Behind the eyes of a watchkeeping officer

An unexpected research outcome with potential applications for watchkeeping practice

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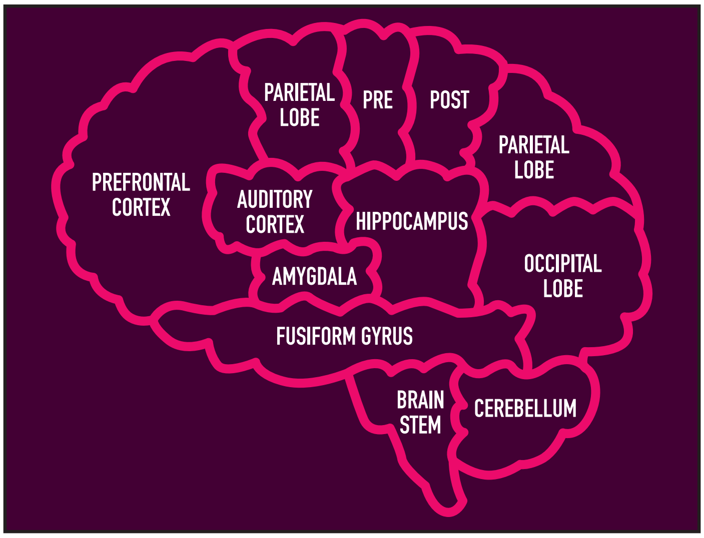
It can be particularly challenging to sustain attention when the task being performed is monotonous and intellectually undemanding, as can be the case with watchkeeping, especially when conducted whilst a vessel is at deep sea. This inevitably leads to the disengagement from the task at hand. Every watchkeeping seafarer knows that their mind can sometimes wander, and probably has tales to tell of it.

Seafarers are regularly warned of the dangers of distraction while being on watch, and failure to pay attention is often cited as a factor in accident reports. Failure of sustained attention can reduce the likelihood of detecting a hazard, and limit the time available for decision making and taking action.

Liverpool John Moores' University's Project Nereus set out to use the tools of neuroscience to examine how and why failure of attention occurs, and what can be done to prevent it – and found some results on focus and distraction which may at first appear surprising.

The neuroscience of watchkeeping

Neuroscience research has been found to enhance understanding of safety-critical behaviour and deliver practical benefits for operator training, design of technology, and operational protocols in a range of fields. In particular, the task of sustaining attention over a long period of time has been extensively studied in human factors psychology.



Navigational watchkeeping falls within this category and is termed as a 'vigilance task'.

Both sustained attentional and cognitive control are fundamental to the activity of watchkeeping. Previous research, conducted on car drivers and aeroplane pilots, identified neurological clusters in the prefrontal cortex (PFC) of the brain that are associated with the increased activation of connections during a vigilance task. Further work in the field of neuroimaging suggests that the performance of these clusters declines the longer the task goes on. Project Nereus explored if this pattern was replicated in the mind of a watchkeeping seafarer.

Methodology

Sixty participants of comparable age, qualifications, rank and seagoing experience were recruited from amongst the membership of the North West England and North Wales Branch of The Nautical Institute and seafarers undergoing training at Liverpool John Moores University's Maritime Centre.

A visual vigilance task was set up in LJMU's 360 ship simulator. Each participant was required to keep watch over an 180° field of view of the open sea, monitoring the forward view from the bridge for the appearance of other vessels. A baseline measurement of PFC activity was taken for each participant. They were then put through one of two exercise scenarios within the simulator:

SCENARIO ONE

An exercise of 30 minutes in duration which required sustained attention to locate a single target vessel that provided a poor radar return. Participants were not informed that there was only one 'target vessel' within the exercise. They were simply instructed to indicate whenever they spotted another vessel. They were to do this by pushing a button to sound an audible alarm and indicating the other vessel's position by pointing towards it on the screen.

SCENARIO TWO

An exercise of 30 minutes in duration. In addition to everything that the first group did, participants were also required to make a verbal report every time their vessel encountered a 'report point'. These occurred at intervals of three minutes throughout the exercise. The purpose of this additional task was to increase the mental workload of the watchkeeper. It was thought that additional reporting would degrade participant's performance by distracting them from the main task, which was to spot the target vessel.

In both scenarios, the target vessel's starting position was over the horizon, approaching the participant's ship on a course that would lead to a collision if a change of course was not made by the participant's vessel. The speed of approach of the target vessel was constant, to ensure that the watchkeeper always had the same amount of time to spot it.

Functional near-infrared spectroscopy (fNIRS)

Activations within the participants' PFC were captured via functional near-infrared spectroscopy (fNIRS). fNIRS is an optical brain monitoring technique that uses near-infrared light to measure the flow of blood to various areas of the brain. Unlike other methods which measure electric or magnetic fields, fNIRS monitors changes in the concentration of haemoglobin within areas of the brain associated with neural activation. It achieves this by 'looking' through the scalp and identifying changes in the absorption of near infrared light.

fNIRS has previously been utilised to study neurophysiological activation of the brain in both simulated and real-world environments. Previous research has found that increased cognitive demand is associated with an increased level of oxygenated blood and an accompanying increase in the degree of activation of clusters of connections within the PFC.

What we expected

Taking into account the results of previous research in the field of neuroscience related vigilance tasks, Project Nereus considered a number of hypotheses:

1. The PFC would be activated during sustained attention as participants sought to spot the other vessel.
2. Activity within the PFC would decline over time as the duration of required sustained attention increased and participants began to experience task-related fatigue.
3. Individuals participating in scenario two would demonstrate a degraded level of performance in the vigilance task.

An unexpected outcome

The data from the 60 participants was collected, processed and analysed. Hypothesis one was found to be correct, in that baseline measurements of brain activity taken before each scenario began were significantly lower than those maintained during each scenario. The PFC was indeed activated during sustained attention as participants sought to spot the other vessel.

Hypothesis two was also found to be correct. Activity in neurological clusters of the PFC declined over time as the period of sustained attention went on and participants began to experience task-related fatigue (see Figure 1).

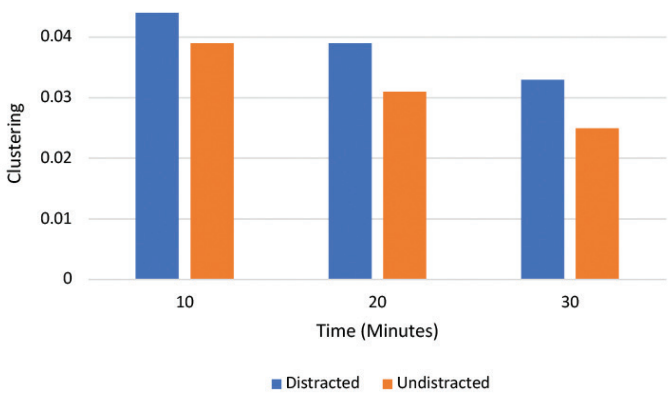


Figure 1: Activity in the PFC (distracted vs undistracted)

However, when it came to hypothesis three, the results appeared to be counterintuitive. Neurological clusters in the PFC of the brain were more active in the 'distracted' participants than the 'undistracted'.

Distraction and monotony

It was hypothesised that the introduction of an additional distraction task would degrade performance in spotting the target vessel, but no evidence was found to support this prediction. Unexpectedly, over a 30-minute vigilance task, the brains of the 'distracted' group performed better than those of the 'non-distracted' group. The decline of activity in the PFC during watchkeeping did not occur for the 'distracted' group to the same extent that it occurred for the 'undistracted' group.

The resources that are necessary to sustain focus on a specific task are finite and decline over time, reducing the quality of attention that is focused on the task. Because of this, participants who had to perform the additional reporting task were expected to demonstrate a steeper drop in performance. However, the increased level of cognitive demand experienced by the 'distracted' individuals appears to have helped them sustain their attention. Rather than degrading their performance, engagement in the reporting process increased activation within the PFC and appeared to improve the watchkeepers mental performance.

Something to do

This study demonstrated a significant association between cognitive demand and watchkeeping efficiency. Although the duration of the watch was limited to 30 minutes, in a bid to facilitate the collection of data, participants with little to do still experienced task-related fatigue. This suggests that to maintain attention during the less 'action-packed' four-hour (or longer) watches, watchkeeping officers need to have something to do. What that 'something' is remains to be seen.

A level of cognitive demand must always be present whilst watchkeeping, but how to generate this on those long quiet watches? One suggestion is to occupy the watchkeeper's brain with a process of relevance to the task of watchkeeping. The most obviously useful of the options suggested for the OOW faced with a featureless horizon and no other vessels readily apparent in the vicinity is to follow a set search pattern of the bridge equipment and the outside world.

It is essential for every watchkeeping officer to develop their own method that works for them. However, to provide them with something to start with, LJMU has introduced two 'starter' scanning patterns into the training provided to trainee OOWs. One of these is the 'window wiper scanning' method, introduced in November 2022's edition of *Seaways*.

Whilst we are most definitely not suggesting chart corrections or other such administrative tasks, simply staring out of the window with nothing stimulating taking place is not an optimal approach to watchkeeping. Likewise, simply positioning an assistant watchkeeper or Able Seaman with a pair of binoculars and telling them to look out of the window may not be the most efficient use of them as a watchkeeping resource.

While this has implications for safety on increasingly automated ships bridges, it is also a concern for a wide range of control rooms, including those which may begin to appear with the emergence of Maritime Autonomous Surface Ships (MASS) where an operator is tasked with overseeing the activities of multiple vessels.

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