Assistive Technology and NeuroRehabilitation: Achievements and Aspirations.

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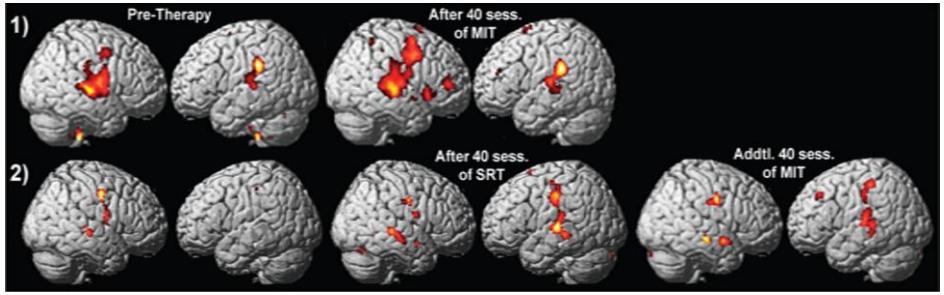
Achievements

- There have been many
- We can start with imaging to help us understand brain injury
- The first vegetative patient to have a PET scan was carried out by Menon et al. (1998)
- They showed that the areas responsible for face processing were indistinguishable from an age-matched non-brain-damaged control participant given the same task.



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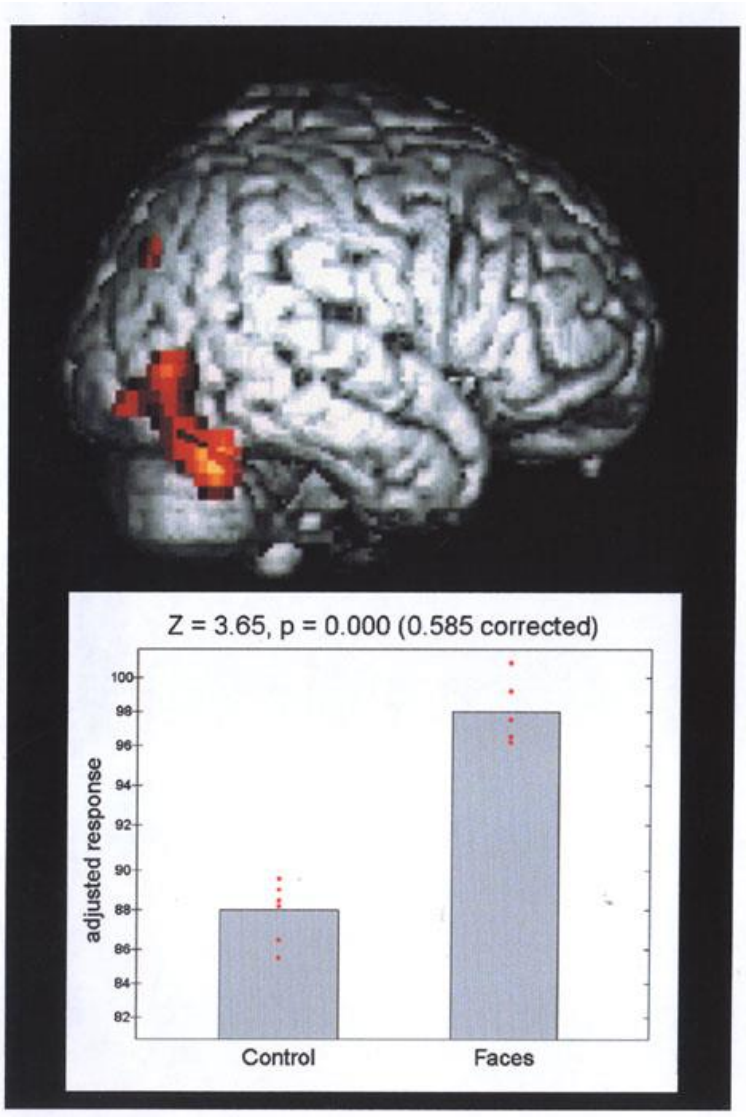

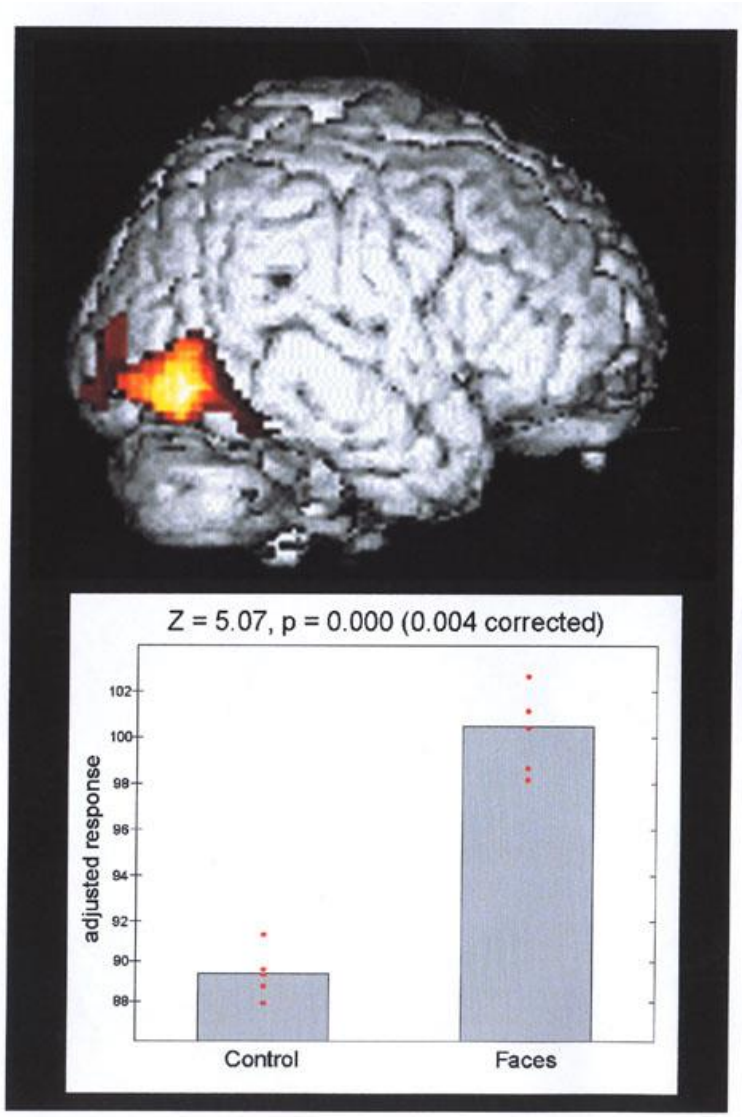

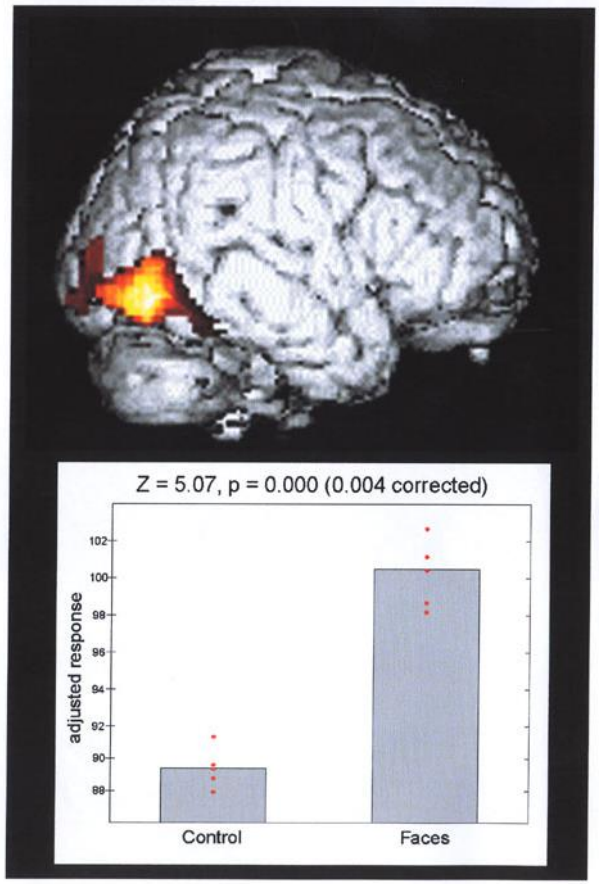

The paper is frequently cited in vegetative studies

But not helpful for rehabilitation (as she was indistinguishable from the age matched control!)

Coma Study Group Cambridge

- Did a fascinating study with a patient who met all the criteria for VS on multidisciplinary assessments
- Yet the areas of brain activation consistent with the areas activated in volunteers
- At least for playing tennis and moving round the room.

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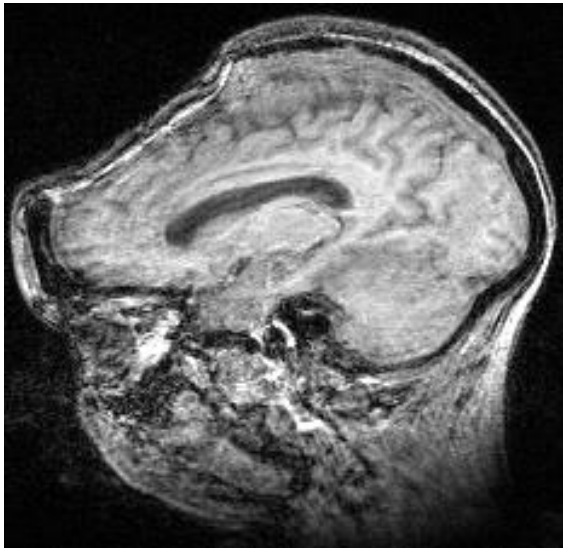
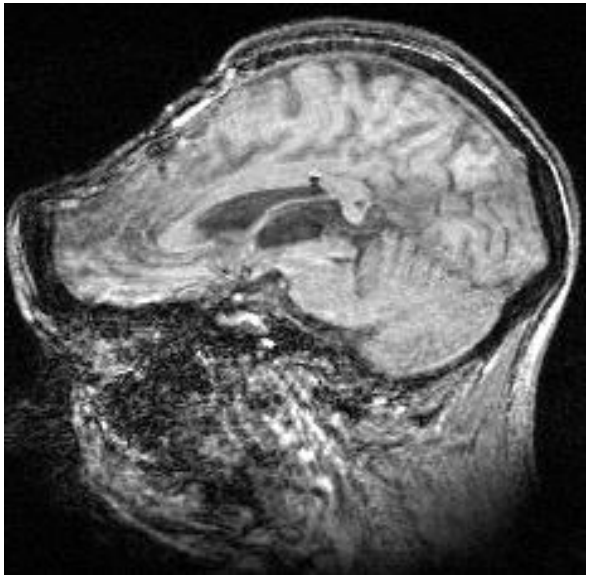
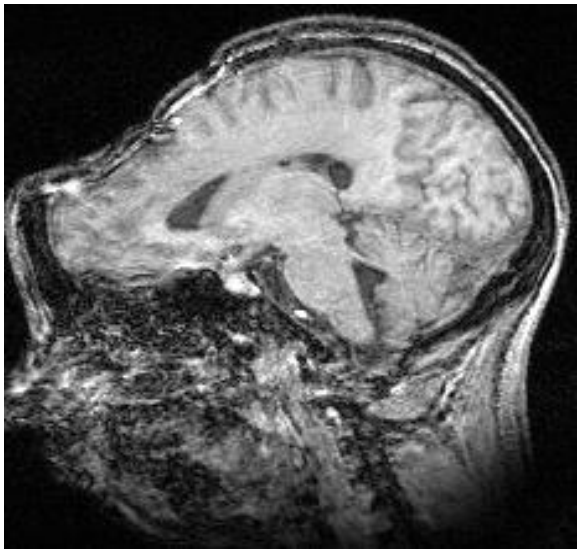
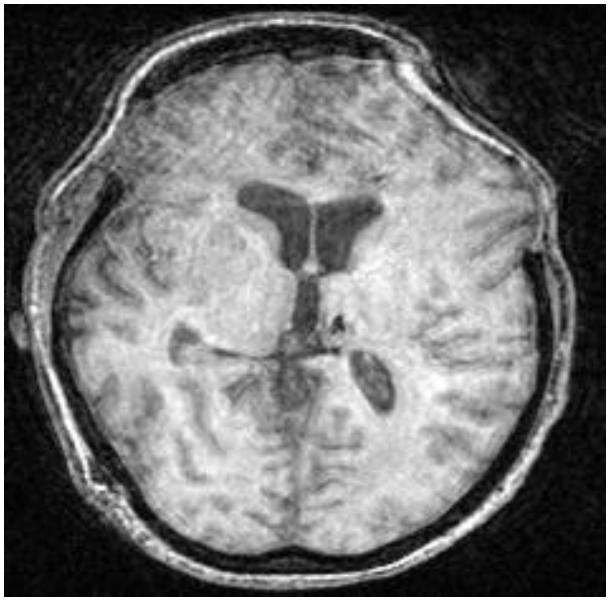
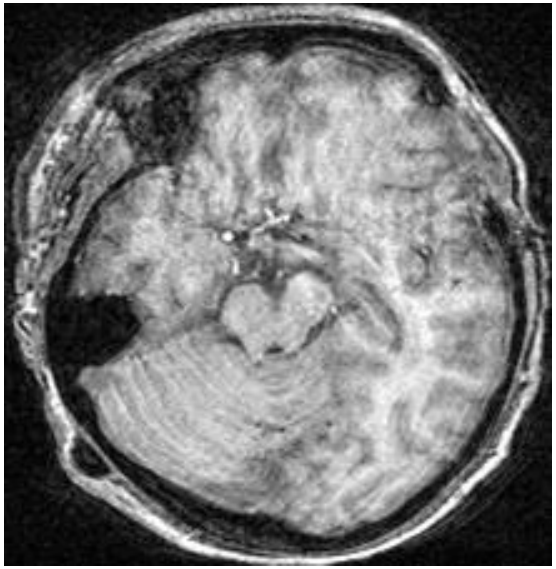
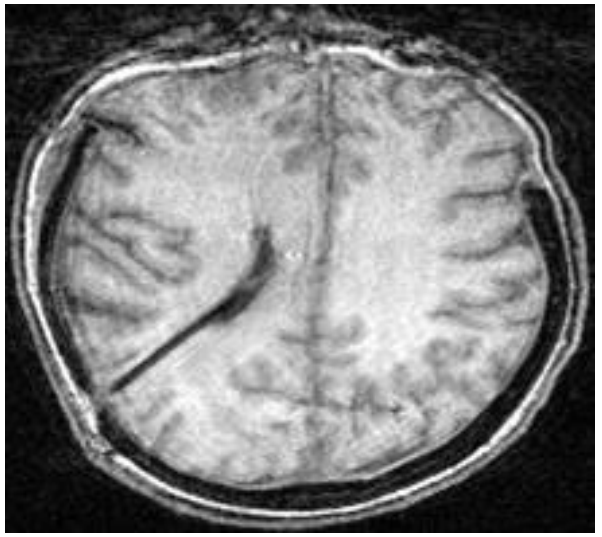




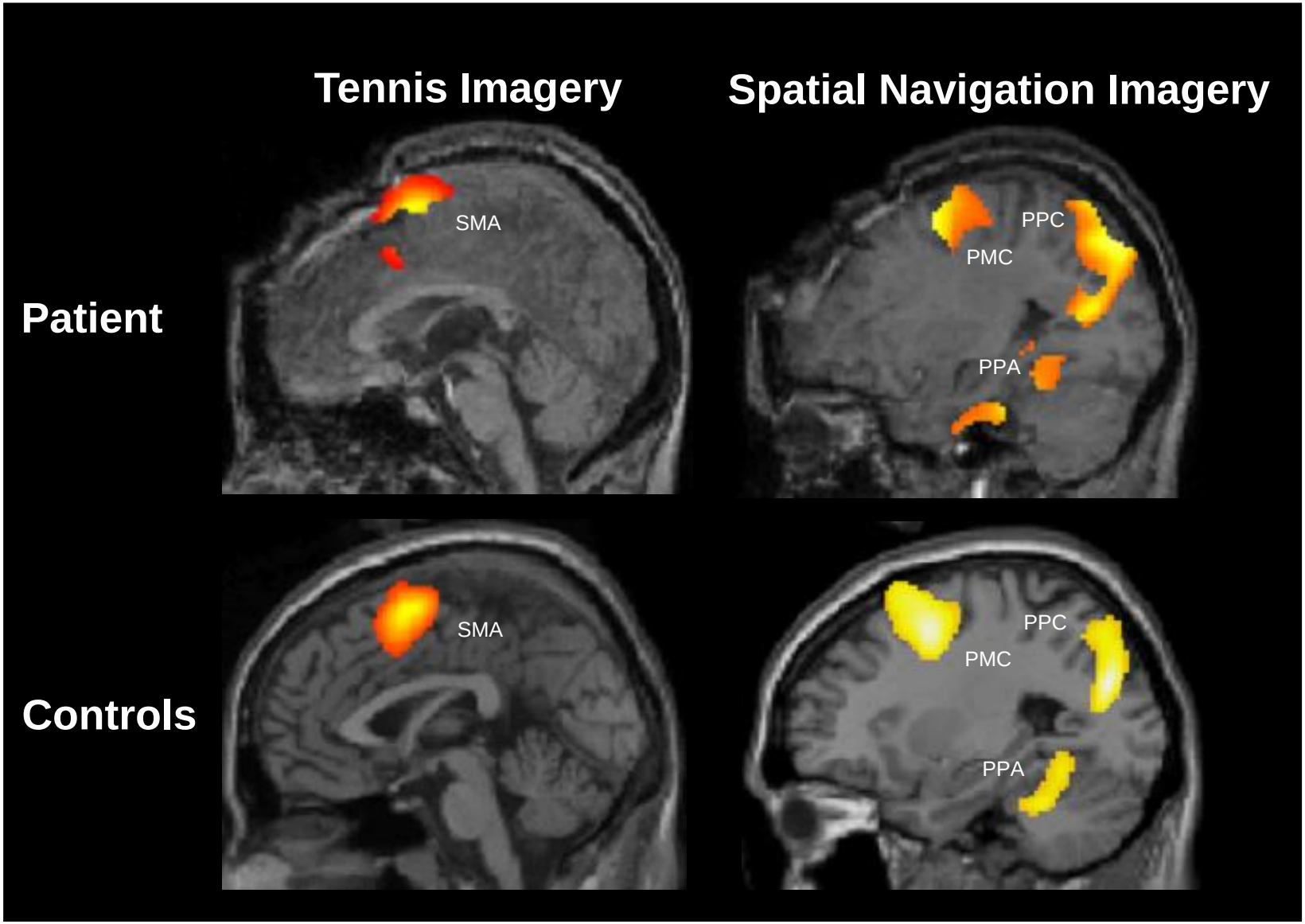








Thanks to Adrian Owen



This procedure has been used with vegetative and minimally conscious patients for Yes/No responses

- Patients asked to think of playing tennis for “Yes” and to think of walking round the room for “No”
- Of 54 patients assessed in this way, five were able to wilfully modulate their brain activity
- This demonstrates that it may be possible to establish a successful method of communication with a small number of patients. incredibly labour intensive.
- This is very labour intensive and expensive and not so helpful clinically

Imaging Procedures

- **Can identify specific lesions and areas of impaired functioning**
- **Can determine the severity of brain damage**
- **Can monitor change in brain functioning over time**
- **Can help with making decisions (e.g. surgical decisions)**
- **Can predict which people are likely to remain with persistent problems after a traumatic brain injury**
- **BUT, at present these procedures do not help us to plan rehabilitation (and they are costly)**

Compensatory Aids More Beneficial

External aids, not necessarily technological, are the most effective and widely used interventions for the rehabilitation of memory impairments.

Can also be used to offset other cognitive impairments such as language disorders, executive problems, calculation deficits, recognition problems and unilateral neglect.

- One of the earliest papers describing the use of an electronic aid for a person with brain damage was Kurlychek (1983).
- This study important because it examined the aid's influence in helping the subject tackle a real-life problem, namely to check his timetable.

- Kirsch and his colleagues (Kirsch, et al., 1987) designed an interactive task guidance system to assist brain injured people to perform functional tasks.
- Since then, there have been numerous papers reporting successful use of technology with brain injured people.
- Boake (2003) includes discussion of some of the early computer based cognitive rehabilitation programs and
- a paper by Wilson et al. (2001) used a randomised control crossover design to demonstrate that it is possible to reduce the everyday problems of neurologically impaired people with memory and/or planning difficulties by using a paging system.

- In 1986, Glisky, Schacter, and Tulving taught memory impaired people computer terminology and one of their participants was able to find employment as a computer operator.

- Many studies can be found providing evidence for the effectiveness of compensatory aids.
- A systematic review of seven studies by Jamieson et al. (2014) showed significant and large effects when people used external memory aids.
- For a recent update on the use of computer assisted devices in neuropsychological rehabilitation see O'Neill, Jamieson, and Goodwin (2017).

Jamieson et al 2014: Systematic Review of External Memory Aids (significant and large effects)

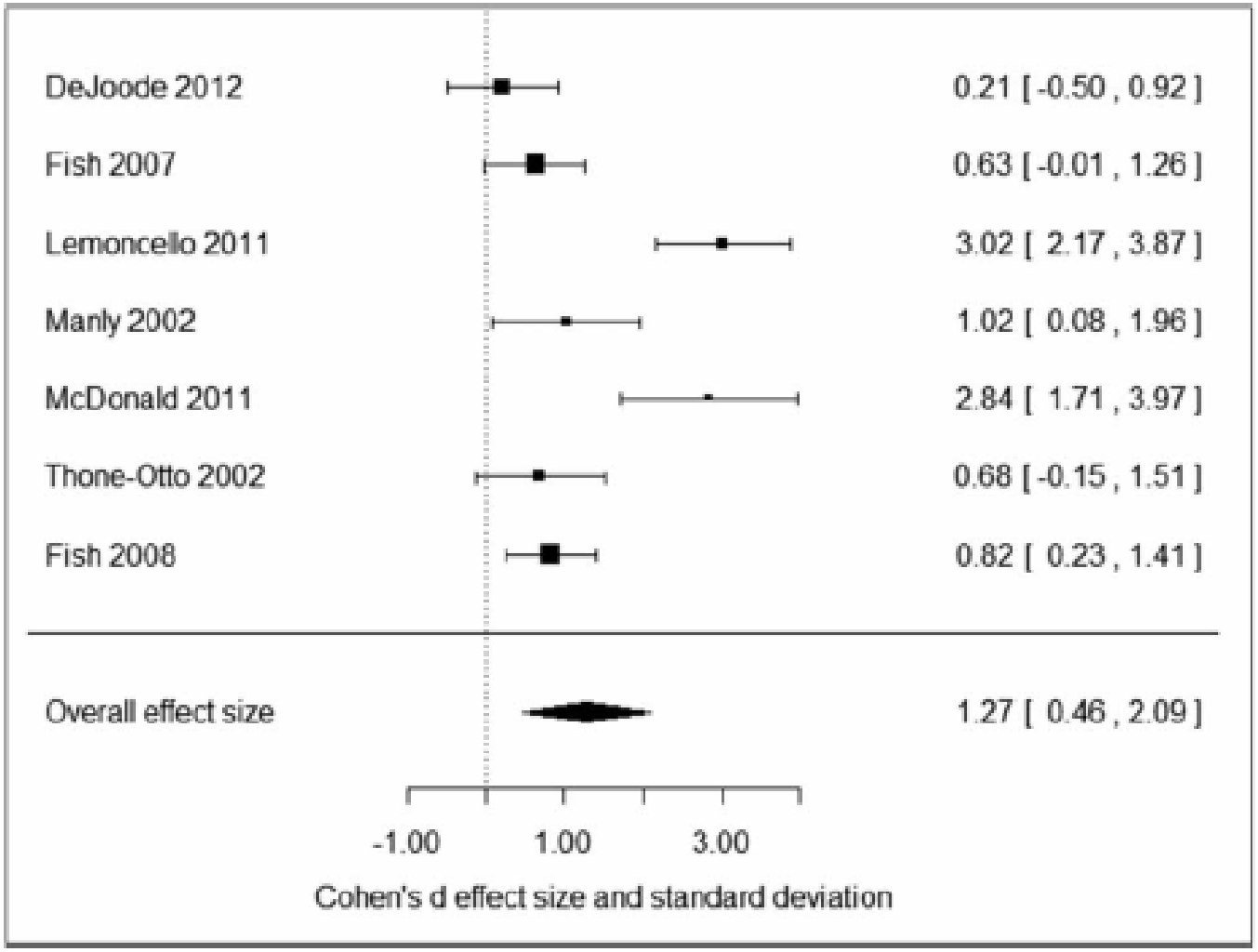
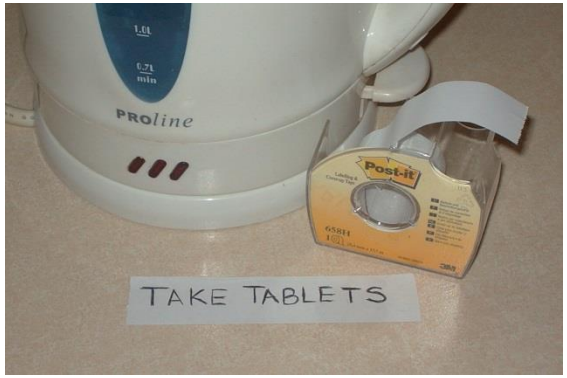


Figure 2. Meta-analysis results with effect sizes, confidence intervals and weightings for each individual study.

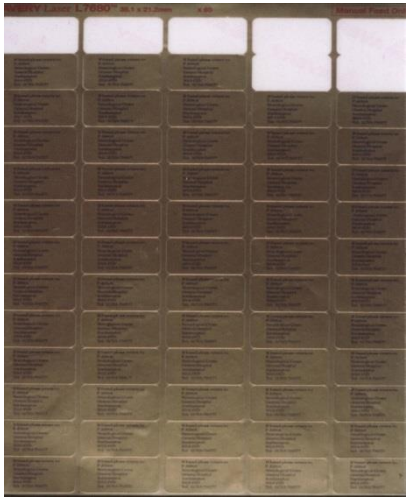
Increasing Use of Technology

- This does not have to be “High-Tec”

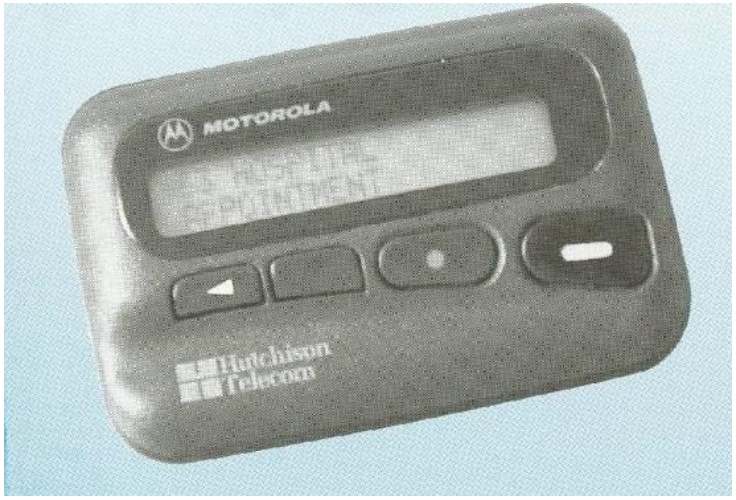


Post-it tape can also be used for writing instructions

on how to use equipment at home



When things get mislaid….
Self-adhesive labels - ‘if found, please contact..’
If you can lose it - label it


MOTOROLA
Hutchison
Telecom

Location Detection Device

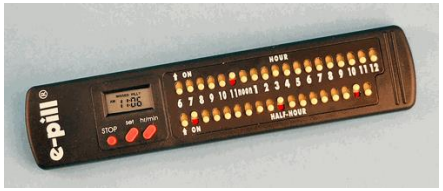
Device

Day Clocks

Voice-Alarm Reminder

Talking Watch

e-pill Multi Alarm



Vibration repeated cueing device that may be useful for those with combined hearing and visual handicaps.

AUTOMATED IN-CAR VOICE REMINDER

Plugs into cigarette lighter socket

Automatically plays message when car is started

Pill Box Reminder

Day Clocks

Two versions –

Day Version

Day & Time Version

£27

www.dayclocks.co.uk

External Aids to Compensate for Prospective Memory problems

- External memory aids are now widely available, can be very inexpensive, and have the potential to be highly effective in the compensation for PM problems.
- There can be difficulty in both learning, and remembering, to use electronic reminders, but even in densely amnesic patients, electronic devices can sometimes be used to aid PM.

External Memory Aids: Can be a real aid to independence but

People with memory problems

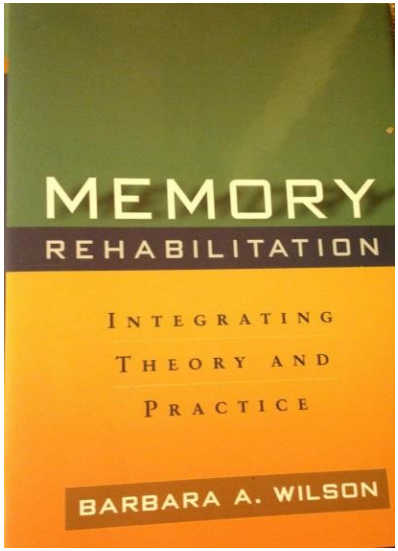
- Forget to use them
- May have difficulty programming them
- May use them in an unsystematic or disorganised way
- May be embarrassed by them

- The people who need memory aids the most have the greatest difficulty in using them.
- Use of a memory aid involves memory.
- But some MI people can use these aids efficiently

Other electronic devices include

- Television Assisted Prompting (TAP) Device
- Mobile phones
- Smart phones
- Google calendar
- SenseCam/Autographer/ Narrative Clip
- etc

Plenty of Evidence For The Success of Compensations



- NeuroPage
- SenseCam
- Google Calendar
- Mobile and Smart phones
- Television Assisted Prompting (TAP) Device
- Etc

Virtual Reality Assessments

- VR refers to the use of computer hardware and software in addition to adjunct technologies to create interactive simulations and environments.
- These allow opportunities to engage in settings that resemble and feel similar to real world interactions

Kizony 2009

- The ultimate goal of VR-based intervention is to make it possible for clients to become more able to participate in community life.
- VR technology simulates real world environments and situations that can be easily adapted to the needs and characteristics of various groups
- And can train cognitive strategies in various contexts, to facilitate their transfer to the real world.

- Within the virtual environment users are provided with different types of feedback modalities for their performance.
- These include visual and audio feedback and, less often, haptic and vestibular feedback (Weiss et al., 2006).
- VR technologies now starting to be used as an assessment and treatment tool in rehabilitation in general and in cognitive rehabilitation in particular .

- The opportunity for experiential and active learning in a relevant setting encourages and motivates the user.
- Enhancing motivation is especially important for clients with cognitive deficits who often have low levels of motivation and compliance during the rehabilitation process
- The same is true for clients with executive deficits which affect their ability to initiate performance and to set goals.

Some Examples

- A virtual kitchen to assess cognitive abilities during meal preparation in people with traumatic brain injury (Christiansen et al 2001).
- Virtual Mall (Rand et al 2009) to look at executive functions
- Library-based task (Renison et al 2012), requiring participants to prioritise and complete multiple tasks whilst managing interruptions and new information necessitating a shift in their approach (assesses 7 types of executive functioning)
- Also virtual classroom, virtual town, hospital etc etc

Virtual Library Task subscales

- Task Analysis
- Strategy generation & regulation
- Prospective working memory
- Interference and dual task management
- Response inhibition
- Time based prospective memory
- Event based prospective memory

Virtual Reality

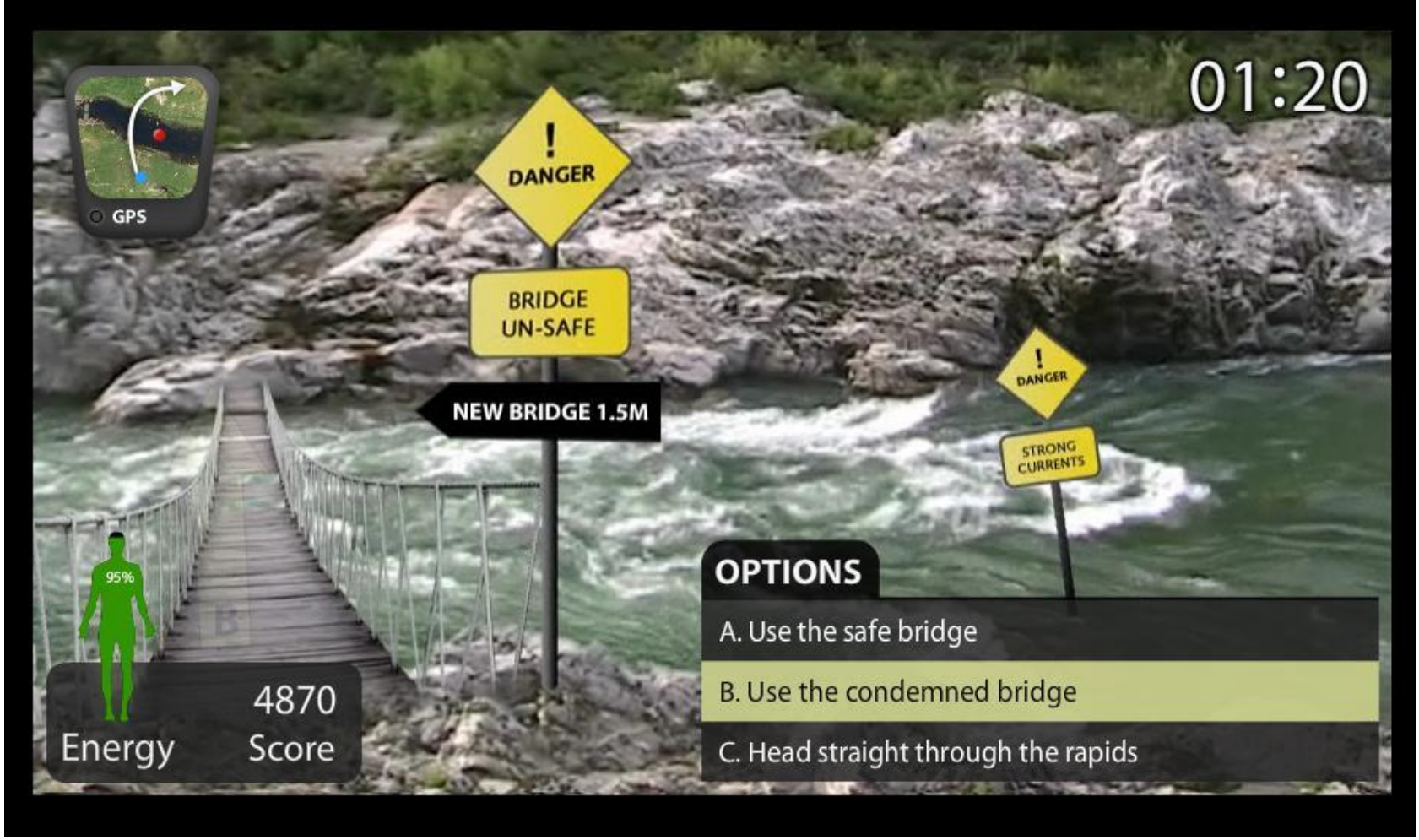
- VR can be used to simulate real life situations and thus be beneficial for both assessment and treatment.
- Rose et al (2005) provide a review of the way VR is being used in brain injury rehabilitation;
- they discuss the use of VR for the assessment and treatment of memory problems, executive deficits, visuo-spatial difficulties, and unilateral neglect.

The Ultimate Goal of VR

- Is to make it possible for patients to become more able to participate in community life.
- Users are provided with different types of feedback modalities for their performance. These include visual and audio feedback and, less often, haptic and vestibular feedback (Weiss et al., 2006).
- VR technologies are now used as assessment and treatment tools in rehabilitation in general, and in cognitive rehabilitation in particular (Kizony, 2011; Jansari et al., 2014 and others).

Experiential and active learning in a relevant setting

- Encourages and motivates the user.
- This is particularly important for survivors of brain injury with cognitive deficits and, often, poor motivation.
- Many different situations have been used in VR assessments including a virtual kitchen, a virtual mall and a library.
- Participants have to prioritise and complete multiple tasks whilst managing interruptions and new information.



Thanks to Robin Morris

a person has to go on special mission,
instructed through a radio by a controller.
On the mission they have
to decide levels of risks, how to regulate
stopping for food versus losing time and
also make ethical decisions about their actions.

Aspirations?

- There are many
- One of the patients groups I am interested in is Locked-In Syndrome
- Computers used to help

Computers in Neurorehabilitation

- Computers, for example, may be used as cognitive prosthetics, as compensatory devices, as assessment tools or as a means for training.
- There is also some recent evidence to suggest that using compensatory aids may increase neuroplasticity in the brain.
- Given, the current expansion in information technology, this is likely to be another area of growth and increasing importance in the next decade.

Recent developments: to be further developed for people with agnosia

- Barcode stickers placed on objects of importance can be readily converted into information that may be more easily processed (such as a spoken label) .
- There are already smartphone apps (e.g. TapTapSee, Looktel) which will return a verbal label of a photographed object.
- Similarly, while a patient with prosopagnosia may have persistent difficulties in recognising others, their phone may already be able identify the unique digital signature of a friend's phone and cue the name (e.g. Apple iPhone "Find Friends" function).

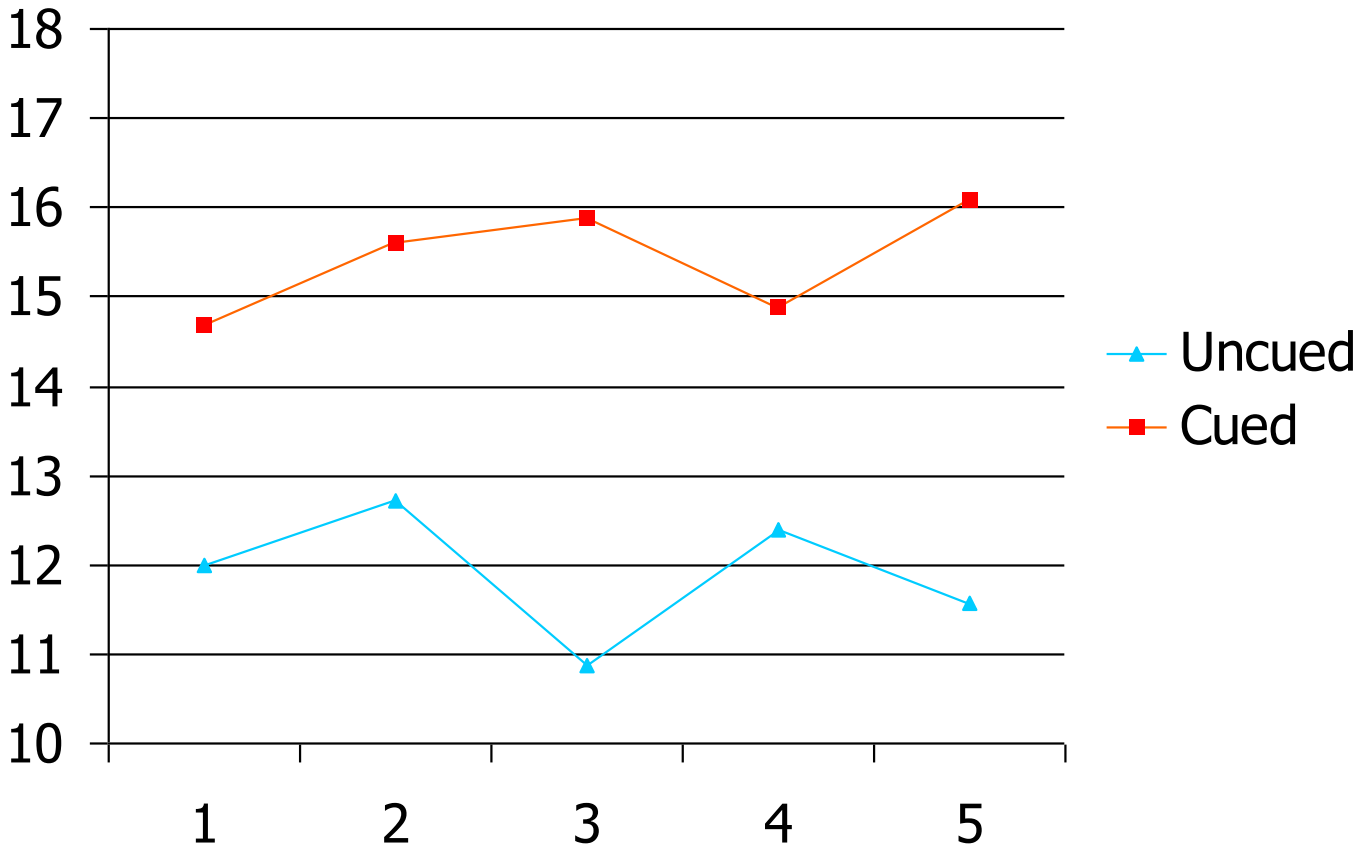
Wearable functional near-infrared spectroscopy in everyday environments

- Burgess and his team have looked at wearable functional near-infrared spectroscopy (fNIRS) in people with executive dysfunction.
- Near-infrared light fNIRS wearable devices monitor changes in brain tissue oxygenation and hemodynamics.
- When a brain region becomes metabolically active, there is an oversupply of cerebral blood flow to meet the increase in oxygen demand.

- The fNIRS wearable device is worn around the forehead. It contains a number of near-infrared lights shining into the brain and optical detectors collect the back-scattered light on to the head.
- Data can be transmitted wirelessly on to a computer while the wearer mobilises freely in the community, interacting with people and performing serial multitasking.
- The potential benefits to our assessment and rehabilitation of people with executive dysfunction is huge.
- It is widely recognised there is often a discrepancy between the way someone with executive dysfunction will behave in a controlled testing environment and everyday life, with deficits clearly evident in the latter scenario but not necessarily in the former (George & Gilbert, 2018).

- Reminders on these systems do not always have to be specific.
- Based on work by Robertson et al. (1997), Manly et al. (1999, 2004) and Fish et al. (2007) found that sending general reminders to “stop, think, organise and plan” led to improvements in a prospective memory task.
- These content free reminders work for people whose prospective memory problems are due to executive deficits such as poor planning or divided attention difficulties. For those with severe memory problems, however, a specific reminder would be required.

Patterns of Performance



Fish, J., Evans, J.J., Nimmo, M., Martin, E., Kersel, D., Bateman, A., Wilson, B.A. and Manly, T. (2007) Neuropsychologia, 45, 1318 - 1330.

Google Glass: Wearers communicate with the Internet

- A Techradar review of Google Glass (Swider, 2017) stated that “Google created the most sought-after sci-fi-looking gadget that everyone wanted to wear at least once.
- Its hands-free picture-taking and head-tracking navigation were visions of our future, and Google Now alerts were put to good use here
- But its everyday uses were limited, and privacy remained a concern.

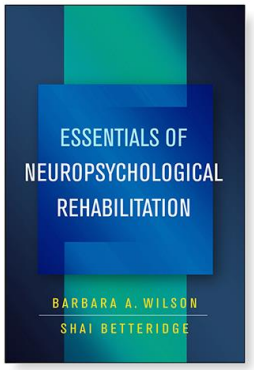
Google glass

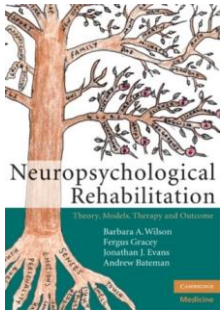
- The advantages are
- 1. Slick, comfortable design
- 2. Easy-to-take hands-free photos
- 3. Google Now rocks
- 4. Head-tracking navigation is surreal and 5. It is a conversation starter.
- The disadvantages are 1. It is outrageously expensive 2. The battery life is very poor 3. The photos need good lighting and 4. There are a limited number of apps.

Use of Robots

- Moyle (2017) discusses the use of robots, particularly for people with dementia, and observes how these can be used to help care for them and reduce the feeling of social isolation.
- McGoldrick and Evans (2018) are also in the process of evaluating an app designed to assist carers of people with dementia (see mindmate-app.com).
- O'Neill et al. (2017) consider several areas where assistive technology can be used not only for cognitive deficits but for difficulties with time perception and recognition of objects, actions, emotions, and faces.

THANK YOU VERY MUCH FOR YOUR ATTENTION





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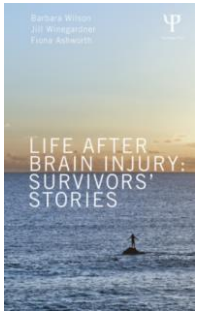

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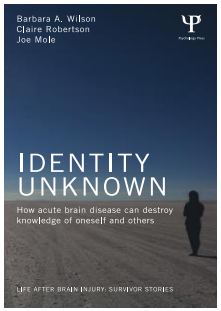

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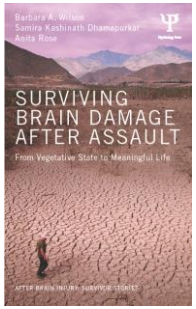

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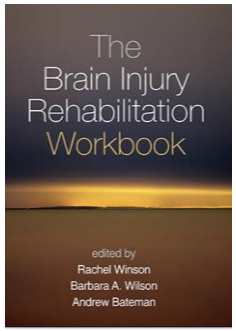

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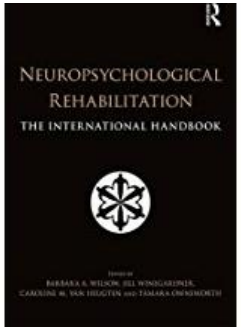

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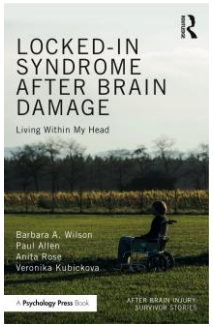

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