation support: A dog by itself can provide healing and relaxation to individuals with dementia (owner) through their fur, gestures, and expressions. Furthermore, dogs mounted with the above devices should be trained to go to owners when an alarm sounds from the IC recorder, or when other devices emit sounds at a set time. Dogs will then be trained to show owners content, such as music, photos, or reminiscence videos.

Scheduling support: By mounting IC recorders and other voice output devices, recorded messages or video instructions can be played to prompt an individual's daily activities, such as taking medication, eating breakfast, and so forth. When an alarm or word is emitted, the trained dogs go to their owners and show the messages or video instruction through the devices. Preceding these presentations, automatic outputs of music are also desirable to raise motivation to accomplish given tasks. Medicine and water prepared in the bag are conveyed by the dog when an alarm sounds along with the message output to "take medicine". The dog will be trained to deliver a note pad and pencil when alarm and message "take memo" are emitted.

Communication support: Individuals with dementia ask the same questions repeatedly, such as "What day is it today?", "Shall I go to the hospital today?" In order to deal with these questions, dogs will go to owners when an alarm or word is emitted intermittently and to give information regarding what an individual wants to know before they ask.

In order to help individuals with dementia converse with remote caregivers and volunteers, small computers and cameras with Internet connections need to be mounted on to dogs. When an alarm or word is emitted by the remote volunteer, the trained dog will go to owners to start a remote conversation with the volunteer. When there are no volunteers to talk to, the free-talking system with the anime agent can be used. This system starts on set times, or an individual's verbal agreement to talk in response to an automatic recommendation is given by the dog, such as "Do you want to talk with the agent?"

Recording support: When an alarm is emitted regularly, the dog goes to their owner and asks what the owner has just talked about, eaten, or what task has been done. The individual's replies are recorded, which will be automatically analyzed by speech recognition software. Later, a caregiver who is living away from the patient's home can check the recorded content via the Internet.

Danger detection support: Certain abnormal changes in the environment, such as smells, heat,

smoke, etc. can be noticed by an assistance dog. The dog will be trained to go to the owner. As for the observation of owner's safety, alarms are emitted at regular intervals. At each time, the dog will search for their owner, and will require owners to touch a monitor on the dog. This touching is transmitted to a caregiver as a safety signal. If no signals were sent, caregivers will confirm the owner's safety through the camera on the dog's head.

Individuals with dementia so often become confused in the evening and want to return to their "home". When an owner steps on a mat near the exit of their home, an alarm sound is emitted. The dog will then rush to this spot, showing previously prepared messages from a caregiver to the owner.

Searching support: Caregiver or volunteer paints some smelling on objects by such as aroma. When owner lost the object, same smelling is sniffed to the dog. The dog will search it and may bring it back. If possible, the word "key" makes the dog search key on the base of previous combination of "key" and its smell.

Group activity support: Dog can accomplish role as pet dog also in the institution. Furthermore, each institutionalized individual is attached with electronic tags, on which special messages for each individual are recorded. When the dog with a tag reader approaches to an individual, the special messages are emitted to the individual like "Hollow, Mr. Yasuda, how about your ache on the back?" When group conversations, such as reminiscence discussions, are held in institutions, the anime agent of the free-talking system can play the role of chairperson through the dog.

Discussion: Wearing ICT devices may be somewhat burdensome for assistance dogs. However, other assistance dogs have been trained to pull wheelchairs, oxygen tanks, etc. Dogs have a natural tendency to share their enjoyment with their owners. By wearing ICT devices, they can assist their owners with dementia, increase their owner's security, communication, and convenience. They also give the owners healing through their fur, expressions, and movements, which ICT devices alone cannot provide. In this way, dogs may be eager to assist their owners and family members living under afflictive situations caused by dementia.

Traditionally, to train assistance dogs required professional trainers, several years, and large expenses. If devices were appropriately mounted on the dogs, and if tasks to be executed by the dogs were selected for owners, selected dogs can become "semi" assistant dogs for individuals with dementia in shorter training periods. The regular routine and responsibility of caring dog are thought to be beneficial for individuals with dementia.

Concurrently, the number of dog lovers is also increasing. Therefore, we consider assistance dogs wearing ICT devices to be a reasonable intervention of assisting individuals with dementia.

This idea will be published on a website. Further appropriate support plans will be desirable to be developed by many professional trainers, engineers, amateurs, and those in the healthcare field. We expect trials and results will be also published on the website (http://hojoken.grupo.jp/) to accelerate development of smarter interventions and implementation of Human-Computer-Animal Interface (HCAI).

Experiments for Assisting dog (Oshima, Yasuda, Machishima et al., 2015): Today, even health professionals use their smartphones to alert them about important tasks. However, these applications have limited use for people with dementia. First of all, most of them forget where their smartphones are located. Second, due to a lack of personal interaction, some people are reluctant to perform the daily tasks instructed by the devices. It is also difficult for a robot at present to chase after a person and run upstairs (Oshima, Yasuda, Machishima et al., (2015).

To overcome these shortcomings, we had the idea of mounting an ICT device on a dog. Now people with dementia would not have to remember to carry their phones. With a little training, a dog can be taught to rush to its owner when the smartphone on its back emits an alarm. Dogs can run to their owners even up a flight of stairs. People with dementia might be more willing to perform tasks if their dogs brought the smartphones.

Methods: They compared the effectiveness of a smart- phone attached to a dog's back to a stationary smartphone. They built an application for an android smartphone, the FleaPhone CP-D02. The display of the application consists of three parts: setting the alarm, inputting a message, and a completion button.

The subject in this experiment is a healthy person in her 50s. She has a five-year old female toy poodle that is kept indoors. The dog wore the smartphone on its back. It took one week for the dog to become accustomed to having the smartphone tied to its back. The subject trained the dog to run to her when the smartphone emitted a specific sound. This training took only three days.

The study was conducted for five days over the course of one week. Each study day lasted from 9 a.m. to 9 p.m. These 12 hours were divided into four parts. In each part, each smartphone emitted an alarm at a random time. The subject had a maximum of eight chances of hearing the alarm. The subject did not know when the alarms would sound. The subject was required to turn off the alarm and to perform an allotted task.

The Kraepelin test was used as a task. This test requires an individual to perform calculations as fast and accurately as possible. The test is a boring task and involves mental stress similar to that experienced by people with dementia who have to take medication.

Results: The responses of the subject to the questionnaire revealed that when the dog responded to the alarm and came to her, she was impressed. In the case of the living room smartphone, when she was cooking, she did not hear the alarm. In the case of the dog-mounted phone, the dog was taking a nap in the early evening and did not wake up by the alarm.

Discussion: It is clear that the subject was quicker to turn off the alarm on Set-A, because the dog was trained to run to her when the alarm emitted. Contrary to our expectations, it took only three days to train the dog. A person with dementia would be more willing to perform tasks if his/her dog brought over the smartphone. In our experiment, we assumed that the Kraepelin test would be boring. Surprisingly, the subject, a healthy person, enjoyed the test on either Set-A or -B; she described it as a brain-training exercise.

Therefore, Individuals with dementia will be more willing to perform daily tasks if influenced through their dogs. This result suggested that other applications for the people with dementia also become the more useful things of their daily lives by the dogs who mount the smartphones.

How a Dog Can Prevent a Person from Opening Door (Oshima, Yasuda, Machishima et al., 2015): In some homes and institutions, caregivers must watch over those people with dementia. That is because these people often try to open a door to go outside. If a dog can be trained to play with the patient until the caregiver shows up, then the dog may prevent that person from going through the door.

A vibration sensor ***(REX-SEEK1-X)***, and a smartphone were used. Aa single tag was hung on a selected door. An application linked to the Bluetooth-compatible tag causes a smartphone to sound an alarm when the door is vibrated. In an extended application, the smartphone can be made to play predetermined messages to the person with dementia. For example, the smartphone says, “Don’t go away!” “Play with me.” or “Shall we go over there?”

A few things are needed to train a dog for this application. The dog’s treat is placed in the box in advance. When the alarm sounds, the dog becomes accustomed to finding the treat in front of the door. Then, the owner reduces the size of the treat. At last, the dog will run to the door whenever the alarm goes off, even if there is no treat.

The smartphone- equipped dog runs up to the person when the alarm goes off. The dog might twirl around or bark. The person with dementia will notice the dog and forget about the door. A caregiver also notices the dog making a commotion and rushes over to the scene. Moreover, we expect that the person with dementia hears the messages from the smartphone and may come back by him/herself.

People with Dementia Talking through a Smartphone on a Dog (Oshima, Yasuda et al., 2015): An experiment was conducted in which one of authors spoke with a person with dementia at a facility through Skype on the smartphone that was on the dog in order to see if a person with dementia would respond to a human voice that seemingly came from a dog. The facility has two dogs, both female Pomeranians. One of them cooperated with the experiment. She is young and easily attaches to a person. She was equipped with a harness that had a smartphone in one pocket.

Eight people with dementia sat in a half- circle and ate ice cream, while hearing someone talking to them through the smartphone on the dog. They were not told that someone would try to talk to them through a smartphone. Some of them responded to the voice through the smartphone. A few samples of conversations are shown; "D" is the author speaking via the dog, "U" is one of the users.

D: What are you going to eat? U2: We are going to eat this, here. (She showed a cup of ice to the dog.).

D: I would like to eat ice shavings with you. U3: Do you want to eat with me? D: Yeah. U3: I want to eat alone.

Most of the users with mild dementia responded to the dog "speaking." However, the user with medium dementia hardly uttered a word. Even when a human unexpectedly talks to someone with medium dementia, he or she does not always react at once. Furthermore, it is not easy for one with medium dementia to comprehend every situation, especially if that situation is something unexpected such as a talking dog. They might be a little confused or avoid confronting the situation because their cognitive functioning has been reduced.

The day will soon come when a smartphone will be able to hold a conversation autonomously. When a dog carries the phone, these people may have an enjoyable conversation. In general, we talk to a dog and infer its feelings from its responses and actions. A voice from a smartphone will support this conversation. The smartphone will encourage new relationships between people and dogs who work for those with dementia every day. One problem revealed in this study was that it is not easy to hear a smartphone outdoors.

The symptoms of dementia are varied and increase with time. Some devices can compensate for the disabilities. However, these devices must be kept on hand according to the person's stage or symptoms of dementia. The smartphone offers a lot of possibilities to provide support through only one device. However, some people with dementia forget to carry their smartphone. Also, many of them do not like to perform the tasks instructed by their device.

Even if she did not have it, a dog can be trained to bring the smartphone to its owner whenever

alarm sound. An owner is happier when the smartphone on the dog gave the alarm. A dog can overcome the problems of non-possession of the smartphone and disinclination of doing daily tasks. Dogs usually follow their owners. These people can be encouraged to remember to input the necessary information into an application on the smartphone carried on the dog.

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