Luria and Fozard as founders for creating suitable environments for people with dementia

J.J. van der Plaats MD PhD
Van der Plaats Ouderenadvies
4103 WL Culemborg, The Netherlands
E: info@dementie-winkel.nl

J.J. van der Plaats. Luria and Fozard as founders for creating suitable environments for people with dementia. Gerontechnology 2010; 9(3):380-387; doi:10.4017/gt.2010.09.03.008.00 Information of modern neuroscience learns us about designs and technology for persons with dementia. Together, the neurological research of Luria and Fozard's transactional concept of gerontechnology form an excellent basis for designing more appropriate and efficient environments in dementia.

Keywords: dementia, cognitive brain, emotional brain, fun technology

There has been a considerable amount of research about the technical needs and design requirements for people with cognitive disabilities, including dementia[1]. Most studies on technical interventions for those with dementia are evidence-based findings about a diverse range of technologies and materials. To be more effective we need to know the basic neurological principles of the functioning of the damaged brain, which is the focus of this contribution.

This paper first looks at life goals from a neurological point of view and explains what is applicable in people with dementia. Next the paper offers suggestions for creating and constructing designs for people with dementia. The paper highlights the importance of environment in designing for dementia and recognizes that engaging the user is as important as the brilliance of the technical design solution.

Luria's research

It is acknowledged that Luria's research[2] provided a foundation for the design of technology to assist people with dementia. The result of his neurological research is consistent with Fozard's transactional concept for gerontechnology, including its life domains and goals[3-6]. This includes happiness as discussed by Fozard and others working in the field of gerontechnology.

A.R. Luria[2] posed in the 1960s that mental activity derives from the brain and its organisation is hierarchical. The hierarchy consists of an increasing complexity of neurons combined with a 'higher' location in the anatomical and functional brain. Subsequently Powers[7] distinguished the different hierarchical levels of which the highest have the most sophisticated information-processing capacity. These highest level neurons produce the most diverse, adaptive, and subtle ways of behaving.

The most interesting aspect of the neurosciences is the distinction made between the 'upper brain' (the cognitive brain) and the 'lower brain' (the emotional brain). The more complete the upper brain is, the richer the repertoire for adaptive behaviour becomes[8]. This adaptive behaviour is specific to humans and comes into play via many alternative routes. It acts independently from the environment, contains an overview of a situation, is problem-solving in preparation for efficient actions, can produce feedback and postpones impulses[9]. When brain-disease or brain damage occurs, especially where the upper brain is affected, the lower

brain has to inform behaviour. However, behaviour guided by the lower brain is merely an emotional reaction to stimuli from the environment and it cannot be unchained from that environment. It has a small repertoire (anxious, happy, sad, and angry) and the person himself or herself has no choice[10]. The person is ruled by emotions and behaviour is impulsive, not well-thought-out and not precautionary. If we understand how a person will perceive the environment, the behaviour is even predictable!

Information processing by the brain has certain patterns that are the same for almost every person with dementia:
(i) The brain can only handle dynamic stimuli: incentives that are moving or producing sound.
(ii) 'Static' stimuli (without movement or sound) cannot be picked up; in a static environment the patient has to produce stimuli himself or herself by wandering or by making obsessive movements or noises.
(iii) In catching 'dynamic' incentives, there is a strict principle: only stimuli from one stimulation source at a time can be processed. The brain of a person with dementia has lost its filtering capacity. All stimuli make the same claims on the brain's attention leading to chaos within and restless, aimless behaviour outside.
(iv) Dynamic stimuli within the sight-field of the patient are processed. Incentives from behind create chaos in the mind that affects the whole person.
(v) Voluntary, purposeful movements cannot be made by the cognitive part of the brain (the frontal lobe). People with dementia are not able to initiate an efficient action on their own or based on only a single verbal instruction.
(vi) To start an action 'incentives in context' are needed by which the action emerges spontaneously; that is to say by the lower brain.
(vii) These contextual stimuli include (a) a familiar environment based on their own technological generation[11] , (b) the right starting position of the body, (c) an emotion or humour, (d) inviting music or songs, (e) the option to imitate someone else (a real person or a person on a screen), or (f) seduction to act, especially by small animals or children.
(viii) Mirror neurons give people the possibility to imitate proper actions; in dementia these remain unimpaired[12].

A new-born baby's brain becomes filled up with knowledge; the lower brain develops in the first three years and the upper brain takes another twenty years to mature. Although people with dementia may appear to behave like children the following points highlight different aspects:
(i) People with dementia do not become children again, but the methods we use with small children are useful in assisting people with dementia. For instance, we always have to attune to how they perceive the world before starting an intervention.
(ii) The memory ´rolls backward´ to his/her youth and early adulthood meaning that s/he cannot recognise modern attributes and scenes.
(iii) If the environment is extremely favourable and the person with dementia senses no negative stress, s/he can ´climb´ in his/her mind and find connection with the upper brain; in this situation s/he can act almost normal[13].
(iv) People with dementia are susceptible to virtual realities; they experience those as real.
(v) By creating an appropriate (virtual) environment, almost normal behaviour can be called up.
(vi) When a person cannot think, behaviour is an exact copy of inner feelings; brain-damaged patients cannot pretend.
(vii) The brain-damaged patient cannot hide emotions, so when s/he feels good, everyone can see it immediately.
(viii) Well-being can be observed through a patient´s pleasant, content radiation, their ability to be quiet and show almost normal behaviour; so the effect of an intervention can be easily noticed.
(ix) Failure, not understanding, feeling compulsion, speaking with many words, a too

difficult task, a too high level of communication, unrecognizable objects: all such incentives will make a person with dementia angry, aggressive, recalcitrant, and uncooperative.
(x) Little children are unexpecting and innocent; persons with dementia are more easily frightened.

As a consequence, if we want to develop technology for people with dementia, we must take into account that they cannot think for themselves, that they cannot manipulate the environment and - because of losing part of their memory- can only recognise familiar forms from their youth. For instance, when we want them to handle an apparatus of music, it has to look and work like an old radio. Even for healthy older people, modern technology is difficult to handle[14].

Fozard: the person-environment system

In 2005 James Fozard published a solid, scientific explanation about the aims, reach and implications of technological interventions for older persons[3]. He presented a transactional model that combined theoretical information from gerontology with environmental applications of technology to further the health and functioning of older people through the science of gerontechnology.

His study reinforced the importance of considering people and their environment as forming one system. Both the environment and a person could be thought of as having three component parts. The three environment components are social, built, natural. The three person components are: receptors to receive information from the environment (input), internal structures to cope with the information (processing) and effectors to act and handle the environment (output).

All these personal components are functions of the human brain and one can imagine that an affected brain has disturbed input (perception), processing (thinking) and output (behaviour). In normal brain-functioning there is a mutual influencing between person and environment[13]. One of the most basic principles in neuroscience is that a damaged brain becomes more and more dependent on the environment and cannot influence that environment anymore[14]. The normal balanced person-context relationship is destroyed. The environment is a determinant for the behaviour of the brain-damaged patient[15]. This has enormous consequences for designing technical aids for people with dementia.

In mentally healthy people, their use of helpful technology can be slightly humiliating but if the effect leads to greater independence, the humiliation is worthwhile. Persons with dementia cannot look that far; they refuse everything that affects their feeling of self-esteem[16]. So the technology has to be absolutely pleasing in use and must not make them more self-conscious. Whatever the goal of the technical intervention, the goal for the person with dementia is joy and pleasure. Pleasure can also be the target of the design[17].

Recently van Bronswijk, Fozard and others[18-21] introduced a working framework model for gerontechnology that could be captured on a single page[4,5]. The model is practical and concrete. It contains four goals - enrichment/satisfaction, prevention/engagement, compensation/substitution, care support/care organisation- and five life domains - health/self-esteem, housing/daily living, mobility/transport, communication/governance and work/leisure.

However, the model cannot answer the question: how can we seduce people with dementia to participate in technology and make them do the things that we want them to. According to the neurological theory we have to create an 'enriched environment' that facilitates spontaneously the correct actions and movements[22]. Here we can discover the importance of virtual realities in presenting modern technology to people with dementia. Virtual reality actually is creating another environment, different from the existing context. According to Fozard

virtual reality normally is used in enhancing imagination, leisure, communication and education. In helping people with dementia it is used to create a suitable environment to make them feel at ease. The most important part of such a design is having only ONE stimulation source that can facilitate appropriate actions.

The designs for people with dementia must –whatever the actual goal may be- result in a feeling of well-being[17]. Well-being through pleasure is their –unintentional- prime motivation[22]. Sixsmith et al.[24] also stress well-being as an important goal in technology for people with dementia. He talks about a so-called ´wish-list´[25]. In this respect, van Bronswijk puts the effects of gerontechnology into the Maslov theories[26,27]. Van der Plaats[17] referred to Maslov as well in her dissertation about what type(s) of care is (are) adequate on behalf of chronically ill and disabled persons. She figured out that chronic care mainly fulfils the basic needs which are physiological care and safety measures. Most technology aims at these basic needs and in the meantime chronically ill patients are bored stiff! Fulfilling of the higher needs (self-actualisation, social participation, and joy), however, makes the difference between a low and a higher quality of life in the last decennium of life. This stresses the need for technology that furthers wellness, social contacts, leisure and fun.

Concluding we can say that the model that Fozard proposed is also useful in designing for dementia. The model gives way to the personal perception, processing and actions in synergy with the environment.

Creating a suitable environment

Most gerontechnology publications on dementia concern watching/helping/safety constructions and designs. In these settings the person with dementia cannot voluntary participate or cooperate. In the case of security-watching, secretly placed security-technology is a solution[28]. One cannot expect people with dementia to have self-knowledge about their helplessness, unsafe situation or disturbance of others. This is the enormous difference in working with persons with and without mental impairments. However, knowledge of the demented brain allows us to try another way.

A design, consisting of virtual reality and dynamic incentives deriving from technology, must appeal to their familiar former environment that may not exist anymore but still has a strong representation in their memory[29]. For people with dementia the only option to influence behaviour is through virtual reality[30]. Its components are old-fashioned looking, fairy tale-like designs, slowly moving objects, one source of stimuli at a time, and clear, standing-out colours.

Every action must be provoked by stimuli from the environment. So we cannot expect them to use technology unless it attracts their attention either by movement or sound. Both the outlook and the operation of the technology must be familiar from youth. For instance, if we want to give a written instruction, it is not sufficient to give a verbal order or to present some sentences on a TV-screen. Instead we show, for instance, an old fashioned teacher who writes and says the instruction on an old fashioned black-board[31].

Much emphasis must be put on the design of the technology, as was also pointed out by Bouwhuis[32]. The effect of technology for the aged is entirely based on the knowledge of their perceptual world. This is especially the case in dementia. After all, their perceptual, cognitive and executive capacities go backward to a more primitive and less complex way of dealing with information. A lot of the information present is, moreover, not even recognised. In their behaviour there is no planned action, no autonomous motivation and choice-making.

Van Hoof et al.[33] describe technology in a nursing home which appeals to primitive, natural or childish behaviour, the behav-

iour of the lower brain. For instance, a dark space will not be entered by a person with dementia. On the other hand, spaces we want them to enter are well lit. In the dark night, lights on the route to the toilet must switch on automatically when the person with dementia leaves his/her bed. Switching on of the light appeals to primitive reflex behaviour of being attracted by a light in the darkness. In the same way as with lighting we can think of sounds, images and objects to attract or repel patients with dementia. So by well-informed insight into the workings of the brain, we can assist people with dementia to both be safe and enhance their experiences of pleasure.

For people with dementia safety while wandering is a major issue as shown in the study of Kearns et al.[34]. That study looked at the kinds of detectors and navigation-systems used to protect people with dementia from becoming lost or straying into unsafe areas. People with dementia were upset and annoyed by them and frequently refused cooperation. On the basis of neurology we can think of a lot more interventions to calm down the wandering and restlessness. The interventions must not prevent wandering, because walking around has a favourable influence on better condition of body and mind[35]. That is why we construct old fashioned or fairy tale-like ´adventure´ spots in the corridors of nursing-homes. Patients interrupt their walking, sit down there or start doing things like gaming, caring for baby-dolls, petting fake animals or looking at films. The result of such an enriched walking area is stopping the aimless wandering that gives rise to falls, and calming down fiddling and screaming, at the same time activating apathetic patients[36].

Sleeplessness is worth combating too. The main cause is profound silence. The situation at night, in the sleeping room, can be too silent for the demented brain. That is why certain people with dementia have to leave their beds every night. Instead of giving these patients sleep medication we must provide them with nice, slightly stirring incentives like a LED lamp that slowly changes colours, or twinkling stars on the ceiling, or appropriate music or the like.

Similar technology can be used for bedridden people with dementia. The lack of meaningful stimuli causes total apathy or continuous obsessive mumbling or fiddling[31]. By a daily program of alternating types of incentives, boredom in all brain-damaged patients can be prevented. Using this technology it is possible to replace tranquillizers, sedatives and anti-psychotics that can cause considerable harm to brain-damaged patients[37].

Another example of creating a virtual situation, especially one that appeals to the past, is Tamura´s offering baby-dolls to people with dementia[38]. This was shown to have a therapeutic effect: there was less aimless wandering and restlessness; there was more communication and accepting care from the staff.

Technology for people with dementia seldom can be used when it is a copy from technology for people without brain damage[39]. There is a need for more flexible systems that can switch to different contexts. Verbal commands and guidance are particularly in need of review as they are difficult to execute. This execution is a process of the upper brain. The design and the construction must fit in the spontaneous processes of the lower brain. An instruction has to be given by every option of perception that is visual, audio, tactile, or olfactory (by sense of smell). The same applies to the feedback that must produce the appropriate signals for the demented patient to fulfil his/her task.

Obviously, working with computers is difficult to realise for people currently with dementia. Future generations who will have life-long experiences with all sorts of apparatus, may not experience those same difficulties with technology. Some investigators have made recommendations[40, 41] regarding technology which are worth noting as to accommodate current understanding of

the demented brain. For example, a touch screen is more frequently and better used by people with dementia. People with mild dementia can sometimes handle a computer with simple learning tasks. They showed they could learn but only with the prerequisite of day-long psycho/social stimulation programs. That means that the environment has to be extremely encouraging and the nursing staff had to be educated to provide the encouragement.

Gaming on the computer has benefits for older persons especially when a virtual reality is created that appeals to games from the old days, for instance, playing shuffleboard. To keep a person with dementia engaged, there must be a lot of feedback that provokes the next action[42].

A nice example is the old fashioned pinball machine with twinkling lights, suitable sounds, a moving ball and an inviting handle for pulling. All in all, the feedback must bring a feeling of joy, of being meaningful and relief from the boredom or chaos in their minds[43].

It seems that all people with dementia love looking at scenes! To make things more satisfying for them we can show them old-fashioned images, as Waller et al.[44] did. The most successful situations were when the images moved slowly, like an old-fashioned film. Also, when photographs were shown in the form of a slide show they were more successful than still images. Still images, which do not move, twinkle or make noise, do not attract attention from people with dementia[45].

Waller and his team[44] used the medium of television for many purposes with people with dementia. He called it 'extended television'. An internal television channel was put in the nursing home and it was filled with pictures of the patients, happenings in the home, pictures of the environment, historical recordings of the region, family members speaking, old-time movie stars, etc. It appeared most attractive for the people with dementia. Family members started to construct slide series out of old photo-albums. Personal TV programs were created. It even resulted in people with dementia using the apparatus themselves.

I observed positive experiences by showing a beloved daughter or spouse, talking from the TV screen to the patients who constantly ask or search for them. In the living room, images on a flat-screen can help people with dementia know what they are going to do (show, for instance, a coffee can pouring coffee into cups), what time of the day it is (show, for instance, a beautiful sunset), what they can do (show, for instance, someone who asks them to join in singing and starts singing indeed), which movements they have to make (show them, for instance, a family that is eating). That is why we are busy making TV programs that run parallel to the order of the day[46].

The neuroscientific way of thinking supports practical technology and designs. This benefits all people with dementia, whether mild or severe dementia, although there appears to be some resistance from those with mild dementia and their care givers who tend to deny the on-set of the disease[47].

Conclusions

Designing technology for people with dementia does not only involve constructing an apparatus. It implies the whole way of life at the specific moment in which the intervention must take place. Also, the goals of the technology are not merely instrumental. The aims include creating a certain atmosphere, ejecting stimuli that have nothing to do with the goal of the desired action, providing incentives that facilitate or provoke the desired actions, avoiding boredom and overstimulation, enhancing safety, supporting self-confidence, and preventing disturbing, harmful and inadequate behaviour[13].

The people with dementia themselves only have one motivation to come to changing their behaviour: being touched and moved

by environmental stimuli that bring them relief, pleasure and good memories. Our most important goal is well-being. We can see this effect by the pleasant and quiet radiation of the patient. If there is no such radiation we know that we must search further until the patient is satisfied.

A great help is the fact that people with dementia are sensitive to virtual realities. We can use flat screens and walls to create a virtual situation that provides an adequate stimulus to start effective behaviour in the mind of the person with dementia.

What we learned from brain sciences is that by creating a specific environment, we can better meet the needs of people with dementia. That means that we can seduce these people to do the appropriate things, at the appropriate time by using the appropriate gerontechnology.

Acknowledgement
I am grateful to Elizabeth Karol for comments and corrections.

References

1. Opie J, Rosewarne R, O'Connor DW. The efficacy of psychosocial approaches to behaviour disorders in dementia: a systematic literature review. Australian and New Zealand Journal of Psychiatry 1999;33(6):789-799; doi:10.1046/j.1440-1614.1999.00652.x
2. Luria AR. The Working Brain. London: Penguin Books; 1973; pp 43-79
3. Fozard JL. Impacts of technology interventions on health and self-esteem. Gerontechnology 2005;4(2):63-76; doi:10.4017/gt.2005.04.02.002.00
4. Bronswijk JEMH van, Bouma H, Fozard JL, Kearns WD, Davison GC, Tuan P-C. Defining gerontechnology for R&D purposes. Gerontechnology 2009;8(1):3-10; doi:10.4017/gt.2009.08.01.002.00
5. Bronswijk JEMH van, Fozard JL, Kearns WD, Davison GC, Tuan P-C. Implementing gerontechnology. Gerontechnology 2008;7(3):325-327; doi:10.4017/gt.2008.07.03.007.00
6. Bouwhuis DG. Not care but leisure. Gerontechnology 2006;5(2):63-65; doi:10.4017/gt.2006.05.02.001.00
7. Powers WT. Behaviour, the control of perception. London: Aldine de Gruyter; 1973; pp 75-90
8. Servan-Schreiber D. Instinct to heal: curing stress, anxiety and depression without drugs and without talking therapy. Chapter 1 & 2. New York: Rodale; 2004
9. Crone E. The puberty brain. Chapter 2. Amsterdam: Bakker; 2008
10. Boer JA den. Neurophilosophy [in Dutch]. Amsterdam: Boom; 2004; pp 191-219
11. Docampo Rama M, Ridder H de, Bouma H. Technology generation and age in using layered user interfaces. Gerontechnology 2001;1(1):25-40; doi:10.4017/gt.2001.01.01.003.00
12. Rizolatti G, Fabri-destro M, Cattaneo L. Mirror neurons and their clinical relevance. Nature Clinical Practical Neurology 2009;5(1):24-34; doi:10.1038/ncpneuro0990
13. Perry B. Neuroarcheology of Childhood Maltreatment. In Geffner B, editor, The cost of child Maltreatment: Who pays? New York: Hayworth Press; 2009; pp 61-88
14. Goldberg E. The wisdom paradox. New York: Penguin; 2005; pp 110-115
15. Cools AR, Jaspers R, Schwartz M, Sontag KH, Vrijmoed-de Vries M, Bercken J van den. In: McKenzie JS, Kemm RE, Wilcock LN, editors, The Basal Ganglia. New York: Plenum; 1984
16. Cools AR. Manifestations of switching disorders in animals and men with dopamine deficit. In: Wolters EC, Scheltens P. Mental dysfunctions in Parkinson's disease. Amsterdam: Free University; 1993; pp 49-67
17. Plaats JJ van der. Geriatrics a matter of flexible balance: Theoretical foundations for the care of chronically ill and disabled elderly. Chapter 10. PhD thesis, University of Nijmegen; 1994
18. Sagawa K. Japanese chapter and pleasantness of designs. Gerontechnology 2006; 4(4):243-244; doi:10.4017/gt.2006.04.04.012.00
19. Franco A, Bronswijk JEMH van, Littler A. Clinical gerontechnology and its assessment. Gerontechnology 2008;7(3):269-270; doi:10.4017/gt.2008.07.03.001.00
20. Franco A, Bouma H, Cornet G, Mallea P. Gerontechnology at IAGG 2009 for optimal health in a multidisciplinary context. Gerontechnology 2009;8(2):63-67; doi:10.4017/gt.2009.08.02.001.00
21. Cruz-Jentoft AJ, Franco A, Sommer P, Baeyens J-P, Jankowska E, Maggi A, Ponikowski P, Ryś A, Szczerbińska K, Milewicz A. European silver paper on the future of health promotion and preventive actions, basic research and clinical aspects of age related disease. Gerontechnology 2008;7(4):331-339; doi:10.4017/gt.2008.07.04.001.00

22. Mirmiram M, Swaab DF, Fliers E. Environmental influences on brain and behaviour in aging and Alzheimer disease. In: Swaab DF, Fliers E, Mirmiran M, Gool WA van, Progress in Brain Research. Volume 70, Chapter 28. Amsterdam: Elsevier; 1986
23. Ratey J. A user's guide to the brain. Perception: Attention and the four Theatres of the brain. New York: Pantheon; 2003; pp 410-435
24. Sixsmith AJ, Orpwood RD, Torrington JM, Clarke P, Gibson G. Well-being and dementia: the role of assistive technologies. Gerontechnology 2005;3(4):187; doi:10.4017/gt.2005.03.04.005.00
25. Sixsmith AJ, Gibson G, Orpwood RD, Torrington JM. Developing a technology 'wish-list' to enhance the quality of life of people with dementia. Gerontechnology 2007;6(1):2-19; doi:10.4017/gt.2007.06.01.002.00
26. Bouma H, Fozard JL, Bronswijk JEMH van. Gerontechnology as a field of endeavour. Gerontechnology 2009;8(2):68-75; doi:10.4017/gt.2009.08.02.004.00
27. Bronswijk JEMH van. Gerontechnology motivation. Gerontechnology 2006;5(2):65-67; doi:10.4017/gt.2006.05.02.002.00
28. Kearns WD, Algase D, Moore DH, Ahmed S. Ultra wideband radio: A novel method for measuring wandering in persons with dementia. Gerontechnology 2008;7(1):48-57; doi:10.4017/gt.2008.07.01.005.00
29. Miesen BML. Dementia in close up. London: Routledge; 1999; pp 72-81
30. Ramachandran VS, Blakeslee S. Phantoms in the brain. Philadelphia: Quill; 1998; pp 60-75
31. Cools A. Moving and mobility of the brain. In: Smits-Engelman BCM, Ham I van, Aufdemkampe G, Dekker JB den, Vaes P, editors, Yearbook of Physiotherapy. Lochem: Bohn Stafleu Van Lochem; 1998; pp 166-183
32. Bouwhuis DG. Design for person-environment interaction in older age: a gerontechnological perspective. Gerontechnology 2003;2(3):232-246; doi:10.4017/gt.2003.02.03.002.00
33. Hoof J van, Berlo A van. Home automation for persons with dementia and their carers. Gerontechnology 2007;6(2):118-119; doi:10.4017/gt.2007.06.02.007.00
34. Kearns WD, Rosenberg D, West L, Applegarth SP. Attitudes and expectations of technologies to manage wandering behavior in persons with dementia. Gerontechnology 2007;6(2):89-101; doi:10.4017/gt.2007.06.02.004.00
35. Scherder E, Eggermont L, Swaab D, Heuvelen M van, Kamsma Y, Greef M de, Wijck R van, Mulder T. Gait in ageing associated dementia's, its relationship with cognition. Neuroscience and Behaviour Reviews 2007;31(4):485-497
36. Plaats A van der, Verbraeck B. De wondere wereld van dementia [The miraculous world of dementia]. Maarssen: Elsevier Gezondheidszorg; 2008
37. Zuidema SU. Neuropsychiatric Symptoms in Dutch nursinghome patients with dementia. Dissertation, Nijmegen University Press; 2008; pp 40-50
38. Tamura T, Nakajima K, Nambu M, Nakamura K, Yonemitsu S, Itoh A, Higashi Y, Fujimoto T, Uno H. Baby dolls as therapeutic tools for severe dementia patients. Gerontechnology 2001;1(2):111-118; doi:10.4017/gt.2001.01.02.004.00
39. Bagnall P, Onditi V, Rouncefield M, Sommerville I. Older people, technology and design – a socio-technical approach. Gerontechnology 2006; 5(1):46-50; doi:10.4017/gt.2006.05.01.005.00
40. Colombo M. Computer for cognitive rehabilitation in dementia. Gerontechnology 2008;7(4):357-358; doi:10.4017/gt.2008.07.04.013.00
41. Wright P. Talking computers and diversity in older audiences. Gerontechnology 2006; 4(4):187-189; doi:10.4017/gt.2006.04.04.002.00
42. Tak SH, Beck C. Computer-assisted stimulating activities for persons with dementia. Gerontechnology 2005;3(4):188; doi:10.4017/gt.2005.03.04.006.00
43. Marti P, Lund HH, Bacigalupo M, Giusti L, Mennecozzi C. A multi-sensory environment for the treatment of dementia affected subjects. Gerontechnology 2007; 6(1):33-41; doi:10.4017/gt.2007.06.01.004.00
44. Waller PA, Östlund B, Jönsson B. The extended television: Using tangible computing to meet the needs of older persons at a nursing home. Gerontechnology 2008;7(1):36-47; doi:10.4017/gt.2008.07.01.004.00
45. Cools A. Animal models of personality. In: D'Haenen HAH, Boer den JA , editors, Biological Psychiatry. Vol II. Chichester: John Wiley; 2002; pp 1333-1344
46. Dementia and well-being [in Dutch]; www.dementie-winkel.nl; retrieved March 20, 2010
47. Vernooy-Dassen M, Lamers C, Felling A, Grol R. Prognostic Factors of Effectiveness of a Support Program for Caregivers of Demented Patients. International Journal on Aging and Human Development 2000;51(4):259-274