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Analyzing the Effect of Age and Gender on the Blink Reflex using MediaPipe

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Abstract: The glabellar tapping reflex (GTR) is a sign related to brain conditions and can be analyzed by clinicians for diagnostic purposes. To facilitate the quantitative analysis of this reflex, we developed a video-based tool using the MediaPipe framework. We tested our approach on healthy subjects to assess the effect of age and gender on reaction time and blinking duration. The reaction time results show that the young group has a mean value (±standard deviation) of 0.091 (±0.066) seconds and the old group has 0.085 (±0.052) seconds, while female and male subjects have 0.097 (±0.053) seconds and 0.080 (±0.064) seconds respectively. For blinking duration, males have a mean value of 0.216 (±0.077) seconds and, females have 0.189 (±0.115) seconds, while old and young groups have 0.132 (±0.039) seconds 0.267(±0.084) seconds respectively.

Keywords: Blinking Reflex, Video-based Analysis, MediaPipe, Gender-based Analysis, Healthy Adults

1 Introduction

The eye lids are closed via the blink reflex. Multiple stimuli can prompt eye lid closure and lead to a multitude of terms describing the blink reflex. For instance, tapping of the glabella region of the forehead result in eye lid closure. The glabellar tapping reflex (GTR) is a clinical examination method defined by Dr. Overend [9] to elicit the primitive glabellar reflex. This process is generally executed by gently tapping the person's glabellar region (area between eyebrows) using the index finger. Based on conventional theory, a healthy person habituates to the stimulation and stops blinking after a few taps or does not blink at all [8]. On the other hand, the lack of habituation is generally associated with some brain-related conditions such as dementia, parkinsonism, etc. [13]. This important connection between GTR and brain conditions has been widely studied by researchers [4, 5, 10] and compared with age-matched control groups [2, 12].

Non-contact blinking detection or tracking is an important research field among researchers focusing on topics such as sleepiness or fatigue detection [1, 6, 7]. However, these works do not focus on the glabellar tapping simulated eye-blinking reflex which is generally used by neurologists in clinical observation. To facilitate the quantification and analysis of this reflex, automated video-based tools could help and provide an objective quantitative analysis.

In this paper, we present a video-based approach using the MediaPipe Face Mesh algorithm [3] to analyze the GTR of healthy old and young subjects as well as to perform a gender-based comparison in terms of reaction time and blinking duration.

2 Material and Methods

In this section, we describe the data recording and processing.

2.1 Participants and Video Recordings

Twenty-three healthy (9 women and 14 men, aged between 21 to 77 years, mean age 40.3 years (± 21.3)) adults with normal ocular function and without any known neurological diseases participated in the study. The subjects were divided into two age groups and two gender groups: 13 young subjects, up to 24 years (range 21 to 24 years, mean age 22.5 (±0.9)) years, and 10 old subjects, older than 53 years (range 53 to 77 years, mean age 63.5 (±6.9)) years.

The videos were taken so that the full face of the subject is visible in the frame. The experimenter tapped the glabellar region of the subject 5 times with a random time invterval lasting an average of 24.3 seconds (±6.164). All videos were recorded at Aachen University Hospital Department of Neurology. The study was conducted in accordance with the Declaration of Helsinki, approved by the Institutional Review Board of the Faculty of Medicine of Rheinisch-Westfälische Technische Hochschule Aachen (reference number EK 369–19) and informed consent was obtained from all participants. Image pro-

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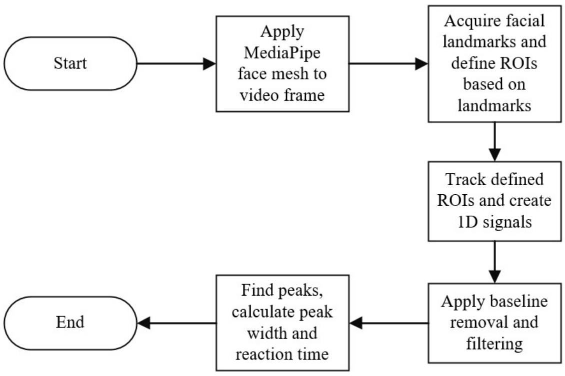

Fig. 1: Analysis tool flowchart.

cessing was performed with Python (Python Software Foundation) and Matlab (Mathworks, Natick, MA, USA).

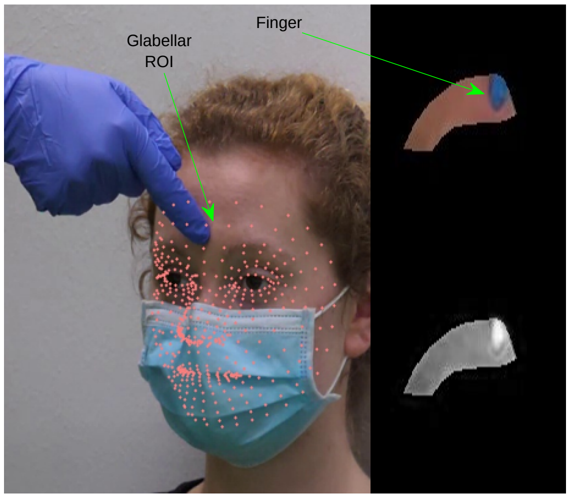

Fig. 2: Glabellar ROI selection and tracking (left facial landmarks with tapping, top right RGB frame and bottom right blue channel).

2.2 Data extraction and processing

Our video-based analysis tool to quantify GTR follows the steps given in Fig. 1.

MediaPipe face mesh produces 468 landmarks in x-y-z coordinates. Using these coordinates, glabellar and eye regions of interest (ROIs) are selected. The glabellar ROI is defined based on landmarks from the mesh. For the eye ROI, based on eyelid landmarks, a rectangular ROI is defined including the eye (pixels out of the eye are set to zero). Afterwards, the blue channel of the glabellar ROI (experimenter wears a blue or blue-toned glove) is used and the average pixel value (brighter values with finger intervention) is used to create a 1 dimensional (1D) signal. Fig. 2 shows tracked glabellar ROI and facial landmarks.

Mesh landmarks also provide the ability to track eyelids. To create the blinking signal, for each video frame, the number of non-zero pixels from the eye ROI is counted and then reversed to acquire a 1D signal having a positive amplitude. Fig. 3 shows tracked eye ROI.

At the processing step, baseline removal and a low-pass filter at 0.75 Hz (corresponds to 45 blinks per minute, and found empirically, to reduce the effect of illumination change) are applied to extracted signals. Peaks of tapping and blinking signals are detected using Matlab's built-in *findpeaks* function. We defined two parameters to compare: The first is reaction time (see Equation 1) to the tap which occurs within 200 ms after the tap. The second is blinking duration (see Equation 2) to refer to how long lasts a blinking of the subject. Following equations define parameter calculations.

$$\mathrm{rt}_i = \mathrm{bt}_i - \mathrm{tt}_i \tag{1}$$

Fig. 3: Tracked eye ROI with eye blinking.

where rt_i is the reaction time of the i-th reflex blinking, bt_i is the time of i-th reflex blinking and tt_i is the time of the i-th tapping. In terms of blinking duration,we calculate full width at half maximum to measure the width of the signal in a robust way.

$$\mathrm{pw}_i = \mathrm{hpt,r}_i - \mathrm{hpt,l}_i, \tag{2}$$

where, pw_i is the peak width of i-th reflex blinking, $\mathrm{hpt,l}_i$ and $\mathrm{hpt,r}_i$ are the times at half peak height of i-th reflex blinking signal (on left-hand-side and on right-hand-side respectively).

An example of extracted 1D tapping and blinking signals with calculated parameters are given in Fig. 4.

3 Results and Discussion

Tab. 1 presents the averaged reaction time and blinking duration results of the participants to 5 sequential taps and Tab. 2 shows group-wise averaged results.

In Tab. 2, based on reaction time, the young subjects have a slightly higher group mean value of 0.091(±0.066) seconds than the old subjects of 0.085(±0.052) seconds, while female and male subjects have 0.097(±0.053) seconds and 0.080(±0.064) seconds respectively. Fig. 5 presents the distributions of calculated mean reaction times.

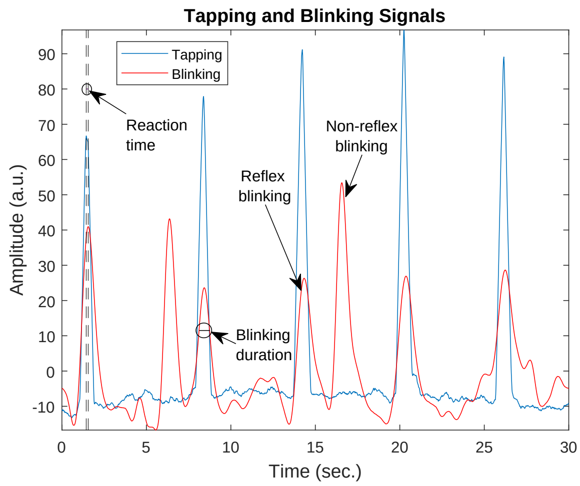

Fig. 4: Example blinking and tapping signals with reaction time and blinking duration.

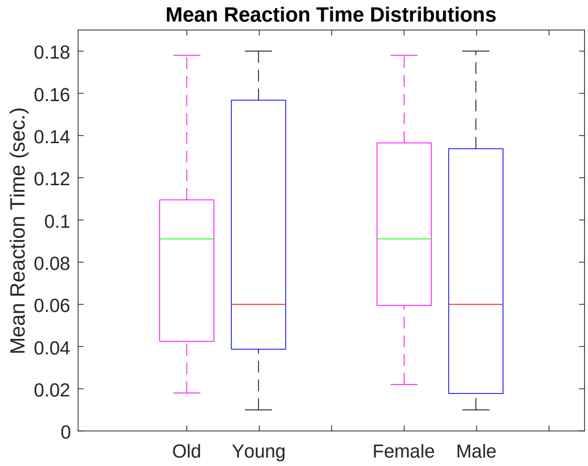

Fig. 5: Reaction time distributions of participants.

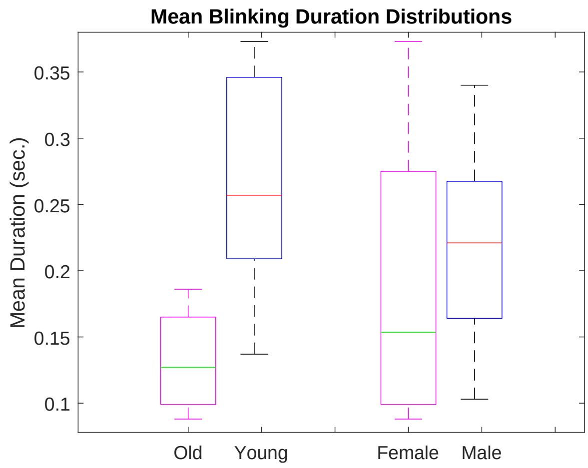

Fig. 6: Blinking duration distributions of participants. Old-young cohort has a significant difference (p-value = 0.0025).

Tab. 1: Mean reaction times and blinking durations.

Subject (Young)	Reaction Time (sec.)	Duration (sec.)	Subject (Old)	Reaction Time (sec.)	Duration (sec.)
Y01-M	N.B	N.B	O01-F	0.178	0.088
Y02-M	N.B	N.B	O02-M	N.B	N.B
Y03-M	0.017	0.137	O03-F	0.022	0.186
Y04-M	0.154	0.340	O04-F	N.B	N.B
Y05-M	0.010	0.173	O05-M	0.018	0.174
Y06-F	0.165	0.364	O06-F	0.083	0.100
Y07-M	0.127	0.221	O07-F	0.099	0.151
Y08-M	N.B	N.B	O08-M	0.111	0.103
Y09-M	0.046	0.299	O09-F	0.063	0.098
Y10-M	0.060	0.257	O10-F	0.108	0.156
Y11-M	N.B	N.B			
Y12-F	0.056	0.373			
Y13-M	0.180	0.238			

N.B:No blinking, F:Female, M:Male

Tab. 2: Group-wise averaged results in terms of mean (±standard deviation).

Group	Reaction Time (Sec.)	Duration (Sec.)
Old	0.085(±0.052)	0.132(±0.039)
Young	0.091(±0.066)	0.267(±0.084)
Female	0.097(±0.053)	0.189(±0.115)
Male	0.080(±0.064)	0.216(±0.077)

From Fig. 5, we see that the old subjects have a higher median value with a lower variability compared to the young subjects as well as female subjects compared to males. Based on the Wilcoxon rank sum test, there is no significant difference between young-old and female-male groups (p-values of 0.9626 and 0.5414 respectively).

Considering blinking duration, the old group shows a lower group mean value of 0.132(±0.039) seconds than the young group of 0.267(±0.084) seconds, while males show 0.216(±0.077) seconds and females show 0.189(±0.115) seconds. Fig. 6 presents the distributions of calculated blinking durations.

In Fig. 6, the young group has a higher median value and wider spread compared to the old group, meaning that the old group blinks faster than the young group in a statistically significant way (p-value = 0.0025). For the gender-wise comparison, male subjects have a higher median value with a lower variability compared to female subjects without a statistically significance (p-value = 0.3704).

In this work, we aimed to present a MediaPipe-supported video-based analysis tool to analyze the GTR blinkings of healthy subjects. To the best of our knowledge, there is no comparative study on GTR reaction time and duration of healthy young and old subjects as well as gender-wise comparison. However, Peddireddy et. al [11] investigated the effect of aging and gender on the blinking reflex using a different stimuli and electromyography (EMG) recordings. They reported that there was no significant difference for the blinking onset latencies between young-old subjects and female-male subjects. As for duration, there was no significant difference between female-male subjects while it was significantly different between young-old subjects (the duration was longer in the old subjects than the young subjects). Direct comparison of our work may not be applicable due to different stimuli and recording method, yet, our findings on reaction time support the literature resulting in with no significant difference between young-old subjects (p-value = 0.9626) and female-male subjects (p-value = 0.5414). For blinking duration, our results on female-male subjects again support the literature findings by showing no significant difference (p-value = 0.3704). On the other hand, based on our results the young group has a statistically significant higher blinking duration compared to the old group (the young group blinks slower), which is an interesting deviation from the literature findings that needs more analysis.

4 Summary and Future Works

We proposed a video-based method using MediaPipe framework to analyze the glabellar tapping reflex on healthy subjects, including the influence of age and gender. This method enables tracking both glabellar and eye ROIs as well as quantifying differences between blinking behaviors of the young-old and female-male subjects. In the future, we aim to apply this method to real patients and healthy controls to compare their blinking behaviors.

Author Statement

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