A step towards VR therapy for Alzheimer's disease

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What is the problem?

Alzheimer's disease is the most common form of dementia that occurs at older age and affects the ability to remember recent events. As the disease progresses, memory functions worsen, other cognitive functions start to decline, and behavioural changes become noticeable. The lack of effective medicines for patients with dementia has called for other forms of interventions which can help slow down the impact of this progressive disease. Technology, such as virtual reality (VR) tools, can provide robust methods to aid cognitively impaired individuals function and live independently. However, we need ways to assess their cognitive decline and identify the types of errors different individuals make in everyday tasks in order to design effective person-centred VR intervention methods which are tailored to and meaningful to the affected individuals, the benefits of which can be transferred to their real-life experiences.

What are we interested in?

We wanted to develop a cognitive assessment tool that monitors the ability to perform everyday-life tasks with the aim of using it to detect cognitive decline in Alzheimer's disease patients.
We wanted to determine the type of errors that take place (e.g. missing actions, performing actions in the wrong order, performing actions that should not take place) and identify which errors become more prevalent when everyday tasks become unfamiliar (simulating the difficulties faced by dementia sufferers) so that we can use this knowledge in developing VR interventions for patients with Alzheimer's disease. We also wanted to investigate the activity of the brain while tasks become unfamiliar.

What did we do?

We asked a group of 48 healthy young adults to perform a multiple errand task (MET) and to undergo neuropsychological tests of their memory, ability to reason and solve problems. The MET required participants to memorise 6 kitchen errand tasks (for example, making a sandwich, see Figure 1), each compromising from 8 to 10 subtasks (total of 54 subtasks) to be performed in the correct order. After a brief introduction and practice session, half of the participants were asked to perform a familiar kitchen errand task (MET) and half of the participants were asked to perform an unfamiliar kitchen errand task (MET). Whilst performing these tasks, participants experienced 5 controlled interferences to which they had to react as previously instructed (e.g. when a dog barks they should touch the kettle). The experimenter scored the participants' performance (e.g. actions correctly performed, actions forgotten etc).

An EEG (electroencephalogram) was collected from participants performing the unfamiliar kitchen errand task to measure their brain activity and explore how brain waves in parts of the brain relate to the participants' performance (see Figure 2).

Figure 1 An example of a multiple errand task (MET).

Figure 2 A participant **(A)** being prepared to **(B)** have their brain activity recorded as an EEG.

What did we find?

We found that we could monitor and assess the ability to perform everyday-life tasks in the group we studied and that making a kitchen task unfamiliar had a drastic effect on performance of the task (see Figure 3). This resembles the everyday life struggles that people with dementia faces in their life (as confirmed by our ongoing studies). We found that particular types of errors were seen more frequently in the unfamiliar kitchen, for example, more actions were missed, performed in the wrong order and actions performed that should not have been. The EEG results are providing clues about specific brain patterns that become evident when everyday tasks become problematic to perform.

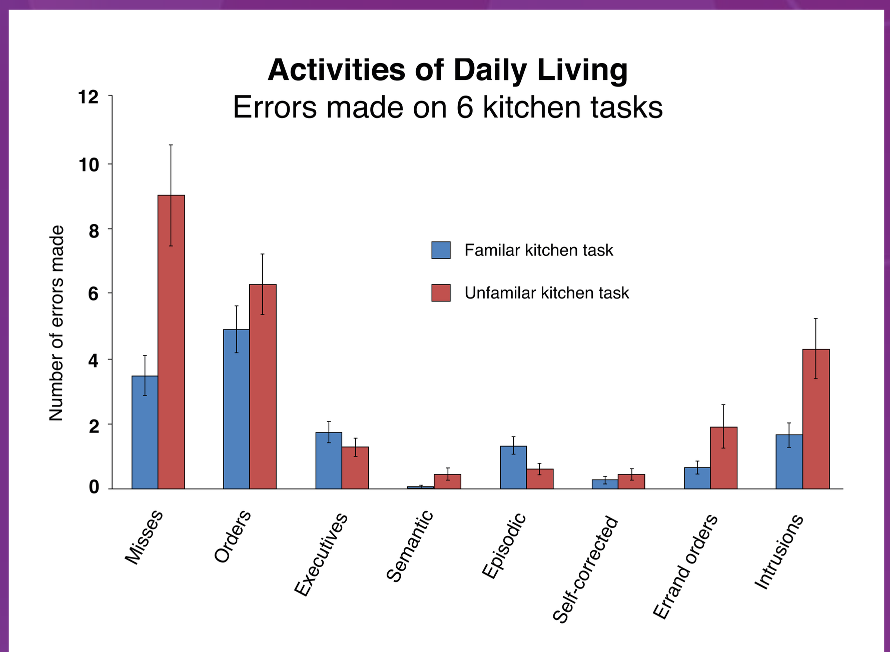

Figure 3 Graph showing which specific types of errors are made during each MET. As the task became more challenging (unfamiliar) participants performed significantly more misses, semantic errors, episodic errors and intrusions. [Misses (actions not performed); Orders (actions performed in wrong order); Executives (wrong action performed to associated sound); Semantic errors (e.g. taking wraps instead of bread when the task was to make a sandwich); Episodic errors (e.g. taking soft cheese instead of cheddar cheese); Self-corrected (self-correcting action); Errand orders (main tasks performed in wrong order); Intrusions (additional actions performed that has not been instructed).]

What does this mean?

We are using the findings of our study to develop VR kitchen scenarios to determine if a VR setting can be used to assess performance of familiar and unfamiliar kitchen tasks (see Figure 4). Ultimately, we hope that we can use our VR setting to identifying the type of errors different patients with Alzheimer's disease make. This would help to develop intervention strategies tailored to the applications which a particular individual finds especially challenging in their everyday life (for example, those due to memory, attention, concentration, planning or other cognitive impairments). By making interventions' scenarios familiar and friendly in a VR setting, we hope that patients' frustration will be reduced, and treatment compliance increased.

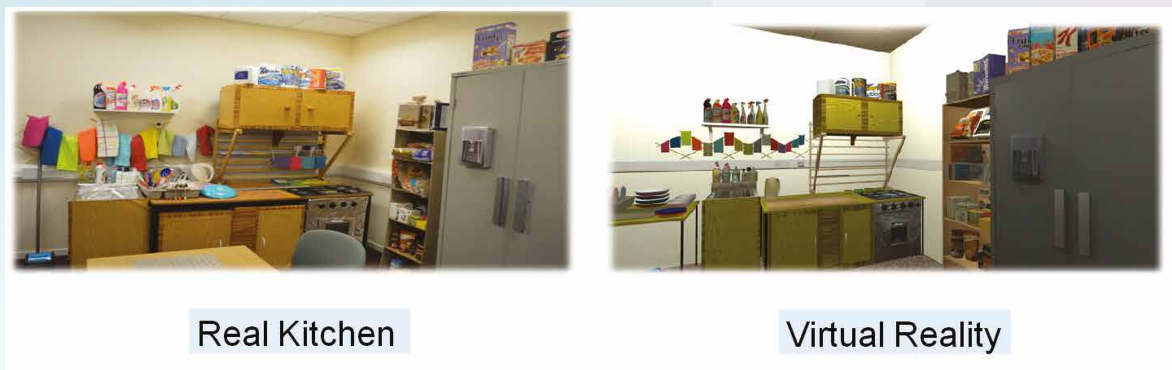

Figure 4 The real-life and VR kitchen settings.

Who am I?

I am a former psychology graduate from Heriot-Watt University who received a Vacation Scholarship from Medical Research Scotland in 2017 in the final year of my degree, after which I was appointed as a Research Assistant to further explore the ways of restoring and rehabilitating cognitive functions in a way akin to how people function in everyday life settings. I work with the Detecting Alzheimer's & Enhancing Memory team (DAEM) at Heriot-Watt University which is interested in the development of assessment and intervention methods for individuals experiencing cognitive decline. You can out more information about the work of the DAEM team at https://www.neurophysiologylab.hw.ac.uk/about.html. I would to acknowledge the Alzheimer Scotland Dementia Research Centre and the Centre for Cognitive Ageing and Cognitive Epidemiology for helping fund this work.

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Centre for Cognitive Ageing and Cognitive Epidemiology

Alzheimer Scotland Dementia Research Centre