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Original Article

Characteristics of gaze tracking during movement analysis by therapists

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Abstract. [Purpose] Visual assessment of the quality of movement is a common and important component of physiotherapy. The purpose of this study is to quantify the level of proficiency of therapists and to obtain a new index of proficiency by measuring the coordinates of the gaze tracking trajectories of therapists with years of experience. [Participants and Methods] Eighteen voluntary physiotherapists (1st year (n=4), 7th year (n=1), 9th year (n=4), 10th year (n=3), 11th year (n=4), 13th year (n=1), and 21st year (n=1)) were recruited for this study. [Results] Discriminant analysis according to the size of the deviation between the X-axis and Y-axis of the range of gaze tracking during movement analysis measured from each therapist showed that the percentage of classification accuracy in the 10th year or less was 72.2%. Cluster analysis showed that two clusters were formed. Thirteen therapists in Cluster 2 were in their 9th year or more. Eye tracking trajectories can be classified by the 10th year of experience as a therapist. [Conclusion] It was shown that full-fledged therapists with 10 years of experience also expanded the range of eye tracking. The trajectory in the Y-axis direction tends to be extended with their 9th year or more of experience. In this point, quantitative judgments of eye-tracking results can serve as indicators of proficiency. The eye movements are important as a tool to objectively measure skills from experience.
Key words: Gaze tracking, Physiotherapists' experience, Movement analysis

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INTRODUCTION

To evaluate gross motor function, physiotherapists use visual motion analysis as a qualitative assessment. Although it is only moderately accurate, visual assessment of the quality of movement is still important in physiotherapy as one of the most common clinical decision-making methods[1, 2)]. This skill of using vision to analyze the movement is still widely employed. Despite the fact that many tools for motion analysis have been developed[3–7)], this technique for visual motion analysis with technical devices is not yet widely used. However, it is well recognized that some students have difficulties in learning techniques for visual motion analysis of patient movements.

In eye tracking, two common eye movement measurements are used: gaze and saccades. The number of gazes and the total gaze time are said to indicate the perceived importance of the object being observed[8)], and these parameters are often used in gaze tracking to quantify how cognition is performed. Topczewski et al.[9)] compared the gaze of undergraduates and postgraduates when interpreting nuclear magnetic resonance spectra. They found that undergraduates' gaze patterns were spread across the graph, whereas postgraduates focused on specific parts. Atkins[10)] found that during graph reading, postgraduates focused on specific information that helped them understand the data. Moreover, Harsh et al.[11)] found that there were differ-

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ences in the way people focused their attention when reading graphs (patterns of fixation and visual search) depending on the level of expertise. The task of visually observing the patient's movements and reading the necessary information is similar to the skill of reading graphs and diagrams, and the movement analysis of physical therapists is a skill of connecting visual information and knowledge. This skill is expected to be acquired through experience, but there are no concrete reports on the number of years it can be acquired. Ashraf et al.[12] conducted a systematic literature review and found that in the medical field, eye-tracking methods have made significant contributions to the training, evaluation, and feedback practices used in clinical practice. Maekawa et al.[13] showed that there are differences in gaze patterns between nursing students and skilled nurses during injection training. Moreover, Yamada et al.[14] reported that differences in eye scan data between physiotherapists and physiotherapy students existed. When a beginner learns motion analysis, it is important to acquire knowledge first. However, it is undeniable that there are students and novice therapists who have learned the knowledge in textbooks but do not know what to look for when analyzing the movements of actual patients. Therefore, the purpose of this study was to quantify the proficiency of therapists, including not only their knowledge but also their experience, by measuring the coordinates of the gaze tracking trajectory of therapists with long years of experience, and to obtain a new proficiency index.

PARTICIPANTS AND METHODS

A low-cost eye-tracking system that can scan eye movements was developed. Details of the proposed device, including the personal computer, Sentry Gaming Eye Tracker (SteelSeries, Chicago, IL, USA), and the video analyzes the free software Kinovea0.8.15 (Boston, MA, USA). The calibration was recognized in every trial. Participants were voluntary physiotherapists: 1st year (n=4), 7th year (n=1), 9th year (n=4), 10th year (n=3), 11th year (n=4), 13th year (n=1), and 21st year (n=1).

The procedures was as follows. A short video of a hemiplegic gait was prepared. The eye movement data of the individuals with seven years' clinical experience were scanned during the visual gait analysis of the video. For the measurement, the participant was asked to view a video of a simulated hemiplegic gait twice for 10 seconds, and the trajectory of the participant's gaze was recorded by an eye-tracking device. The participants were instructed to perform motion analysis while viewing the videos and to record the analysis results after viewing. The standard deviation of the two measured eye trajectories was then calculated, and a discriminant analysis was performed using IBM SPSS Statistics for Windows (ver. 26.0, IBM Corp., Armonk, NY, USA), with the number of years of experience of 10 years or more as the objective variable and the X-axis deviation and Y-axis deviation as explanatory variables. Cluster analysis (Ward method, Euclidean distance using raw data) was conducted for grouping.

The Ethics Committee of Tokoha University approved the research proposal (ethics number: 17-24).

RESULTS

The mean X-axis and Y-axis deviations by years of experience were 1st year (5.5 ± 0.8 (px), 33.4 ± 10.1 (px)), 7th year (12.6 (px), 55.8 (px)), 9th year (16.5 ± 0.4 (px), 83.3 ± 6.5 (px)), 10th year (25.7 ± 7.6 (px), 85.3 ± 3.8 (px)), 11th year (13.9 ± 2.7 (px), 83.5 ± 9.6 (px)), 13th year (23.1 (px), 96.6 (px)), and 21st year (18.0 (px), 99.6 (px)). As for the classification of therapists according to their years of experience, we were able to classify them into those with more than 10 years of experience and those with less than 10 years of experience according to the size of the deviation between the X-axis and Y-axis of the range of gaze tracking during movement analysis measured from each therapist. Discriminant analysis showed that the percentage of classification accuracy in the 10th year or less was 72.2% (Table 1). The cluster analysis included all participants, and their similarity was calculated using the square Euclidean distance. Cluster analysis results showed that two clusters were formed. All therapists in cluster 2 were in their 9th year or more (Fig. 1).

Table 1. Results of the diiscrimminant analysis

	Model
Predictor variable	X-axis (0.342)
	Y-axis (0.756)
Wilk's lambda	0.061 (p=0.022)
Canonical correlation	0.632
Classification accuracy	72.2% (66.7%)

Discriminant model considering the anthropometric characteristics and flexibility variables.
Predictor variable showed significant predictor variables, with standard discriminant coefficients in brackets. Wilk's lambda showed its value and the significance in brackets. Classification accuracy showed a percentage of cases correctly classified, with cross-validated classification accuracy shown in parenthesis.

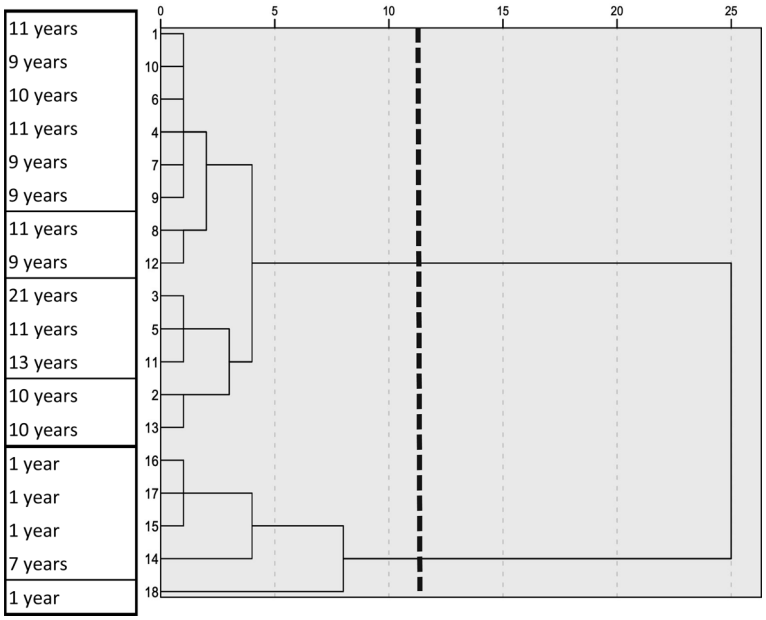

Fig. 1. Diagram of relationships among the number of years of experience (dendrogram). The dotted line to separate into 2 clusters.

DISCUSSION

Eye tracking trajectories can be classified by the 10th year of experience as a therapist. If the number of years of experience is less than nine years, the trajectories can be separated to some extent. It is possible that more years of experience does not necessarily mean that the physiotherapists belong to the skilled group.

The trajectory in the Y-axis direction tends to be extended rather than focused. Quantitative judgments, such as eye-tracking results, may also serve as indicators of proficiency. Although years of experience alone cannot clarify differences in individual skills, it is usually said that an individual qualifies as a full-fledged therapist after gaining 9 or 10 years of experience, which is reasonable from the perspective of expanding eye tracking.

In the field of gaming, there are reports of significant performance improvements associated with provision of eye-tracking feedback[15, 16]. At the end of the gaze training program, students reported a decrease in time and number of fixation points, and progress in skills toward the level of a practicing cell engineer[17]. Moreover, it is predicted that movement analysis skills can also be trained using eye-tracking devices as feedback systems for physiotherapists' perspectives.

In terms of years of experience, studies on occupational therapy[18] report that therapists with less than 10 years of experience are more likely to experience burnout and display inefficiency in decision-making. It can be presumed, therefore, that inexperienced occupational therapists have: 1) a greater workload and 2) find it more difficult to cope with work situations than more experienced therapists[19].

It is said that it takes about ten years of training to become an expert chef, as in "three years to cook rice, eight years to make sushi". This means that it takes approximately 10 years of experience to master a technique. In this study, the 10th year was also the turning point, indicating that a certain level of experience is necessary at this stage to transition from novice to expert in the therapist field. Moreover, experience was shown to be involved not only in decision-making and job processing skills, but also in technical aspects, such as motion analysis. Not only knowledge from textbooks, but also skills gained from experience were needed in the field of motion analysis. From this study, the eye movements are important as a tool to objectively measure skills from experience, although it will take 10 years to obtain them. There are several notable limitations of the study. In this study, the movement analysis was screen-based. In addition, the participant demographics were unevenly distributed, and data from therapists with many years of experience were lacking. Moreover, eye tracking does not necessarily indicate cognitive aspects (i.e., analytical ability). However, only the range of eye tracking was covered. We recommend that gazing points and gazing time should be examined in future studies.

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Conflict of interest

None.

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