Does fatigue predictably alter visual attention and memory retrieval efficiencies in older people?

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Currently, work-related mental fatigue, sometimes described as burnout, is strongly associated with both mental and physical health issues[1]. Worryingly it is increasing in the population[2]. The increase in burnout has been particularly prevalent in older people, with a 5% increase in burnout complaints in sample of 65-74 year olds between 2015 and '17[2]. Potential evidence-based strategies to reduce older people's cognitive load in work is currently underexplored. In this interdisciplinary project, we will investigate how different types of fatigue impact specific aspects of memory performance in older people. This will form part of our larger plan to assess the cognitive interactions between fatigue and ageing and develop strategies to reduce cognitive fatigue.

Both ageing[3] and fatigue[4] cause a shift in the hemispheric responsibility for allocating attention from the right, to the left hemisphere. One region known to be important in guiding attention is the inferior parietal lobule (IPL)[5]. Recent work by authors OG and DM proposed, and provided novel and compelling evidence, that attention allocation and memory retrieval processing in the IPL both depend on the type of information being processed. This work is briefly described below.

Gray *et al.,* (in preparation) presents a review of memory retrieval studies using brain imaging (122 contrasts, 65 studies). It demonstrates that across the literature, the right IPL is much more consistently activated during the retrieval of the perceptual than the semantic aspects of episodic memories (96% versus 46%). In contrast, left IPL activation is more consistently associated with the retrieval of the semantic, than the perceptual aspects of memory (95% / 83%).

Next (Gray, McFarquhar, Montaldi, in preparation), demonstrate how this same relationship dictates the lateralisation of attention allocation to visual space. We observed the established pseudoneglect attention effect (a left visual field bias, reflecting a right hemisphere processing bias) with highly perceptual line bisection tasks. In contrast, the bisection of objects revealed the opposite visual field bias, with the left hemisphere dictating a right visual field bias.

We predict that the effects of ageing and fatigue on attention will also impact memory retrieval processes. As occurs in attention, we hypothesise that these factors will shift the memory retrieval processing responsibility to the left hemisphere and force subjects to rely more heavily on the semantic aspects than the perceptual aspects of memories. This will impair performance particularly when memory accuracy depends on perceptual memory (e.g. "where did I park the car this morning?").

Procedures

We will recruit 25 young adults and 25 older adults to this research study. All participants will be asked to complete the Implicit Primed Attention (IPA) task, developed in our lab. On each trial of this task, participants make a judgement on a centrally presented image. After each judgement, they are quickly shown an "X"-target in their peripheral vision. Like a traditional Posner cueing task, the accuracy and speed of identification (reaction time) of the peripherally presented targets provides an index of the difference in fronto-parietal attention network activity between the two hemispheres[5–7].

Rather than presenting an explicit cue to attend to one side of space, we will assess the spatial attention modulation imparted by each of four different central image judgements: 1) A perceptual non-memory judgement – identifying whether the shape in the image is a circle and a polygon; 2) A semantic non-memory judgement – naming silhouette images; 3) A perceptual memory task; 4) A semantic memory task. Both memory tasks will present single object images that were either presented in a pre-task study phase or are either unseen/new. They will be asked to identify which

images were studied. In the perceptual memory task, each unseen/new object will be within the same semantic category as a studied item. As a result, subjects will need to use the perceptual features of the remembered item to make their judgement. In contrast, the semantic memory task will present unrelated unseen/new object images, allowing participants to use the object category to classify the item as studied or unseen. We will increase the distinction between these strategies by pre-exposing participants to the test formats and directly encouraging them to encode the perceptual features and semantic labels of each item for their respective test phases.

For each of the judgement types, we will compare both the identification accuracy and reaction times for X-targets presented on the left and right side of visual space. In addition, we will assess the effect of age (young/older) and fatigue on these measures. Fatigue will be manipulated in two ways. Firstly, we will repeat the procedure (the four blocks, each with their own judgement) three times. Secondly, participants will be tested both in the morning (9am) and the evening (6pm, with a counterbalanced session order to mitigate the confounding effects of practice). We will measure fatigue using methods like the Chadler Fatigue, and Fatigue Assessment scales that have previously been utilised and developed by AW[8–11]. We predict that young adults will be more resilient to effects of fatigue than older adults and, as a result, will display faster and more accurate detection of X-targets in the left visual field for the perceptual judgement tasks. Their semantic judgement tasks should produce only a small speed and accuracy bias to the right side of visual space. In contrast, older adults should be more susceptible to fatigue-related changes in their detections. Their age should produce either a small leftward visual field advantage or relatively equal reaction times and accuracy for each side of space for the perceptual tasks. Marked advantages for the right side of visual space should be visible in the semantic judgement tasks. These lateralisation biases should become even more striking with increasing levels of fatigue.

Logistics and Cost

The funds from this grant will be used to employ a Research Assistant (Grade 5.3) at 50% FTE for 16 weeks (£5922). The first three weeks will be used for training, and further piloting and adjustment of the task. We will collect the data during the subsequent four weeks. The last week of the Research Assistant's time will be spent formatting the data for effective storage and conducting preliminary planned analyses. OG will provide day-to-day supervision, practical assistance, and guidance throughout this process. AW and DM will provide oversight, and both practical support and theoretical guidance. Funds have already been secured for participant payments (50 (participants) x £15 (2 hours/session) x 2 (2 sessions/participant) = £1500).

Future Work and Impact Objectives

This project will contribute in several different ways. First, the results of this project will be worthy of publication in a strong scientific journal. Second, the project will form the basis of a Medical Research Council grant application to be submitted in 2020. This MRC project will assess, using transcranial magnetic stimulation, the causal role of the IPL in driving memory retrieval and attention allocation mechanisms in the elderly; assess the prevalence of fatigue-related hemispatial neglect symptoms in daily living using immersive VR environments and eye-tracking; and investigate the power of these relationships to provide early diagnosis of disease states, e.g. Alzheimer's Disease, Chronic Fatigue Syndrome. Third, we will develop better public understanding regarding the cognitive management of fatigue in older people. Our work will inspire strategic changes to fatigue management to enhance productivity, create an increasingly resilient workforce, and improve the quality of life and well-being of older people.

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