Background
Little is known about age-related changes in episodic memory in middle age. Less still is known about age-related differences in the context of induced cognitive fatigue. Yet insight into changes present during middle age and the effects of factors encountered during daily life, such as fatigue, are important to our understanding of the process of cognitive aging and the ecological validity of this understanding.

Introduction
Healthy cognitive aging is thought to impact most heavily on episodic memory [1]. However, changes in episodic memory prior to the age of 60 are more controversial than changes in older adults [2]. Furthermore, cognitive decline already present in middle age may not yet manifest in behavior due to the action of neural repair processes that preserve performance at the behavioral level. Therefore, fMRI can provide valuable insights into age-related changes present in middle age [3]. It is also important to determine the extent to which middle-aged adults must compensate for the effects of cognitive aging in order to maintain performance not just in the short-term, but following sustained, fatigue inducing task performance likely, for example, to be commonly encountered during the workday. Therefore, in the current study, each participant was tested twice: once following a fatigue condition involving inducing task performance likely, for example, to be commonly encountered during the workday.

Methods
Participants: 14 young (25-35) and 15 middle-aged (50-60) male teachers.
Procedure: Participants completed the fatigue manipulation before entering the scanner to perform the episodic memory task.
Manipulation: Baseline condition - 1.5 hrs of low demand tasks.
Fatigue condition – 1.5 hrs of cognitively demanding tasks.
Subjective fatigue measure: Profile of Mood States fatigue subscale (before and after the fatigue manipulation, and after the scanning session).

Episodic memory task: Encoding – categorisation of 100 words into 4 semantic categories
Recognition – presentation of the 100 encoding phase words plus 100 new words. Participants indicated whether words were ‘old’, ‘maybe old’, ‘maybe new’, or ‘new’.

fMRI analysis: SPM8 was used to examine 'successful encoding' using the subsequent memory paradigm [4]; encoding task items subsequently remembered on the recognition task minus subsequently forgotten items.

Objective
We examined differences in episodic memory encoding performance and brain activation between young and middle-aged adults at baseline and in the context of induced cognitive fatigue. Furthermore, we examined the effect of induced fatigue compared to baseline within each of these age groups.

We hypothesized that fMRI would show brain activation differences between the two age groups at baseline (specifically, increased brain activation in frontal regions in middle-aged adults reflecting neural compensation), and that induced fatigue would increase the level of demand experienced on the task (leading to an exacerbation of activation differences between the two age groups, or an exhaustion of cognitive resources in the middle-aged group).

Results
Subjective ratings: Fatigue ratings (Figure 1) increased significantly following the fatigue manipulation (time point 1), but did not differ between age groups.

Conclusions
1. At baseline, activation was greater, primarily in PFC regions, in middle-aged compared to young adults. This suggests increased exertion of top-down cognitive control in middle-aged adults during successful encoding.

2. In the fatigue condition, activation differences between the two age groups were no longer apparent. Activation in both age groups, but particularly the middle-aged group, decreased in comparison to baseline activation. Therefore, in a state of induced fatigue, middle-aged adults no longer showed greater exertion of cognitive control than young adults, and instead showed activation changes suggestive of an exhaustion of cognitive resources.

References