Pilots' Eye Movement Patterns during Performing Air-to-Air Mission

*Wen-Chin Li[1], Chung-san Yu [2], Lon-Wen Li[3] and Matthew Greaves[4]

[1&4]Safety and Accident Investigation Centre, Cranfield University, Bedfordshire, U.K.

[2&3]Department of Industrial Engineering and Engineering Management, National Tsing Hua University, Hsinchu, R.O.C.

Abstract. Eye movement patterns are linked closely with the cognitive process of encoding information that pilots seek and perceive in the cockpit. A total of 30 qualified mission-ready military pilots participated in this research. The ages of participants are between 26 and 51 years old (M=29, SD=6); and total flying hours between 310 and 2920 hours (M=844, SD=720). Eye movement data were collected by a head-mounted ASL (Applied Science Laboratory) Mobile Eye combined with a jet fighter simulator which is a dynamic high fidelity trainer that replicates actual aircraft performance, navigation and weapon systems. The scenario was an air-to-air (AA) task. To complete the task, pilots have to search for the target with eye contact, pursue for aiming at the target, and lock-on for pick-off. The results showed there were significant differences in pilots' fixations among the five different areas of interest (AOIs), $p<.001$. Also, there were significant differences in pupil size ($p<.001$) for three different operating phases between experienced and less-experienced pilots; however, the average saccade velocity showed no difference. Understanding the pilot's visual scan pattern for attention distribution whilst pursuing a dynamic target will facilitate aviation professionals in developing an effective training syllabus to improve safety of flight operation.

Keywords: Attention distribution, Eye movement, Cognitive processes, Fixation, saccade velocity

Introduction

The pattern of eye movement is one of the physiological measures for assessing a pilot's cognitive process. It can provide numerous clues related to the processes of encoding information that pilots seek and perceive in the cockpit. Previous studies have found that eye movements offer evidence of attentional distributions and provide reliable indicators of the main focus of attention allocation in active visual tasks (Kowler, 2008; Kilingaru, Tweedale, Thatcher and Jain, 2013). Also, Lavine, Sibert, Gokturk, and Dickens (2002) suggested that visual attention is a precursor to initiate the cognitive process. The information from visual senses within a cockpit is directly connected with a pilot's attention allocation to gain the situational awareness for making decisions. Due to the limited capacity of a human's working memory, it is necessary to pay attention to the most critical task at hand and ignore stimuli from the environment when selecting the visual channel to be attentive to (Morelli and Burton, 2009). Tracking eye movements provides a sensitive, real-time behavioural index of continuous visual and cognitive processing (Di Stasi, Antolí and Cañas, 2011; Henderson, 2003). An eye-tracker is a proper device to measure an operator's visual direction and where his attention is allocated during the performed task under analysis (Zelinksy, 2008). The analysis of eye tracking data can proceed either top-down, based on cognitive theory or design hypotheses; or bottom-up, based on observation of the data without predefined theories relating eye movements to cognitive activity, it driving data interpretation activity (Goldberg, Stimson, Lewenstein, Scott and Wichansky, 2002).

© The Authors.
Published by EAAP. This is the Author Accepted Manuscript.
Please refer to any applicable publisher terms of use.

In general, an individual spends more time looking at important or interesting objects in the environment. The length of fixation duration can reflect difficulty of information extraction, and the number of fixations indicate the importance of that area of the display (Kotval and Goldberg, 1998). Research into the differences in visual time distribution has suggested that experts spend more time looking at thematically relevant elements of a task, while novices spend more time on the salient features (Carmichael, Larson, Gire, Loschky and Rebello, 2010). The results from eye movement research in operational tasks are not always concordant; e.g. expert pilots had a longer duration of focus on relevant cues when a stimulus was present (Schriver, Morrow, Wickens and Talleur, 2008). However, expert pilots also have a pattern of more fixations and shorter fixation duration during landing operations (Kasarskis, Stehwien, Hickox, Aretz and Wickens, 2001). Previous studies present different viewpoints on the relationship between visual fixation and attention. It has been suggested that visual fixations and duration focused on a certain location might indicate where attention was allocated (Ratwanti, McCurry and Trafton, 2010; Wang, 2010); however, Shinar (2008) suggested the location of fixations does not always reveal the location of attention. Nevertheless, eye movements might provide valuable evidences on the focus or shift of visual attention (Duchowski, 2007). Therefore, eye movements can be used to examine differing attention patterns between experts and novices on thematically relevant areas or tasks.

Wiggins and O'Hare (1995) found that experienced pilots switch their attention more frequently and efficiently to search and acquire relevant information. Moreover, attention is critical for extensive visual surveys and for ensuring that saccades land on the selected object in a timely manner (Kowler, 2008). Therefore, effective saccadic scans play a critical role especially for pursuing a moving target during air-to-air combat manoeuvres. It appears that saccade velocity might be the index to assess the performance of a pilot's attention shift for pursuing a moving target. Saccade velocity was defined as pixels over the time (in sec) taken to initiate a saccade to the approaching target in this study. Pupil size is an important indicator to understand visual attention. Also, pupil size has been used to assess training effectiveness (Sibley, Coyne, and Baldwin, 2011) and explore a pilot's mental process, cognitive workload and visual attention objectively while performing a flight task (Wang, 2010; Duchowski, 2003; Pomplun and Sunkara, 2003). Therefore, the objectives of this research were (1) to investigation pilot's scan pattern during an air-to-air task, (2) to evaluate pilots' saccade velocity and attention shift during the tasks, and (3) to measure the change of pupil diameter during different operational phases.

Method

1. Subjects

A total of 30 qualified mission-ready military pilots participated in this research. The ages of participants are between 26 and 51 years old (M=29, SD=6); total flying hours between 310 and 2920 hours (M=844, SD=720).

2. Apparatus

2.1 Flight Simulator

The flight simulator used in the experiment is a formal military trainer of IDF. It is high fidelity and fixed-base type for the purpose of routine flight training and combat planning. The simulator is equipped with a 2-D and 1:1 image projected on the 5-meter wide and 3-meter high screen. It supports pilots' routine flight training and combat planning. The instructor can install scenarios and observe the trainee pilot's performance via a console with three monitors.

2.2 Eye Tracking Device

A mobile head-mounted eye tracker (ASL Series 4000) was used to collect pilot's eye movement data. The sampling frequency was 30 Hz which means one-second of eye

movement data can be divided into 30 frames for further analysis. The definition of a fixation point was three gaze points occurring within an area of 10 by 10 pixels with a 200 millisecond dwell time (the time spent per glance at an area or instrument). The eye tracker is portable and only 76g so pilots could move their head without any limitation during air-to-air manoeuvres. The eye movement data in five areas of interest (AOIs) were defined as following, AOI-1: Head-up Display (HUD); AOI-2: Integrated Control Panel (ICP); AOI-3: Right Multiple Function Display (RMFD); AOI-4: Left Multiple Function Display (LMFD); and AOI-5: Outside of cockpit (OC). The function and information of those AOIs could satisfy most of the requirements to complete the manoeuvres, which were designed following the operational contents of the standard operating procedures (SOP) of air-to-air training.

2.3 Scenario

The scenario of this experiment was an air-to-air manoeuvre. The altitude of interceptor during combat patrol was 20,000 feet with a cruise speed of 300 knots indicated airspeed (KIAS) and heading 050° under the weather conditions of 7-mile visibility and scattered clouds. During a visual rule flight in a patrol area, a foe produced by the simulator unexpectedly would appear at the 9 o'clock position at the same altitude as the interceptor, moving from left to right with heading of 090° and air speed of 300 KIAS. The participants have to search the air space for the foe, and intercept the foe immediately by tactical manoeuvres. In this study, three primary visual behaviours were observed: searching for target with eye contact, pursuing for aiming, and lock-on for pick-off.

3. Research Design

All subjects undertook the following procedures, (1) briefing about the objectives and procedures of experiment (10 minutes); (2) calibrating the eye tracking device by using three points distributed over the cockpit display panels and screen (15 minutes); (3) participants performed the air-to-air task (3-5 minutes); (4) debriefing for subject's feedback and comments (10-15 minutes). Each subject took around 40 minutes to complete the experiment. There were three stages for analyzing eye movement data from the air-to-air task. To complete the task, pilots had to search the target via eye contact, pursuit for aiming the target, lock-on for pick-off. The pilots' eye movement data were including gaze points, fixation points, pupil size and average saccade velocity occurred within AOIs for five seconds at each stage of tactical operations.

Results

The distributions of percentage of fixation and average fixation duration among five AOIs are illustrated as table 1. The pupil size and average saccade velocity in three operational phases, searching, aiming, and lock-on for pick-off are shown as table 2.

The 'percentage of fixation' is proportional data, and it has to be transformed as an arcsine value before conducting analysis of variance. There were significant differences in pilots' percentage of fixation among the five AOIs, $F(4, 145) = 164.35$, $p<.001$, $\eta 2\rho = .85$. Further comparisons by using post-hoc Bonferroni adjusted tests showed that AOI-5 (Out of cockpit) has a significantly higher percentage of fixation than AOI-2, AOI-3, and AOI-4. Similarly, AOI-1 (HUD) has a significantly higher percentage of fixation than AOI-2, AOI-3 and AOI-4. Also, significant differences were observed in pilots' average fixation duration among the five different AOIs, $F(4, 145) = 85.74$, $p<.001$, $\eta 2\rho = .75$. Further comparisons by using post-hoc Bonferroni adjusted tests showed that AOI-5 has significantly longer average fixation duration than AOI-2, AOI-3 and AOI-4; and AOI-1 has significantly longer fixations duration than AOI-2, AOI-3 and AOI-4 (table 1).

Table 1. Participants' percentage of fixation and average fixation duration among five AOIs during Air-to-Air task

Subjects	Percentage of fixation (arcsine values)					Average fixation duration (msec)				
	HUD	ICP	RMFD	LMFD	OC	HUD	ICP	RMFD	LMFD	OC
1	55.9	0	0	0	34.1	400	0	0	0	310
2	45.84	3.72	0	0	43.92	460	230	0	0	410
3	46.24	0	0	0	43.76	640	0	0	0	570
4	49.59	0	0	0	40.41	650	0	0	0	750
5	31.09	21.41	0	6.62	49.99	670	410	0	340	590
6	42.03	0	7.54	0	46.98	580	0	240	0	480
7	51.88	0	0	0	38.12	300	0	0	0	320
8	35.55	0	6.82	9.67	51.93	500	0	300	550	470
9	65.67	7.9	0	7.9	22.86	500	270	0	270	420
10	42.68	0	0	0	47.32	660	0	0	0	400
11	27.31	0	0	0	62.69	300	0	0	0	390
12	31.85	0	0	0	58.15	560	0	0	0	470
13	49.68	8.78	0	0	38.96	690	330	0	0	660
14	44.03	5.29	0	0	45.49	560	570	0	0	520
15	42.27	0	0	0	47.73	360	0	0	0	370
16	30.61	0	0	0	59.39	380	0	0	0	500
17	54.74	0	0	0	35.26	450	0	0	0	480
18	12.16	0	0	0	77.84	320	0	0	0	450
19	21.01	6.87	0	0	67.79	530	330	0	0	410
20	40.6	0	6.24	0	48.72	310	0	470	0	360
21	0	0	0	7.75	82.25	0	0	0	300	530
22	25.07	0	0	0	64.93	650	0	0	0	560
23	37.08	0	0	0	52.92	410	0	0	0	330
24	31.76	6.29	0	0	57.47	490	260	0	0	480
25	25.61	6.02	0	0	63.59	280	200	0	0	400
26	34.96	0	0	0	55.04	510	0	0	0	310
27	30.66	0	0	0	59.34	340	0	0	0	500
28	8.53	8.53	0	0	77.89	380	340	0	0	410
29	37.76	0	0	0	52.24	380	0	0	0	510
30	21.41	0	0	7.43	67.21	450	0	0	300	430
Mean	35.8	2.5	0.7	1.3	53.1	457	98	34	59	460
SD	14.55	4.73	2.1	3.01	13.77	152	163	107	140	102

There were significant differences in pilots' pupil size in three operating phases, $F(2, 87) = 15.30$, $p<.001$, $\eta 2\rho = .35$. Further comparisons by using post-hoc Bonferroni adjusted tests showed that pilots' pupil size in the phase of lock-on for pick-off was significantly higher than in aiming and in searching (Figure 1). However, there were no significant differences on pilots' average saccade velocity at three operating phases, $F(2, 87) = .36$, $p>.05$, $\eta 2\rho = .01$ (Figure 2).

Table 2. Subjects' eye movements of pupil size and average saccade velocity at three phases of air combat manoeuvres

Subjects	Pupil size (pixel^2)			Average saccade velocity (pixel/sec)		
	searching	aiming	Lock-on	searching	aiming	Lock-on
1	26594	27412	29251	794	525	875
2	27108	28469	30975	833	395	325
3	15234	17378	18053	96	440	96
4	28768	26954	28192	698	792	1117
5	18139	15763	16931	986	758	864
6	13865	16523	15688	1549	1338	1017
7	27715	27178	28102	443	242	219
8	31484	30651	33823	649	636	895
9	25181	24919	25744	659	702	718
10	26811	27528	28612	889	1454	458
11	20255	21936	20855	828	751	511
12	30482	32965	32382	1218	638	1124
13	29139	27055	28107	911	894	1486
14	39718	39719	42008	980	670	897
15	35438	37345	37887	739	1097	636
16	23569	26121	25761	297	912	1851
17	32381	32817	32962	980	694	586
18	27557	26607	28050	1099	1345	986
19	26630	28379	29785	1244	994	1267
20	22058	22402	22702	1042	1028	363
21	21197	22320	25369	898	912	599
22	20994	21663	21956	815	789	1061
23	28051	28870	29603	1473	1055	1881
24	29761	29422	33033	1084	790	754
25	24804	26163	25193	807	1116	795
26	20546	20584	18616	889	525	1329
27	14930	13446	15818	513	146	473
28	25011	25221	27701	821	794	770
29	26429	26347	28017	561	736	898
30	35893	34790	35923	837	1072	1118
Mean	25858	26232	27237	854	808	866
SD	6137	6070	6457	307	308	427

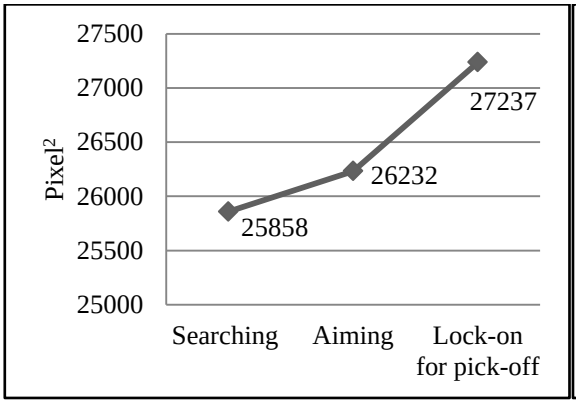


Figure 1. Pilots' pupil size on three operational phases

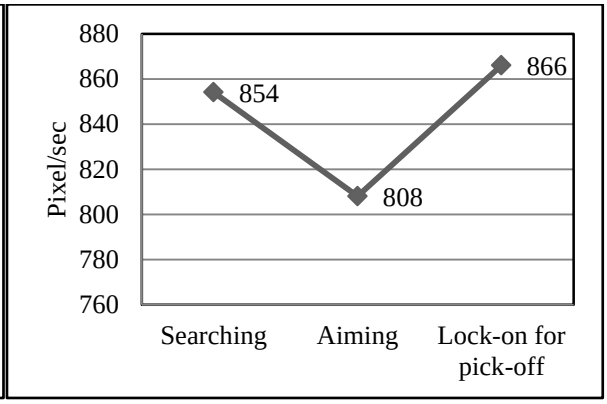


Figure 2. Pilots' average saccade velocity

Discussion

Understanding pilot's visual scan patterns for attention distribution in order to achieve a high level of operational performance will allow aviation professionals to move beyond the retrospective diagnosis of the problems of attention, situational awareness, and decision-making in the cockpit. The results of table 1 indicate that pilots distributed 35.8% of their fixations on the HUD (AOI-1) and 53.1% outside of the cockpit (AOI-5) respectively whilst performing the air-to-air task. Also the average fixation durations on the HUD and outside of the cockpit are significantly higher than on the ICP (AOI-2), RMFD (AOI-3) and LMFD (AOI-4). It means that information provided by the HUD and outside of the cockpit are the main supports for completing the task of dog-fight successfully. This shows how the information captured with visual scans from the HUD and outside of cockpit is very critical to operate a time-limited tactical mission.

The previous study found a negative correlation between fixation number and searching efficiency (Kotval and Goldberg, 1998); however, the total time of measurement for performing the task and the fixation duration should be considered concurrently, for the longer operation time usually accompanied with more fixations. There were varied time frame for each pilot performing air-to-air mission at the present study, so the time of collecting eye movements data at three operational phases only counted for 15 seconds, searching, aiming and lock-on for pick-off, were five seconds respectively. Table 1 indicates that the percentage of fixation allocated out of cockpit is higher than the HUD followed by ICP, LMFD and RMFD. These outcomes are different from the previous study that the highest percentage of fixation allocated on the HUD (59.92%) and the out of cockpit (39.18%) (Yu, Wang, Li and Braithwaite, 2014). The difference is due to the context of task between aiming a dynamic target and stationary target, which is matched with the findings of Sarter, Munaw and Wickens (2007) that pilots did not employ a standardized scanning pattern but monitored the situations of surrounding environment based on expectations associated with specific flight contexts. The pattern of pilots' attention allocation are affected by the tasks in hand during the dog-fight in this research. Furthermore, the average fixation duration on the HUD and the out of cockpit are different by only 3 msec (457 and 460 msec respectively). The phenomenon of longer fixation duration focused on the certain locations might indicate that the information coming from those AOIs are critical to the operations and need to be allocated more attention (Kotval and Goldberg, 1998; Ratwanti, McCurry and Trafton, 2010; Wang, 2010). More fixations and of longer duration on the HUD and outside the cockpit seems to reflect the importance of the elements during the air-to-air task, but the other three AOIs with fewer fixations and shorter duration can not be interpreted as meaning those AOIs were less important. Based on the frame-by-frame analysis of eye movement parameters, it was found that pilots operated the task following the tactical standard operation procedures (SOPs) combined with individual visual scan patterns for conducting dog-fight manoeuvres. Pilots focus on the HUD and outside cockpit for most of the time, however, at some critical points they shifted fixations, for example, to the ICP for entering required information or to LMFD for acquiring target's data. By using an eye-tracking device, pilots' attention allocation can be reviewed and analyzed precisely with a very short scale of time. It is beneficial to explore objectively when, where, why, what and how pilots were viewing for investigating their cognitive processing the information during flight operations.

Kowler (2011) found saccades and pursuit depend on the past history of target motions, and saccades between fixations might reflect the direction of a shifting attention, and average saccade velocity might be linked closely with attention which even initiated before the motion of the target begins. Based on the findings of this research, the pilots' average saccade velocity at searching, aiming and lock-on for pick-off are 854, 808, and 866 pixel/sec. The fastest saccade velocity occurred at the phase of lock-on for pick-off followed by aiming then searching. Attention shift by saccade velocity is associated with how long the duration landed on the target (Kowler, 2008) and the latency from the onset of a stimulus (a moving target) until the pilot first noticed it (Schriver, Morrow, Wickens and Talleur, 2008). In addition, the phenomenon might reflect psychological or physiological stress that pilots suffered during the dog-fight. It might be influenced by pilot's mental workload (Dahlstrom, Nahlinder, Wilson and Svensson, 2011) resulting in poor situational awareness performance (Morelli and Burton, 2009). Those eye movement patterns relevant to pilot's situational awareness need to be explored further in future work. Moreover, pilots pursuit of the moving target showed a rapid and constant decision-making to aim and lock-on the moving target based on estimation and prediction of the target's probable trajectory of manoeuvre, speed and heading. Those intuitable responses and tactical activities were the results of cognitive processes which are not easy to describe by using traditional flight training devices. Eye-tracker data can facilitate a pilot's smooth pursuit training on simulator, as the eye movement information is the main support of pursuit control (Spering and Montagnini, 2011).

Pupil size is influenced not only by illumination, but also by the difficulty and complexity of tasks in hand and the pilots' cognitive workload (Pomplun and Sunkara, 2003; Gabay, 2011). Table 2 and figure 1 indicate that pilots' pupil size in the phase of lock-on for pick-off is significantly higher than aiming and searching. A pattern can be identified where the pupil size increases as the target is approached. It indicates that pilots reach the most complex situation for making decisions (to be or not to be for pick-off) at the operational phase of lock-on for pick-off. Also, pilots suffered the highest cognitive workload at the moment of lock-on for pick-off. It might be interesting to examine pupil size by the objective measurement of the eye tracking data to compare with the outcome of self-reports of subjective rating scale of workload. In summary, the present study supports the previous research on percentage of fixations and average fixation duration having a close link with where attention is distributed. Eye movement patterns could reflect participants' experience and mental workload. Most importantly, current research applying an eye-tracking device combined with a fighter simulator to study pilots' performance by measuring pupil size and saccade velocity while operating an air-to-air task. The findings of this research have potential application for improving training effectiveness of military pilots and aviation safety in the future.

References

Carmichael, A., Larson, A., Gire, E., Loschky, L., & Rebello, N. S. (2010). How does visual attention differ between experts and novices on physics problems? *Physics Education Research Conference*, Portland, Oregon, U.S.A.

Dahlstrom, N., Nahlinder, S., Wilson, G. F., & Svensson, E. (2011). Recording of Psychophysiological Data During Aerobatic Training. *The International Journal of Aviation Psychology*, *21* (2), 105-122.

Di Stasi, L. L., Antolí, A., & Cañas, J. J. (2011). Main sequence: an index for detecting mental workload variation in complex tasks. *Applied Ergonomics, 42*, 807-813.

Duchowski, A. (2007). *Eye tracking methodology: Theory and practice*. Secaucus, NJ: Springer.

Gabay, S., Pertzov, Y., & Henik, A. (2011). Orienting of attention, pupil size, and the norepinephrine system. *Attention Perception Psychophys*, *73*, 123-129.

Goldberg, J. H., Stimson, M. J., Lewenstein, M., Scott, N., & Wichansky, A. M. (2002). Eye tracking in web search tasks: Design implications. In: *Proceedings of the Eye Tracking Research and Applications Symposium 2002*, 51-58. NY: ACM Press.

Henderson, J. M. (2003). Human gaze control during real-world scene perception. *Trends Cogn Sci, 7*, 498-504.

Kasarskis, P., Stehwien, J., Hickox, J., Aretz, A., & Wickens, C. (2001). Comparison of expert and novice scan behaviors during VFR flight. In: *Proceedings of the 11th International Symposium on Aviation Psychology*; Columbus, OH: The Ohio State University.

Kilingaru, K., Tweedale, J. W., Thatcher, S., & Jain, L. C. (2013). Monitoring pilot ' situation awareness'. *Journal of Intelligent and Fuzzy Systems, 24*, 457-466.

Kotval, X. P., & Goldberg, J. H. (1998). Eye movements and interface components grouping:An evaluation method. In: *Proceedings of the 42nd Annual Meeting of the Human Factors and Ergonomics Society*. Santa Monica: Human Factors and Ergonomics Society, 486–490.

Kowler, E. (2008). Attention and eye movements. *Encyclopaedia of Neuroscience* (Krauzlis R, ed. pp. 605-616). Amsterdam: Elsevier Ltd.

Kowler, E. (2011), Eye movements: The past 25 years. *Vision Research, 51*, 1457-1483.

Lavine, R. A., Sibert, L., Gokturk, M., & Dickens, B. (2002). Eye-tracking measures and human performance in a vigilance task. *Aviation, Space and Environmental Medicine*, *73*, 367-372.

Morelli, F., & Burton, P. A. (2009). The impact of induced stress upon selective attention in multiple object tracking. *Military Psychology, 21*, 81-97.

Pomplun, M., & Sunkara, S. (2003). Pupil dilation as an indicator of cognitive workload in human-computer interaction. In: *Proceedings of the International Conference on Human-Computer Interaction*. Crete, Greece.

Ratwanti, R. M., McCurry, J. M., & Trafton, J. G. (2010). Single operator, multiple robots: An eye movement based theoretic model of operator situation awareness. In: *Proceedings of the Fifth ACM/ IEEE International Conference on Human-Robot Interaction*. Nara, Japan.

Sarter, N. B., Mumaw, R. J., & Wickens, C. D. (2007). Pilots' monitoring strategies and performance on automated flight decks: An empirical study combining behavioral and eye-tracking data. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 48*(3), 347-357.

Schriver, A. T., Morrow, D. G., Wickens, C. D., & Talleur, D. A. (2008). Expertise differences in attentional strategies related to pilot decision making. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 50*, 864-878.

Sibley, C., Coyne1, J., & Baldwin, C. (2011). Pupil dilation as an index of learning. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, Las Vegas, U.S.A., *55* (1), 237-241.

Spering, M., & Montagnini, A. (2011). Do we track what we see? Common versus independent processing for motion perception and smooth pursuit eye movements: A review. *Vision Research, 51*, 836-852.

Wang, J. T. (2010). Pupil dilation and eye tracking. *A handbook of process tracing methods for decision research: A critical review and user's guide* (Mecklenbeck S., Kuehberger M. A., & Ranyard, R. eds. pp. 185-204). New York: Psychology Press.

Wiggins, M., & O'Hare, D. (1995). Expertise in aeronautical weather-related decision making: A cross-sectional analysis of general aviation pilots. *The Journal of Experimental Psychology: Applied*, *1*, 305.

Yu, C., Wang, E. M., Li, W. C., & Braithwaite, G. (2014). Pilots' visual scan patterns and situation awareness in light operations. *Aviation, Space, and Environmental Medicine*, *85*, 708-714.

Zelinksy, G. J. (2008). A theory of eye movements during target acquisition. *Psychological Review*, *115*, 787-835.

Contact Information

Wen-Chin Li, PhD MErgS
Senior Lecturer, Safety and Accident Investigation Center,
Cranfield University, Bedfordshire, MK43 0AL, UK
Email: wenchin.li@cranfield.ac.uk



https://dspace.org/

Pilots' eye movement patterns during performing air-to-air mission

Li, Wen-Chin; Yu, Chung-San; Li, Lon-Wen; Greaves, Matthew

2014-09-26
EAAP
https://dspace.lib.cranfield.ac.uk/handle/1826/12877
Li W-C, Yu C-S, Li L-W, Greaves M, Pilots' eye movement patterns during performing air-to-air mission, Proceedings of 31st European Association for Aviation Psychology Conference (EAAP31), 22-26 September 2014, Valletta, Malta

Downloaded from a DSpace repository. https://dspace.org/