Distracted Boating Experiment
US Coast Guard
Report on effects of Scan Training on Operator Attention

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Introduction

The US Coast Guard and National Safe Boating Council (NSBC) approached EMOTIV Inc. and its subsidiary EMOTIV Research Pty Ltd to perform a preliminary assessment of the effectiveness of a proposed training program for casual small-boat operators. The method taught consists of a formalised repeated scanning pattern and continual risk assessment while the boat is in operation.

Experiment

Four healthy adult subjects (one female, three male) were selected with varying degrees of prior experience. Each subject was fitted with an EMOTIV EPOC+ EEG headset which records brain activity and the session and surrounds of the boat were recorded on video.

The subjects chosen were Emily (novice), Rich (some experience), Nate (some experience) and JPW (very experienced). Three phases of measurement were performed.

1. Pre-training: Each subject initially navigated a boat through a live environment while EEG data was recorded, and an observer on the boat logged significant events and was available to provide supervision in the event of difficulties. The sessions lasted 10.6 mins, 25.9 mins, 11.8 mins and 32.8 mins for Emily, Rich, Nate and JPW respectively.

2. Training: Each subject received individual tuition in the proposed method while navigating the vessel under supervision of the observer, who logged events of interest. The training sessions lasted 11.1 mins, 15.4 mins, 10.2 mins and 17.7 mins for Emily, Rich, Nate and JPW respectively. Longer times were required for Rich and JPW due to the requirement to readjust the headset during the session and continue the recording.

3. Post-training: Each subject repeated the navigation activity while applying the methods learned during the training session. The sessions lasted 10.0 mins, 23.8 mins, 11.6 mins and 17.5 mins for Emily, Rich, Nate and JPW respectively.

Analysis

EMOTIV Research has developed a validated metric which is able to determine the level of Attention (distraction) experienced by the operator, time locked to events within the experiment. The Attention detection was applied to the data recorded during the experiment and was subsequently analysed to reveal differences for each subject before, during and after the training session. Examples of the raw EEG data and the Attention metric are shown in Figures 1 and 2 respectively.

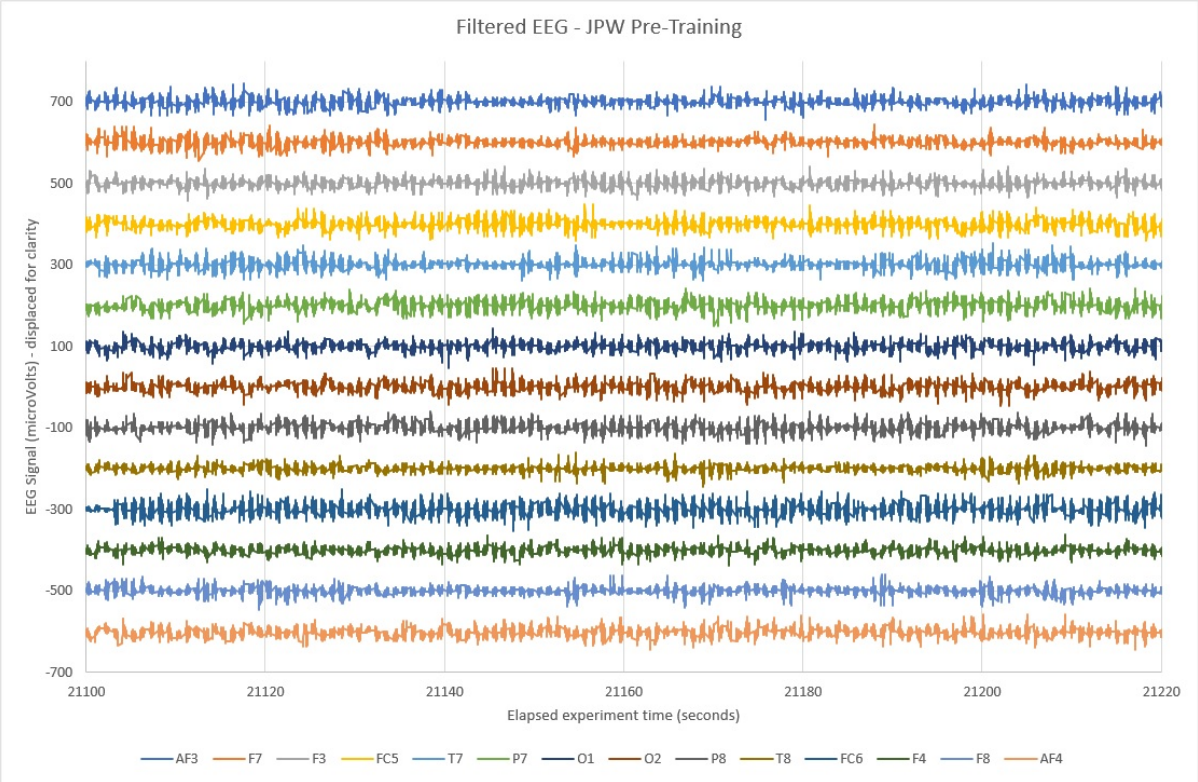

Figure 1: Filtered EEG data, JPW Pre-Training. Eye blinks removed, filter 4-40Hz passband. Note: traces show Left Frontal activity (AF3, F7, F3, FC5), Left Temporal/Parietal (T7, P7), Left and Right Visual Cortex (O1, O2), Right Temporal/Parietal (P8, T8) and Right Frontal activity (FC6, F4, F8, AF4) in order from top to bottom traces.

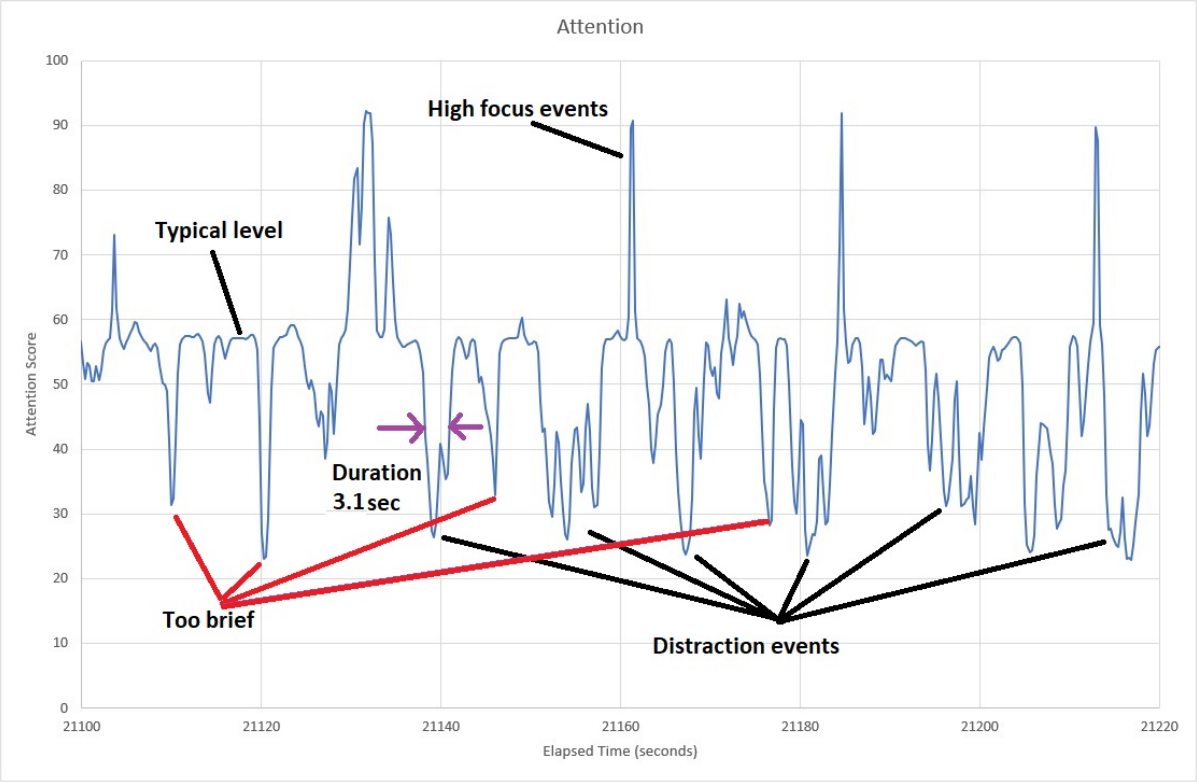

Figure 2: Attention detection output, same time period as Figure 1.

Two metrics of interest were calculated from each session, as follows.

DISTRACTION RATE – this corresponds to the average number of flagged distraction events per minute (that is, those events greater than 2 seconds duration, deemed to be of significance in a situation such as driving or navigating a boat).

VIGILANCE – this is the calculated from the total accumulated time of all distraction events T_D and the total duration of the experimental session T, as VIGILANCE = $(T - T_D) / T$ x100%
Vigilance can be considered to be the percentage of the available time which is achieved without distraction events.

Results

The results of this analysis are tabulated here in Table 1 and shown graphically in Figures 3 and 4.

Table 1: Improvements in DISTRACTION RATE and VIGILANCE as a result of SCAN training

DISTRACTION RATE				
	Pre_Training	**Training**	**Post_Training**	**Improvement**
Emily	**7.71**	**6.88**	**3.68**	**52%**
Rich	**5.81**	**2.66**	**3.12**	**46%**
Nate	**4.28**	**5.83**	**3.11**	**27%**
JPW	**2.71**	**2.08**	**0.66**	**76%**

VIGILANCE				
	Pre_Training	**Training**	**Post_Training**	**Improvement**
Emily	**45.2%**	**51.1%**	**82.0%**	**81%**
Rich	**54.2%**	**86.7%**	**83.8%**	**55%**
Nate	**77.2%**	**65.1%**	**86.2%**	**12%**
JPW	**85.3%**	**88.8%**	**96.8%**	**13%**

All improvements between Pre-Training and Post-Training were statistically significant ($p<0.05$)

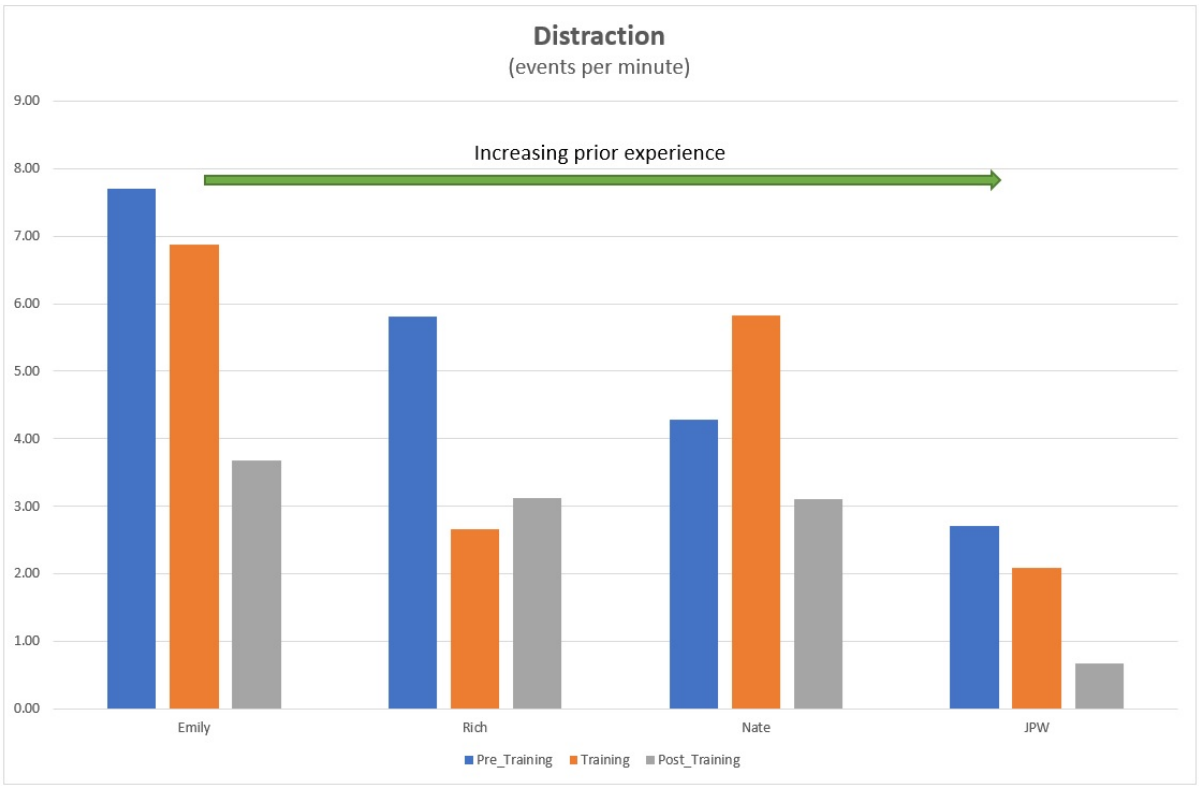

Figure 3: DISTRACTION RATE by subject, before, during and after training

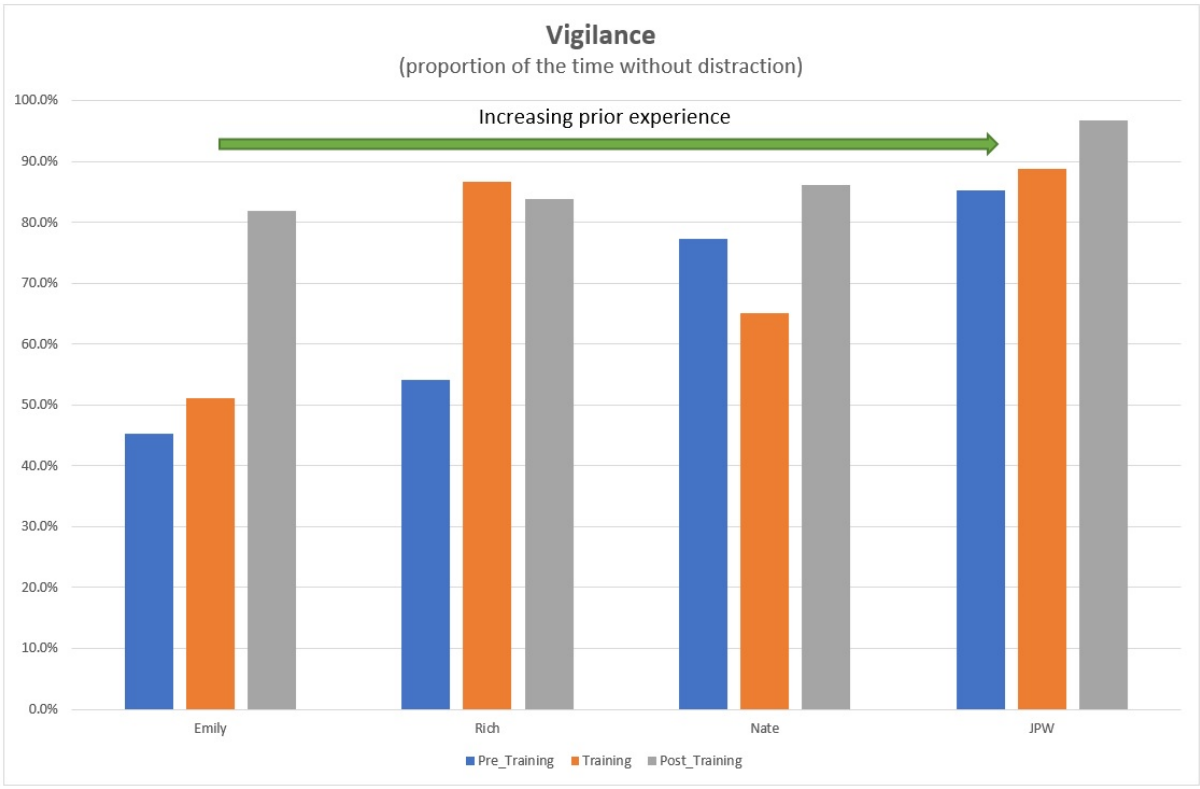

Figure 4: VIGILANCE by subject, before, during and after training

Conclusion

This study explored the effectiveness of NSBC's safe boating program in the development of an attention measurement protocol. Psychological attention levels were recorded by EMOTIV's neuroheadsets, and tracked across three experimental phases; pre-training, training and post-training.

Comparisons between phases showed that the SCAN technique significantly improved operator attention while boating, irrespective of the level of experience. Major reductions were seen in distraction rate, to levels typical of experienced operators. Considerable improvements in vigilance were seen in the inexperienced operators, to levels comparable to those of experienced operators before training - from 45%-80% up time to over 85% in all cases. Even for the experienced operator, vigilance levels rose from ~85% up time to over 95% by post-training.

The results of this preliminary assessment suggest that maintaining proper lookout procedures, as specified through SCAN training, is effective in decreasing distraction and increasing vigilance in small-boat operators.