THE DIFFERENCE IN VISUAL SEARCH STRATEGIES BETWEEN EXPERT AND NOVICE INSTRUCTOR IN EXERCISE MOVEMENT ASSESSMENT

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The purpose of this study was to compare visual search strategies (fixations duration ratio on each segment, frequency of fixations and average of fixations duration) between expert and novice in exercise movement assessment using eye-tracking device. Sixteen experts with 5+ years of experience and seventeen novices with less than 1 year of experience were recruited. In eye-tracking experiment they watched three pre-recorded Functional movement screen videos (squats in the frontal and sagittal planes and push-ups in the sagittal plane). There were no significant differences with fixations duration ratio on each segment, frequency of fixations and average of fixations duration. The results show doubts about evaluations by eyes and suggest motion analysis by biomechanics as alternatives.

KEYWORDS: eye-tracking, proficiency, functional movement screen.

INTRODUCTION: Selective attention is the ability of the eyes to focus on the required stimuli. And there is an association between selective attention and mind process (Just & Carpenter, 1980). Eye-tracking is used to interpret a person's mind and explain visual perception process. Some previous studies used eye-tracking devices to research experts' visual search characteristics and analysed experts' gaze patterns in medical education for novices (Ji et al., 2022; Li et al., 2023). Robson et al. (2021) said experts outperform novices on cognitive and perceptual tasks. Therefore, it can assume that differences of stimuli processing between expert and novice instructors could be found with an eye-tracking device. Exercise movement assessment is the process by which exercise instructors evaluate and observe the quality of client's movement to identify patterns of muscle imbalance, neuromuscular coordination, or movement impairment that can lead to injury during exercise (Clark & Lucett, 2010). Generally, exercise instructors mainly rely on eyes to evaluate client's movement, and it was questionable whether they were looking at the exact segment of body at the right time. However, visual search strategies such as specific gaze pattern or most viewed segments during exercise movement assessment according to proficiency are not well understood. Therefore, the purpose of this study was to compare visual search strategies according to proficiency using an eye-tracking device. It was hypothesized that there would be differences between experts and novices in visual search strategies during exercise movement assessment. If evidence supporting our hypothesis is found, it would provide guidelines for a novice, establish objective and quantitative data, and validate that there are differences according to proficiency.

METHODS: In the current study an expert group of sixteen exercise instructors with more than 5 years of experience (6.3±3.1years) and a novice group of seventeen exercise instructors with less than 1 year (0.4±0.4years) of experience were voluntarily recruited. All participants had a nationally exercise instructor certification. The experimental tool was an eye-tracking device, Tobii Pro Spark (Tobii Technology, Sweden), attached to the bottom of the monitor (at a sampling rate of 60Hz). Because this remote type is more accurate than glasses eye-tracking device, with an accuracy of 2000Hz. Before the experiment, three Functional movement screen (FMS) videos were created and consisted of squats in the frontal and sagittal planes and push-ups in the sagittal plane. FMS was used as an exercise movement assessment for this eye-tracking experiment. Bonazza et al. (2017) reported that FMS had acceptable interrater reliability, with intraclass correlation coefficient values of 0.76 to 0.98. Also, FMS was used as assessment tool for field of sports (Garrison et al., 2015). This experiment was conducted in the laboratory protected from sunlight. Participants were seated in a comfortable position and watched FMS videos once at 65-70cm from the monitor. Eye-tracking data was collected by setting a body segment as the areas of interest (AOI) in the software program associated with the device to collect data on gazing at that area (Figure 1). AOI of squats were upper body, lumbo-pelvic-hip complex (LPHC), knee, foot, and ankle. AOI of push-ups were cervical, scapula, LPHC. Variables of visual search strategies were fixations duration ratio on each segment during squats in the frontal and sagittal planes and push-ups in the sagittal plane, frequency of fixations and average of fixations duration for all videos. Fixations duration ratio was calculated as the percentage of fixations on the AOI over the total fixations duration. It means how long the gaze was fixed on the AOI. Frequency of fixations is the total number of times the gaze was fixed on the AOI. Average of fixations duration is the total duration divided by a fixations duration. It means the average time spent during a single fixation. All statistical analyses were performed with SPSS version 28 (SPSS Inc., USA). After normality test, Mann-Whitney U-tests were used to test whether there were differences between two groups in fixations duration ratio on each segment during squats in the frontal and sagittal planes and push-ups in the sagittal plane, frequency of fixations and average of fixations duration for all videos. Statistical significance was set $\alpha = 0.05$.

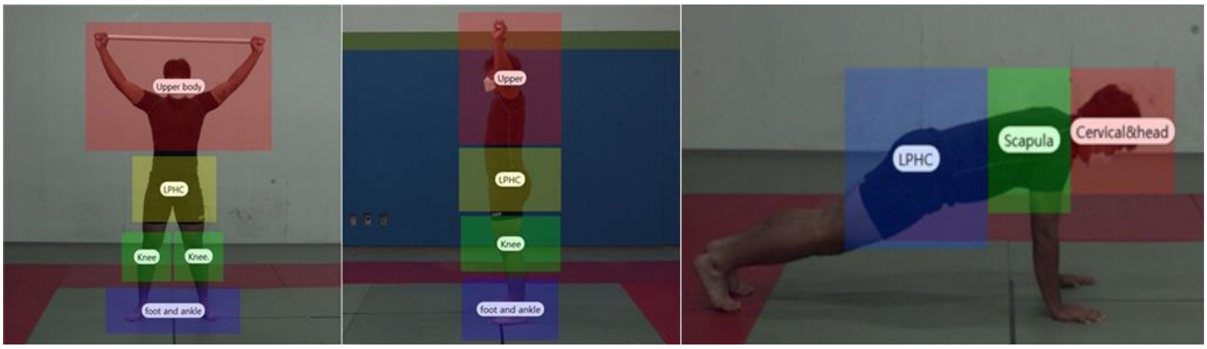

Figure 1: Model's AOI (from left to right: squats in the frontal and sagittal planes and push-ups in the sagittal plane).

RESULTS: In the present study Figures 2 and 3 indicate means of the visual strategies variables with standard deviations between an expert group and a novice group. At fixation duration ratio on each segment (Upper body, LPHC, Knee, Foot and ankle) during squats in the frontal and sagittal planes, there were no significant differences (Figure 2(a) and 2(b)). And no significant difference was observed at fixation duration ratio on each segment (Cervical, Scapula and LPHC) during push-ups in the sagittal plane (Figure 2(c)). Figure 3(a) shows that frequency of fixations was not significantly different for all videos (Squats in the frontal plane, Squats in the sagittal plane and Push-ups in the sagittal planes) and average of fixations duration was also no significant differences for all videos between two groups (Figure 3(b)).

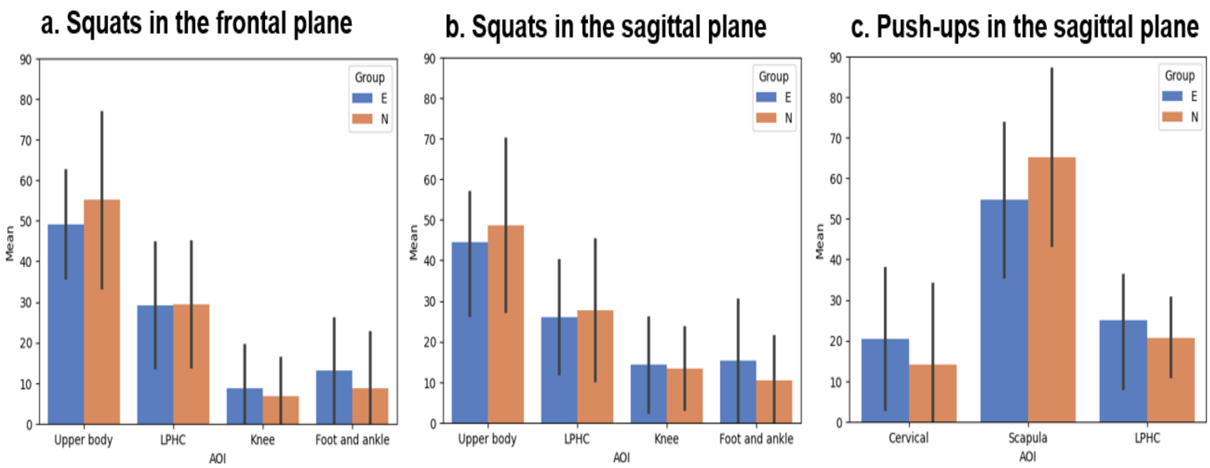

Figure 2: Fixations duration ratio on each segment (unit: %). Bars indicate mean, and vertical lines indicate standard deviation. E: expert group (blue), N: novice group (orange).

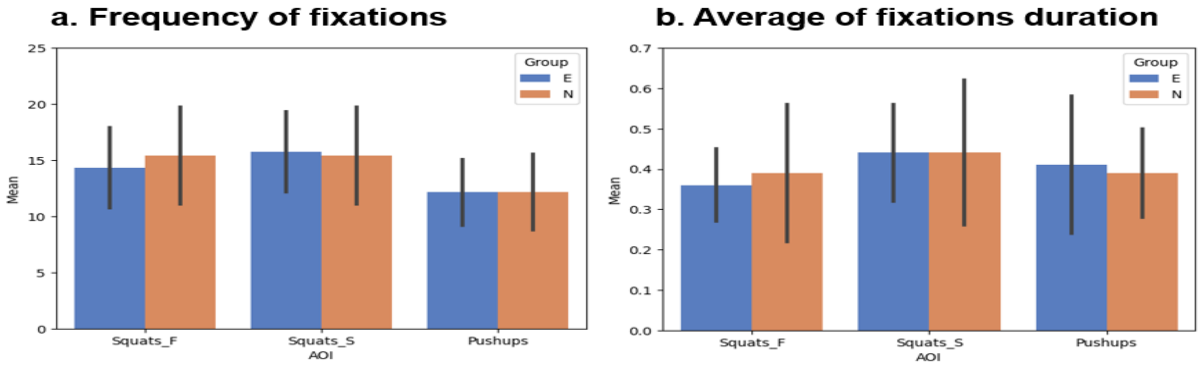

Figure 3: Frequency of fixations for all videos (unit: number) (a) and Average of fixations duration for all videos (unit: seconds) (b). Bars indicate mean, and vertical lines indicate standard deviation. E: expert group (blue), N: novice group (orange), Squats_F: Squats in the frontal plane, Squats_S: Squats in the sagittal plane.

DISCUSSION: The purpose of this study was to investigate the differences of visual search strategies between expert and novice. However, the current study found that there were no significant differences at all visual strategies variables. Figure 2(a) shows that both groups had fixations duration ratio in the order of upper body, LPHC, foot and ankle, and knee. Similar result is shown in Figure 2(b). Cook et al. (2014) reported that squats need most power movements involving the lower extremities, but the results of this study were different. These discrepancies make it difficult to interpret the significance of segmental ratings observed in the present study. Park (2009) found that, in general, experts exhibit lower visual search rates than novices, with lower frequency of fixations and higher average of fixations duration during task performance. However, our findings are inconsistent with the previous study. Several limitations in the current study would contribute to these contrary results. First, we measured once on eye-tracking experiment at laboratory environment which does not resemble field-like environment with a remote type of eye-tracking device. Second, Shanteau (2002) mentioned that years of experience do not always imply expertise. It would be not reasonable to categorize individuals with over 5 years of experience as proficient experts. Third, these results would be influenced by the participants' predominant focus on the upper body, particularly the face. Previous research showed that the eyes as crucial inertial facial features when someone gazes at another's face (Guo et al., 2012). In the current study, we found that many participants tended to track the model's eyes during video observation (Figure 5), leading to a gaze pattern primarily concentrated on segment areas unrelated to the exercise movement assessment. Observed gaze patterns raise concerns about the objectivity of assessing body movement with the naked eye. The implication of the present findings can suggest that the accuracy and practical applicability of biomechanical methods can be better realized through the utilization of image processing techniques and sensor-based motion analysis, as opposed to relying on visual observation. By incorporating these advanced technologies, we can enhance the objectivity and precision of evaluating human motion.

Figure 5: Participants' gaze pattern for model's eyes.

CONCLUSION: It was expected that more experienced instructors would be better at observing movements in this study. Better observation here is defined as looking at the segment that is relevant in a particular movement more often or for longer than others. But this study found that there were no significant differences at all variables about eye-tracking between expert and novice instructors and many participants frequently directed their gaze towards areas unrelated to the exercise movement assessment regardless of their experience. While future research is needed to address the limitations of the present study, it would become evident that relying on visual observation may not be the most accurate approach. The neuroscientific limitation of human visual attention and potential biases emphasize the need for advanced technologies in biomechanics. Moreover, integration of increasingly sophisticated artificial intelligence technology holds promise in revolutionizing the observation and judgement of movement. By utilizing this technology, it can enhance the objectivity and accuracy of analysing human movement, providing potential benefits to instructors and clients in the fields of exercise instruction and biomechanics.

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