Assessment of the Reproducibility of Pupillometer Measurements obtained from a Virtual Reality Headset: a control subject analysis.

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Introduction

The evaluation of pupillary responses is a fundamental process in identifying neurological and ocular conditions. However, the subjectivity involved in traditional assessment techniques has frequently resulted in inconsistent and unreliable diagnoses. Although there have been improvements in this field, the need for an objective and consistent method remains unmet, with current practices still relying heavily on the subjective judgment of clinicians.

Virtual reality (VR) technology offers a potential breakthrough with its precise eye tracker as a valuable tool for enhancing the accuracy of pupillary assessments. This study investigates the use of a VR headset integrated with specialized software as a novel approach to pupillary measurement.

Purpose

To evaluate the reliability of pupillometer measurements obtained from a novel software application incorporated into a commercially available virtual reality (VR) headset (Heru Prime, Heru, Miami, FL).

Methods

A total of 25 consecutive subjects participated in the study. Each subject was assessed using the VR-based pupillometer on three separate occasions within a single day. The measurements recorded included pupil size in dim and bright light conditions, as well as the velocity of pupillary constriction (Figure 1).

The data obtained were then analyzed using Intraclass Correlation Coefficient (ICC) and Cronbach's alpha to assess the reproducibility of the measurements.

Results

Out of the 25 consecutive subjects, 24 completed all three tests and were included. High reproducibility measurements for pupil size in both dim and bright light conditions were found, with Cronbach's alpha values of 0.987 and 0.985, respectively. Intraclass Correlation Coefficient (ICC) for average measures was 0.981 (95% CI: 0.959 to 0.991) for dim light and 0.973 (95% CI: 0.909 to 0.988) for bright light. For accommodation measurements, the results demonstrated good consistency, with a Cronbach's alpha of 0.837 and an ICC for average measures of 0.829 (95% CI: 0.724 to 0.898). The reproducibility was moderate for the velocity of pupillary constriction, with a Cronbach's alpha of 0.716 and an ICC for average measures of 0.717 (95% CI: 0.544 to 0.832).

Pupillary reactivity was categorized into three groups based on constriction velocity: non-reactive (velocity < 0.4 mm/s), sluggish (0.4 mm/s ≤ velocity < 0.8 mm/s), and brisk (velocity ≥ 0.8 mm/s). The measured reproducibility among these categories was 100%.

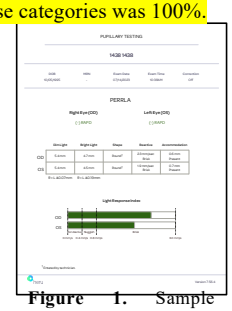

Figure 1. Sample report generated by the VR-based pupillometer.

Figure 2. Study subject undergoing the VR-based pupil test protocol

Table 1. Reproducibility analysis of pupillary metrics in control subjects.

	Cronbach's alpha	ICC – Average Measures	95% CI		ICC– Single Measures	95% CI	
			Lower	Upper		Lower	Upper
Dim Light (Diameter mm)	**0.987**	**0.981**	0.959	0.991	**0.946**	0.886	0.973
Bright Light (Diameter mm)	**0.985**	**0.973**	0.909	0.988	**0.922**	0.770	0.966
Reactive Velocity (mm/s)	**0.716**	**0.717**	0.544	0.832	**0.458**	0.284	0.622
Pupil Reactivity Category	**1.000**	**1.000**			**1.000**		
Accommodation (mm)	**0.837**	**0.829**	0.724	0.898	**0.618**	0.467	0.747

Intraclass Correlation Coefficient (ICC), Confidence Interval (CI)

Conclusion

Our results indicate that a pupillometer based on a wearable VR device can provide consistent and reproducible pupillometry results, demonstrating its potential as a reliable tool for pupillary assessment.

References

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