Evaluating sea experience with an eye mark recorder in a ship handling simulator

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Abstract

This study analyses the navigator's eye movement on the navigation bridge simulator. The main objective of this study is to find the differences between the sea experience level and educational level to evaluate the navigator's sea experience; this by fixation points in the ship-handling simulator. A measurement device ("EMR-8") is used for recording eye movements. There are three kinds of examinee groups, each group has 4 examinees.

Group 1 is 2nd class, deck department students who have up to 2.5 months sea experience onboard training as a cadet. Group 2 is 4th class, deck department students who have up to 12 months. Group 3 is ocean-going masters who have different experiences as master or chief officer. The same scenario was used by each examinee. The visual field was divided into three parts inside, outside and others. Significant results, as shown below, were obtained by the comparison with differences among the groups.

In Group 1, the examinees paid less attention to sailing. They had a remarkable difference in fixation duration between the inside and the outside; their fixation duration for "other places" was much longer than the other groups, and they had very little experience in using the inside equipment. In Group 2, the examinees showed differences in capabilities as a navigation officer which could be based on their sea experience and educational program. In Group 3, the examinees were professional seafarers, so they were able to pay more attention to all kinds of navigational information such as target ships or navigational aids. The study shows that sea experience as a seafarer or a cadet could be evaluated by using the eye mark recorder utilizing the ship-handling simulator.

Keywords: human factors, eye movements, sea experience, ship handling simulator.

1 Introduction

Navigation technology has been rapidly developing in recent years. The fixing of position and the handling of ships are more easily done than before because of information technology [1,2]. This study analyses the navigator's eye movements and uses the same environmental conditions for carrying out the same simulator scenario. The main objective of this study is to find the differences between the sea experience level and educational level, and to evaluate the navigator's sea experience by viewing points when using the ship-handling simulator.

2 Experimental study

A measurement device "EMR-8" was used for recording the eye-movements of examinees at the Istanbul Technical University Maritime Faculty (ITUMF) Ship Handling Simulator. The examinees were divided into three groups according to their experience levels. Each group had four examinees at ITUMF [3].

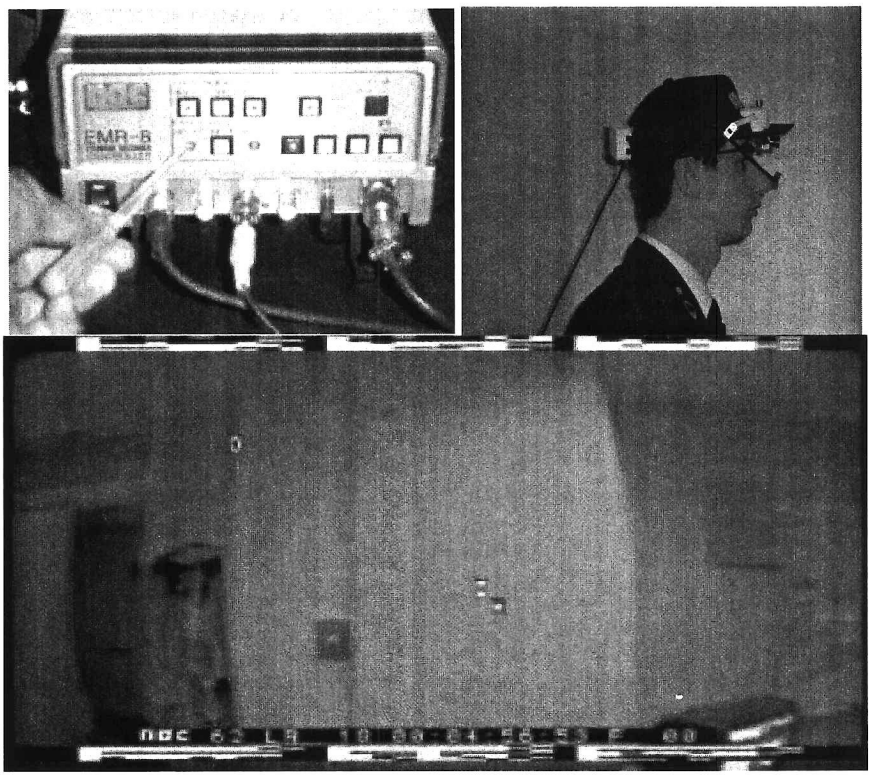

Figure 1: EMR-8 Instrument [5].

Group 1 was 2nd class deck department students who had up to 2.5 months sea experience onboard training as cadets. Group 2 is 4th class, deck department students who had up to 12 months sea experience. Group 3 was ocean-going masters who had different sea time as either master or chief officer. All examinees were equipped with the EMR-8 instrument, and it was the same scenario of passing through the Istanbul Strait, Turkey. The EMR-8 had a recording unit, which could record all the areas looked at by the examinees and with eye-marks. 20,000 raw data was obtained for each examinee in 10 minutes.

Figure 1 shows how to use EMR-8 during experimental studies. The left side of the figure is the main part of EMR-8 used for calibration and synchronization with eye movements. The right part of the figure is human interface of EMR-8 which is used for recording both eye movements and looking area. The apparent screen, which records data by human interface, is on the lower side of Figure 1.

2.1 Analyzing method

The visual field was divided into three parts: inside, outside and others. The "inside" part had three components: instruments, indicators and engine telegraph. The "outside" part had three different components the sea condition, navigational aids around the navigable area and target ships. "Others" means all meaningless images and saccade of eye-movements. Their viewing points and durations were recorded by a continuous weaving sight line on the image picture. The raw data was tabled by using the "frame by frame method".

Table 1: Tabled by "Frame by frame" method [4].

	nautical ins.	indicators	eng. telegr.	nav. aids	Target	sea	other
08:05:50							
08:05:52							
08:05:54							
08:05:56							
08:05:58							
08:06:00							
08:06:02							
08:06:04							

Every cell shows 1/30 per second, and coloured cells show the duration of looking period to fixation points in the experimental studies.

3 Results

Table 2, Figure 2 and Figure 3 show a remarkable difference in the using of nautical instruments between Group 1 and the others. Members of Group 1 used the nautical instruments less than others. There is also a big difference within Group 1 between the members use of nautical instruments. But conversely, there is more homogeneity within the other groups. Group 1 looked to "other" places more than the others.

Table 2: Percentage and duration of examinees to fixation points.

	INSIDE PART			OUTSIDE PART						
	nautic ins.	indicator	telegraph	nav. Aids	target	sea	other		INSIDE	OUTSIDE
GROUP1-1	7181	449	0	523	123	1675	2102	12053	7630	2321
	59,58%	3,73%	0,00%	4,34%	1,02%	13,90%	17,44%	100,00%	76,68%	23,32%
GROUP1-2	877	146	80	1971	988	5153	2440	11655	1103	8112
	7,52%	1,25%	0,69%	16,91%	8,48%	44,21%	20,94%	100,00%	11,97%	88,03%
GROUP1-3	981	492	954	624	290	10402	688	14431	2427	11316
	6,80%	3,41%	6,61%	4,32%	2,01%	72,08%	4,77%	100,00%	17,66%	82,34%
GROUP1-4	6281	648	354	654	355	1842	1835	11969,0	7283,00	2851,0
	52,48%	5,41%	2,96%	5,46%	2,97%	15,39%	15,33%	100,00%	71,87%	28,13%
GROUP2-1	4795	206	0	1628	450	3892	298	11269	5001	5970
	42,55%	1,83%	0,00%	14,45%	3,99%	34,54%	2,64%	100,00%	45,58%	54,42%
GROUP2-2	6320	631	0	980	378	2704	988	12001	6951	4062
	52,66%	5,26%	0,00%	8,17%	3,15%	22,53%	8,23%	100,00%	63,12%	36,88%
GROUP2-3	6438	1272	0	654	124	3235	224	11947	7710	4013
	53,89%	10,65%	0,00%	5,47%	1,04%	27,08%	1,87%	100,00%	65,77%	34,23%
GROUP2-4	7703	1071	0	71	0	2349	536	11730	8774	2420
	65,67%	9,13%	0,00%	0,61%	0,00%	20,03%	4,57%	100,00%	78,38%	21,62%
GROUP3-1	4588	34	0	883	2587	3601	488	12181	4622	7071
	37,67%	0,28%	0,00%	7,25%	21,24%	29,56%	4,01%	100,00%	39,53%	60,47%
GROUP3-2	4458	492	0	1329	714	4415	271	11679	4950	6458
	38,17%	4,21%	0,00%	11,38%	6,11%	37,80%	2,32%	100,00%	43,39%	56,61%
GROUP3-3	6960	34	9	1574	655	894	2366	12492	7003	3123
	55,72%	0,27%	0,07%	12,60%	5,24%	7,16%	18,94%	100,00%	69,16%	30,84%
GROUP3-4	4477	1306	0	2276	194	2778	1053	12084,0	5783	5248
	37,05%	10,81%	0,00%	18,83%	1,61%	22,99%	8,71%	100,00%	52,42%	47,58%
GROUP1	31,59%	3,45%	2,56%	7,76%	3,62%	36,40%	14,62%	100,00%	37,66%	62,34%
GROUP2	53,69%	6,72%	0,00%	7,17%	2,05%	26,04%	4,33%	100,00%	60,43%	39,57%
GROUP3	42,15%	3,89%	0,02%	12,52%	8,55%	24,38%	8,50%	100,00%	46,10%	53,90%

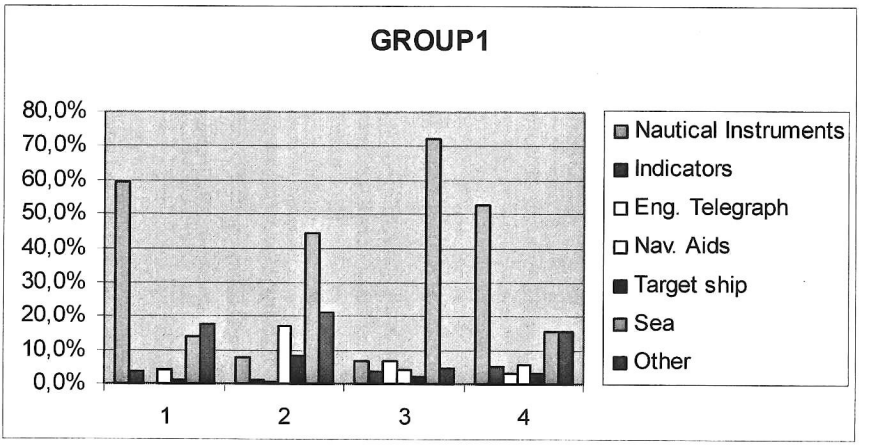

Figure 2: Percentage of Group 1 members' fixation duration of fixation points.

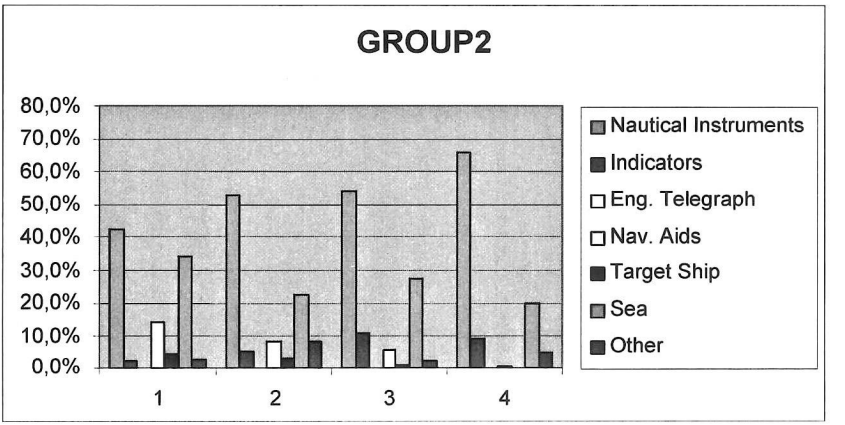

Figure 3: Percentage of Group 2 members' fixation duration of fixation points.

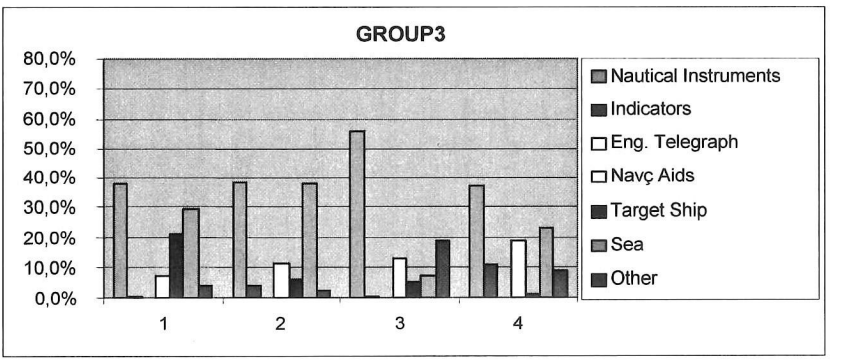

Figure 4: Percentage of Group 3 members' fixation duration of fixation points.

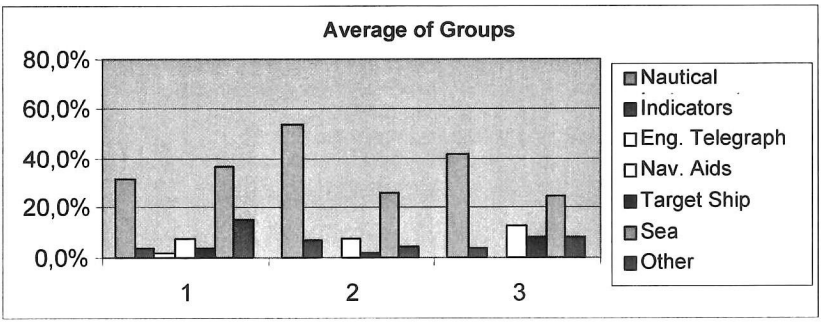

Figure 5: Percentage of group's average fixation duration of fixation points.

The fixation duration to one point in Group 2 is longer than Group 3, and Group 2's fixation duration to inside parts is longer than other groups.

The fixation duration to target ships and navigational aids in Group 3 is more than in other groups. The difference between inside and outside of fixation duration in Group 3 is less than in other groups.

4 Consideration

Significant results are shown in Figure 6. The authors obtained the comparisons between the groups.

As for Group 1, who were all beginners, the examinees paid less attention to sailing. They had a remarkable big difference of fixation duration between the "inside" and "outside". Their fixation duration of "other places" was also so much longer than in the other groups. Also they had little experience in using inside equipment.

As for Group 2, the examinees had intermediate characteristics as navigation officers between professionals and beginners. Their differences in capabilities as a navigation officer should be based on their sea experience and educational program. They had moderate knowledge of the use of instruments, and not enough experience, so their fixation duration to the instruments was longer than in the professional group. As for Group 3, examinees of this group were professional, so they paid more attention to all kinds of navigational information, target ships, and navigational aids and alike. Their fixation duration of instruments was the shortest of all because they had knowledge of and experience in using the instruments.

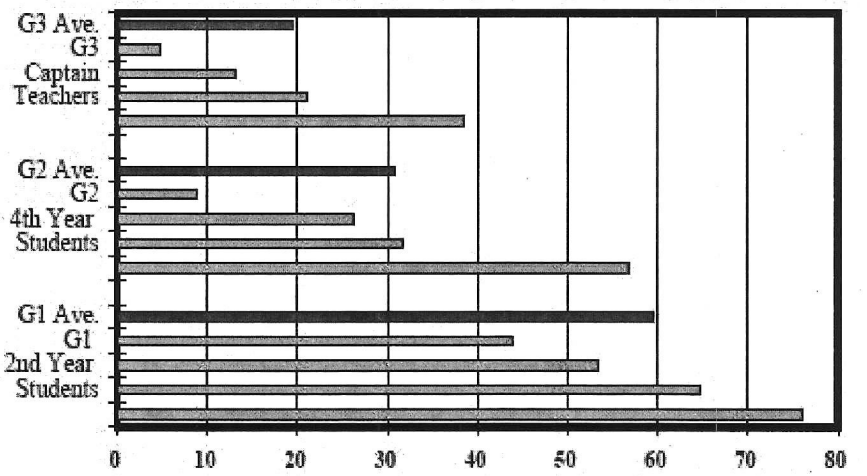

Figure 6: Percentage of examinee's fixation durations between "inside" and "outside" area.

In Figure 6, red depicts the average of the group's fixation duration between the "inside" and "outside" area. Blue depicts the difference between the duration of the inside and outside area examinee by examinee for each group. Remarkable differences can be seen between the different groups in this figure.

5 Conclusion

Experience and educational levels play an important role on eye mark fixation points and fixation duration. The more sea experience increases attention on the Navigation Bridge. Lower educational level and little sea experience decrease the use of nautical instruments. The more sea experience decreases the fixation duration of one fixation point. Finally, sea experience as a seafarer or a cadet obtained by actual onboard experience can be evaluated by using the eye mark recorder when using the ship-handling simulator.

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