How Does Wearing a Facecover Influence the Eye Movement Pattern in Times of COVID-19?

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Abstract

Background: Since the emergence of the COVID-19 pandemic facecovers have become a common sight. The effect of facecovers on the gaze when looking at faces has not been assessed yet.

Objective: The aim of the present study is to investigate a potential difference in eye movement pattern in observes which are exposed to images showing a face without and with facecover to identify if there is truly a change of gaze when identifying (masked) facial features.

Materials and Methods: The eye movement of a total of 64 study participants (28 males and 36 females) with a mean age of 31.84±9.0 years was analyzed in this cross-sectional observational study. Eye movement analysis was conducted based on positional changes of eye features within an x- and y- coordinate system while two images (face without/with facecover) were displayed for 8 seconds.

Results: The results of this study revealed that the sequence of focussing on facial regions was not altered when wearing a facecover and followed the sequence: perioral, nose, periorbital. Wearing a facecover significantly increased the time of focussing on the periorbital region and increased also the number of repeated eye fixations during the interval of visual stimulus presentation. No statistically significant differences were observed between male and female participants in their eye movement pattern across all investigated variables with $p > 0.433$.

Conclusion: Aesthetic practitioners could utilized the presented data and develop marketing and treatment strategies which majorly target the periorbital area understanding the altered eye movement pattern in times of COVID-19.

Since its emergence in November 2019, the COVID-19 pandemic has changed todays' society and the field of medicine and plastic surgery fundamentally. [1–4] With approximately 58 million reported cases of COVID-19 infections and 1.5 million reported deaths world-wide, healthcare workers and governments are facing the biggest pandemic of the 21st century. [5] Physical distancing, limited travels and reduced social interactions have been implemented to influence the spread of the virus and to ultimately reduce virus related mortality. [1,6] A globally accepted measure to reduce the transmission of the virus was the introduction of facecovers/facemasks to prevent virus-loaded aerosols from spreading.

Concerns have been expressed that facecovers will inhibit the physiological exchange of in- and exhaled air and might lead to a limited supply of fresh oxygen. [7,8] However, the psychological and sociological aspects of wearing facecovers have been majorly disregarded. Previous eye movement pattern analyses have shown that the perioral region conveys the most relevant information for discriminating between expressive and non-expressive faces [9] and that the lower face was most frequently addressed during expression discrimination tasks.[10] However, the periorbital region was most important for static information like gender and expression categorization.[10]

These results could indicate that wearing a facecover would limit the ability of an observer to identify and to assess a persons' facial expression and therefore might shift its attention to other facial areas which remain uncovered by a facecover like the frontal or periorbital regions. It could be hypothesized that the gaze of an observer changes in its pattern (sequence of scanning the face) and in its attention span (focusing more time on uncovered facial regions) when observing a face with/without a facecover. This would consequently indicate that uncovered facial regions receive more attention than covered facial regions which could ultimately lead to a shift in the desire toward aesthetic procedures.

Recent internet and market analyses have indicated a change in the desire for aesthetic procedures which were related to the presence of the COVID-19 pandemic.[11,12] Jenny et al. concluded that interest increased the most for non-invasive procedures and facial surgery since the beginning of the COVID-19 pandemic.[12] However, it has to be noted that the desire for aesthetic procedures during times of COVID-19 is substantially influenced by the availability of a health care provider (due to closure of practices) and by the financial power of the patient and might only be a secondary marker of an altered behavior when it comes to aesthetic procedures.

It might be hypothesized that the facecover of the lower face, including the perioral region, leads to a reduced visual stimulus, consequently resulting in a loss of gaze intensity in this area, while shifting an observer´s focus to exposed areas of the face, such as the periorbital region. Increased fixation of the periorbital region might, in turn, have several implications for both patients seeking aesthetic treatments, as well as aesthetic physicians. An increased focus on the periorbital region might on the one hand reveal signs of aging, while on the other hand increasing visibility of surgical manipulation, as the periorbital region ascends to the centre of attention. Thus, the aim of the present study is to investigate a potential difference in eye movement pattern in observes which are exposed to images showing a face without and with facecover to identify if there is a change of gaze when identifying (masked) facial features. This would allow drawing conclusion about a primarily altered behavior of individuals seeking aesthetic procedures in times of COVID-19.

METHODS

Study sample

The eye movement of a total of 64 study participants was analyzed in this cross-sectional observational study. The study participants were recruited from at the Department of Hand, Plastic and Aesthetic Surgery of the Ludwig – Maximilian University Munich, Germany without specific inclusion criteria. Exclusion criteria were severe vision impairment which would not allow for the participant to assess the presented images or if bi-ocular vision was not possible (f.i. due to loss of an eye).

Prior to the enrolment into the study, participants were informed that their gaze will be recorded upon looking at images and provided written informed consent for the use of their data and associated images. The study was approved by the Institutional Review Board of Ludwig-Maximilian University Munich (IRB protocol number: 20-1018) and conducted in accordance with regional laws (Germany) and good clinical practice. The study was conducted between October 2020 and November 2020.

Eye movement analysis

The eye movement of each participant was assessed using a Tobii Pro Nano binocular eye – tracker (Tobii Pro AB, Stockholm, Sweden). The eye-tracking device was attached to the inferior aspect of a laptop monitor and recorded each participant's eye movement at a frequency of 60 Hz. The utilized laptop monitor was a 15" commercially available laptop (Surface Laptop 3, Microsoft, Redmond, WA, US) with a screen size of 340 mm x 244 mm. The area of eye movement capture by the eye-tracking device was was 35 cm x 30 cm at a distance of 65 cm to the laptop monitor.

Eye movement capture is based on the digital recognition of the corneal light reflex and on the contrast between the dark iris and the white sclera using an EyeChip processor (Tobii Pro AB, Strockholm, Sweden). Eye movement analysis is based on positional changes of the above described eye features within an x- and y- coordinate system over a certain time period Tobii Pro Lab Software (Tobii Pro AB, Stockholm, Sweden). A stable eye fixation was defined as the constant eye position toward a predefined area of interest which lasted longer than 0.08 sec.

Visual stimulus

Participants were asked to sit upright on a stable chair with a fixed backrest at a distance of 45 cm to the laptop monitor. Eye movement pattern was recorded while two separate images were shown to the participants: the images displayed the frontal view of a 26 year old female without and with a commercially available surgical facemask (3M™ Earloop Procedure Face Mask 1820, St. Paul, MN, USA) (Figure 1). Each image was displayed for 8 seconds to the 64 participants with a white screen between the images for the duration of 2 seconds to allow for eye movement readjustment. All eye movement analyses were conducted in the same location under similar light conditions to assure consistency throughout data capture.

Before the eye movement analytic cycle, a calibration test was conducted for each participant individually to calibrate the system. The average calibration accuracy across all 64 study participants was 1.46 ± 0.5 degrees and 64 ± 19 pixels with a mean accuracy of 15.1 ± 3.3 mm.

Data analysis

The captured data (eye movement pattern for the two displayed images) was processed with the eye-tracking internal software toolkit (Tobii Pro Lab Software, Tobii Pro AB, Strockholm, Sweden). Additional to the total image analysis (of the two displayed images), equal areas of interest were defined in both images (with and without a facemask) which included the periorbital region, the nose and the perioral region. The following variables were analyzed for the total time of stimulus exposure (= 8 seconds) (Figure 2, 3):

- Time until first fixation (= interval between initial exposure of the visual stimulus and eye fixation to the pre-defined areas of interest) (Figure 3)
- Time of fixation (=duration of eye fixation to the pre-defined areas of interest within the time of visual stimulus exposure = 8 sec) (Figure 4)
- Count of fixation (= number of repeated eye fixations to the pre-defined areas of interest within the time of visual stimulus exposure = 8 sec) (Figure 5)

Statistical analysis

Differences in the variables of interest between the two stimulus images (with and without a facemask) were calculated using paired student's T-Test and between the different facial regions of interest (periorbital, nose, perioral) using multivariate analysis (ANOVA). All calculations were performed using SPSS Statistics 26 (IBM, Armonk, NY, USA) and results were considered statistically significant at a probability level of ≤ 0.05 to guide conclusions.

RESULTS

General observations

The eye movement of a total of 64 study participants (28 males and 36 females) with a mean age of 31.84 ± 9.0 years [Range: 20 – 56| was analyzed in this cross-sectional observational study. No statistically significant differences were observed between male and female participants in their eye movement pattern across all investigated variables with $p > 0.433$.

Eye movement pattern (face without facemask)

The facial region with the shortest time for their first fixation was the perioral region with 0.50 (1.0) sec followed by the nose with 1.38 (1.4) sec and by the periorbital region with 1.79 (0.8) sec ($p < 0.001$) (Figure 4).

The facial region with the longest duration of a stable eye fixation during the 8 sec stimulus exposure was the periorbital region with 3.73 (1.4) sec followed by nose with 0.69 (0.6) sec and by the perioral region with 0.20 (0.4) sec ($p < 0.001$) (Figure 5).

The facial region with the greatest count of eye fixations during the 8 sec stimulus exposure interval was the periorbital region with 13.44 (4.6) followed by nose with 2.69 (2.4) and by the perioral region with 0.98 (2.3) ($p < 0.001$) (Table 1) (Figure 6).

Eye movement pattern (face with facemask)

Displaying the stimulus image with a facemask for the duration of 8 seconds revealed that the shortest time until the first stable fixation occurred was again the perioral region (despite covered by a mask) with 1.30 (1.2) sec which represents a statistically significant increase of 0.80 sec and $p < 0.001$ when compared to the stimulus image without a facemask. The sequence of the next fixated facial region was the nose with 1.31 (1.3) sec (difference to without a face mask: - 0.07 sec with $p = 0.761$) and by the periorbital region with 1.51 (0.7) sec (difference to without a face mask: - 0.29 sec with $p = 0.031$).

The facial region which had the longest duration of a stable eye fixation during the 8 sec stimulus exposure was the periorbital region with 5.47 (1.4) sec (difference to without a facemask: + 1.74 sec with $p < 0.001$) followed by the perioral region with 0.57 (0.5) sec (difference to without a facemask: + 0.37 sec with $p < 0.001$) and followed by the nose with 0.55 (0.6) sec (difference to without a facemask: - 0.14 sec with $p = 0.180$). There was a statistically significant difference when comparing the duration between the three investigated facial areas with $p < 0.001$.

The facial region with the greatest count of eye fixations during the 8 sec stimulus exposure was the periorbital region with 18.42 (5.4) (difference to without a facemask: + 4.98 with $p < 0.001$) followed by nose with 2.52 (2.2) (difference to without a facemask: - 0.17 with $p = 0.670$) and by the perioral region with 2.44 (2.6) (difference to without a facemask: + 1.45 with $p < 0.001$). There was a statistically significant difference when comparing the count between the three investigated facial areas with $p < 0.001$ (Table 1).

DISCUSSION

This cross-sectional observational study was designed to investigate the eye movement pattern of 64 volunteers when exposed to two different images: a face without a facecover vs. a face with a facecover. The results revealed that the volunteers focussed first on the perioral region followed by the nose and the periorbital region when observing the image of a face without a facecover. Interestingly, this sequence did not change when the volunteers observed the image of a face with a facecover. However, the time to focus on the perioral region statistically significantly increased in time by 0.80 sec in the presence of a facecover but decreased by - 0.07 sec when focussing on the nose and decreased by - 0.29 sec when focussing on the periorbital region. These results indicate that in the study setup the volunteers focussed in the following sequence: perioral, nose, periorbital independent whether the displayed image showed a female without/with a facecover. This is in line with previous investigations on eye movement pattern which have indicated that the perioral region is most informative for an observer if the type of a facial expression is to be analyzed.[10] Covering this area with a facecover does not alter the desire of an observer to inspect this area first but results in a longer time until this area is inspected. It could be hypothesized that the presence of a facecover is identified first and then the sequence of perioral, nose and periorbital is initiated. This is supported in our study by the statistically significant increase in time to focus on the perioral area with $p < 0.001$. It can be further speculated that once the observer does not receive the desired information from the perioral area, they focus faster on the other facial regions to obtain the desire dinformation. This is supported in the present investigation by the statistically significant decrease in time to focus the nose and on the periorbital region with $p = 0.031$.

Wearing a facecover limits the ability to receive information from the perioral region which shifts the focus toward the periorbital region. The periorbital region provides the greatest amount of information per area and is crucial in determining whether a face has been seen before, classification of gender and expression categorization.[13–17] In the present study, the periorbital region was focussed longer than the nose and the perioral region independent of the presence of a facecover. When observers inspected the image with a facecover, the periorbital region was statistically significantly focussed on longer ($p < 0.001$) when compared to the image without a facecover. This could be potentially explained by the need to extract more information from this facial region as the majority of the face was not available for information extraction. A similar trend was observed for the number of fixation points which was statistically significantly increased when compared to the exposure to the image without a facecover with $p < 0.001$.

The results of the present study could help to understand the perception of patients when being exposed to people wearing a facecover in real life, on social media, or when viewing themselves in the mirror. The results showed that the periorbital area is viewed longer when a facecover is present which is not surprising and could have been expected a priori. However, the results of this study provide valid arguments that this is truly the case and provide a fundament to claims as to why aesthetic providers should focus more on the periorbital region than on other facial regions. Offering a spectrum of surgical and minimally-invasive options which are directed to the periorbital region could provide a more targeted approach to the needs of patients in a world where the new normal allows only for the exposure of the forehead, glabella, eyebrows and orbital facial areas.

This study is not without limitations. The volunteers included in this study were of white Caucasian background only. It can be speculated that the results might vary if observers from the Asian or from the African-American community were included. Future studies could focus on the diverse cultural background of todays' patients which could allow for more targeted and diverse stratified results. When comparing the results between male and female observers, no statistically significant differences were detected for all variables investigated with $p > 0.433$. This shows that despite the stimulus image displayed a young female, no gender bias toward the results presented influenced the study outcome. Moreover, displaying a broader range of masked and unmasked facial images, including different genders and ethnic backgrounds, might have added further strength to the study. The fact that the stimulus displayed is a young female might influence the overall gaze pattern. To the knowledge of the authors no data regarding the influence of age on gaze patterns is available to date. In the future, studies should focus on age-dependent gaze patterns, in order to further elaborate on this. It should also be mentioned that the only areas of interest where the periorbital region, nose and mouth region. Observations about gaze changes when looking at other areas of the face were not obtained, but could reveal further informative conclusions i.e. if ears are an area of bigger interest when looking at a bare face or one wearing a facecover. Regarding the areas of interest, the area around the respective structures were chosen slightly bigger than the actual structure itself. This might reflect the way people are assessing faces in a more appropriate manner rather than just focusing on the structure itself.

CONCLUSIONS

The results of this study revealed that the sequence of focussing on facial regions was not altered when wearing a facecover and followed the sequence: perioral, nose, periorbital. Wearing a facecover significantly increased the time of focussing on the periorbital region and increased also the number of repeated eye fixations during the interval of visual stimulus presentation. Aesthetic practitioners could utilized the presented data and develop marketing and treatment strategies which majorly target the periorbital area understanding the altered eye movement pattern in times of COVID-19.

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FIGURE LEGEND

Figure 1. Visual stimulus image of a 22-year-old female without (A) and with (B) facecover presented to the observer for the duration of 8 seconds each.

Figure 2. Eye movement pattern analysis showing the facial regions of interest (A) and a heat map of the stimulus image showing a 26-year-old female without a facecover. The red areas indicate longer eye fixation whereas the green areas indicate a shorter duration of eye fixation (B).

Figure 3. Eye movement pattern analysis showing the facial regions of interest (A) and a heat map of the stimulus image showing a 26-year-old female with a facecover. The red areas indicate longer eye fixation whereas the green areas indicate a shorter duration of eye fixation (B).

Figure 4. Bar graph showing the time until first fixation on the facial regions of interest when presenting the stimulus image without (blue) and with facecover (grey).

Figure 5. Bar graph showing the mean duration of eye fixation on the facial regions of interest during the 8 second interval when presenting the stimulus image without (blue) and with facecover (grey).

Figure 6. Bar graph showing the mean count of eye fixations on the facial regions of interest during the 8 second interval when presenting the stimulus image without (blue) and with facecover (grey).

Table 1. Table showing the mean time until first fixation, mean overall duration of fixation and mean count of fixations for the respective regions (periorbital, nose and perioral) for the visual stimulus presented with and without facecover.

	No Facecover			Facecover		
	Periorbital	Nose	Perioral	Periorbital	Nose	Perioral
Time until first fixation (sec)	1.79 (0.8)	1.38 (1.4)	0.51 (1.0)	1.51 (0.7)	1.31 (1.30)	1.30 (1.2)
Duration of fixation (sec)	3.73 (1.4)	0.69 (0.6)	0.20 (0.4)	5.47 (1.4)	0.55 (0.55)	0.57 (0.53)
Count of fixation	13.44 (4.5)	2.69 (2.4)	0.98 (2.3)	18.42 (5.4)	2.52 (2.2)	2.44 (2.6)

Figure 1A

Figure 1B

Figure 2A

Figure 2B

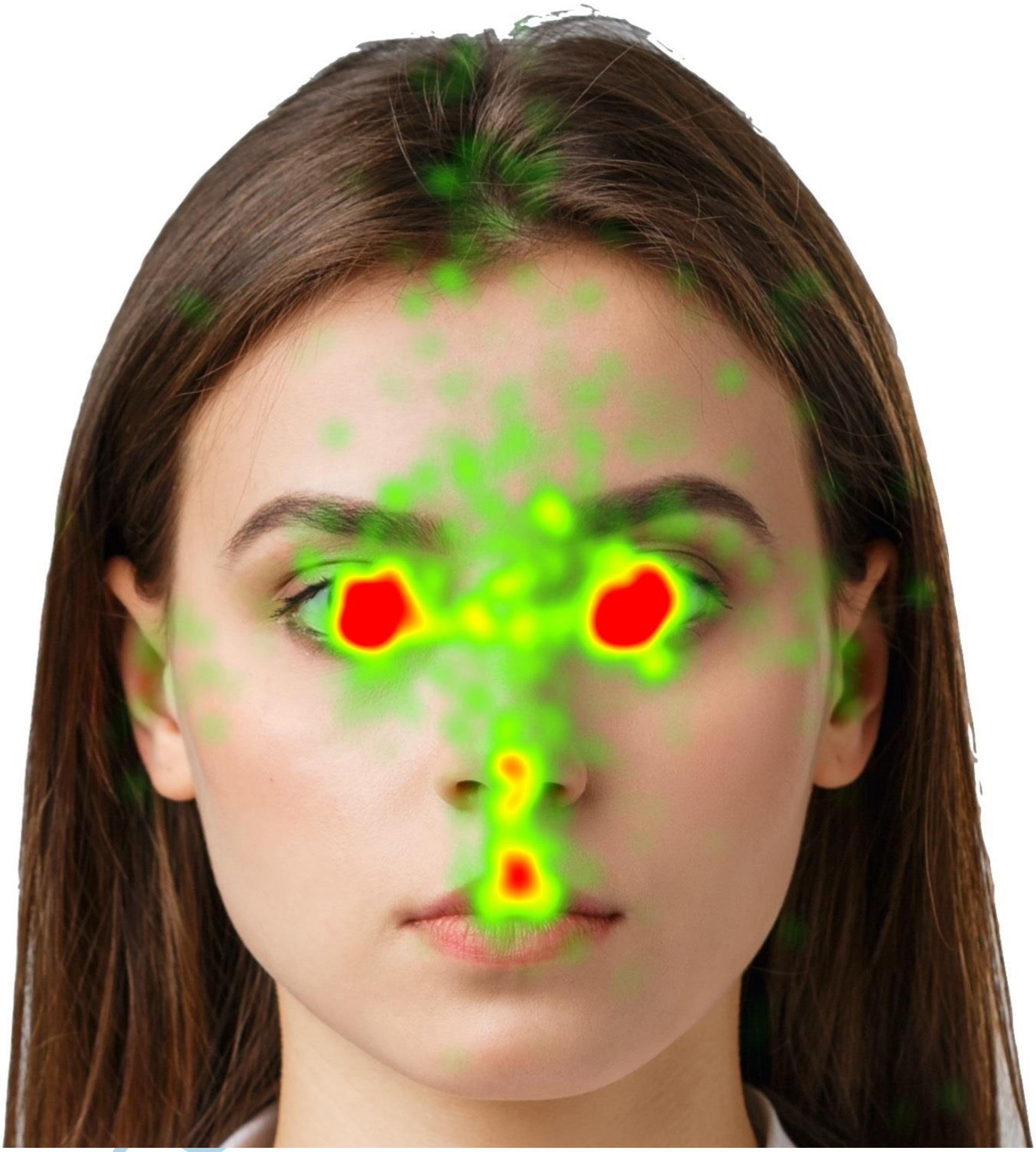
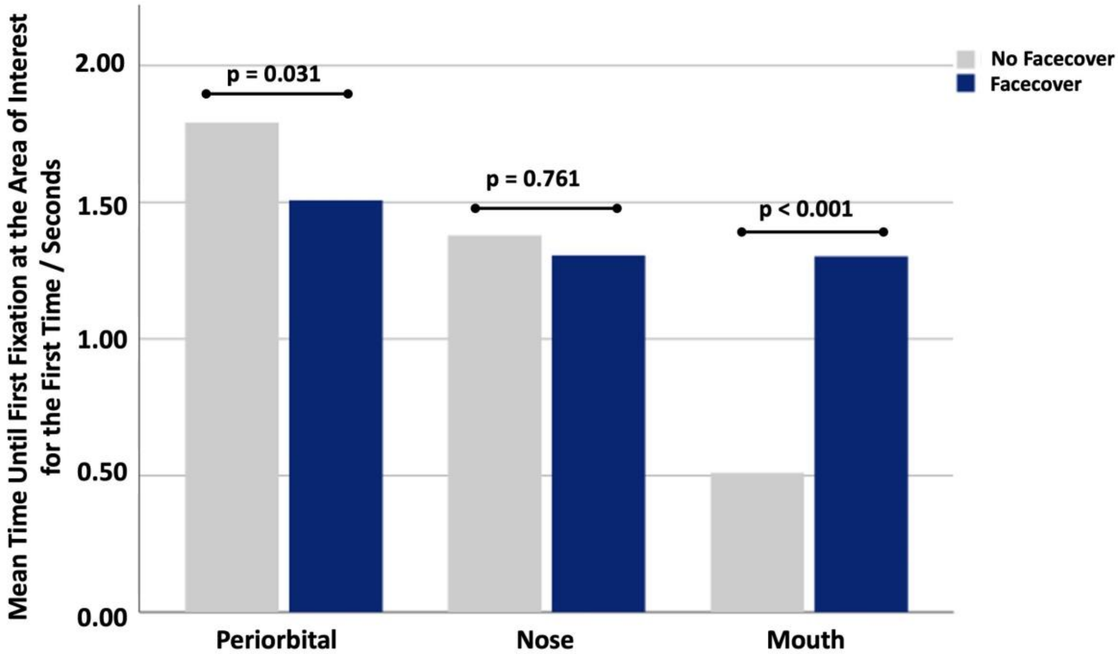


Figure 3A

Figure 3B

Figure 4



Mean Time Until First Fixation at the Area of Interest for the First Time / Seconds
2.00
1.50
1.00
0.50
0.00
p = 0.031
p = 0.761
p < 0.001
No Facecover
Facecover
Periorbital
Nose
Mouth

Figure 5

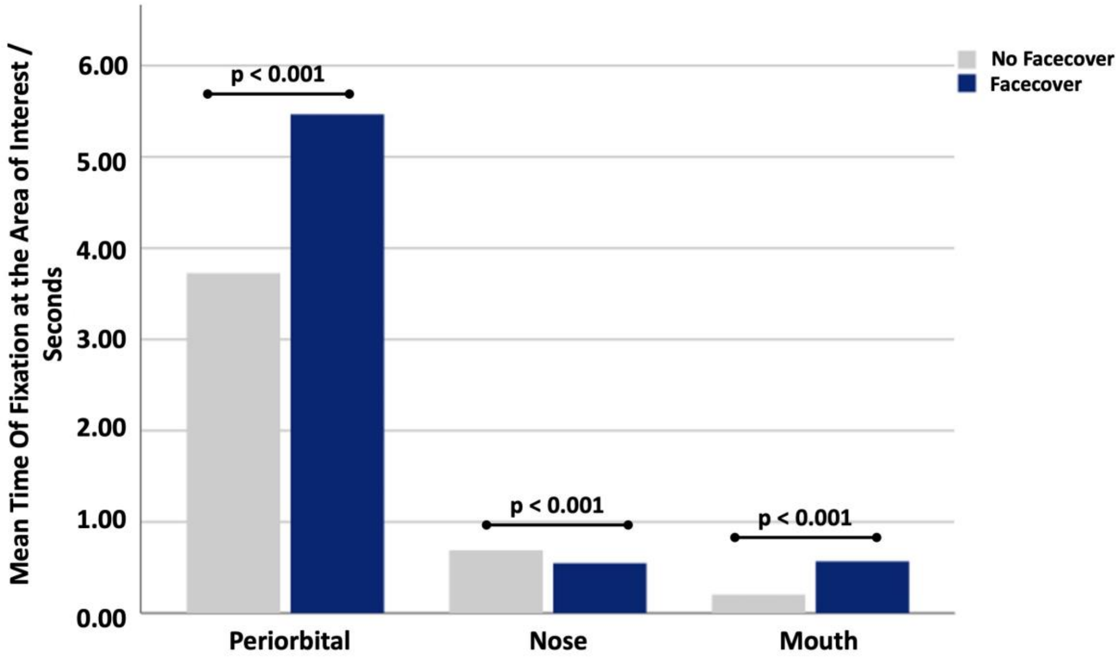
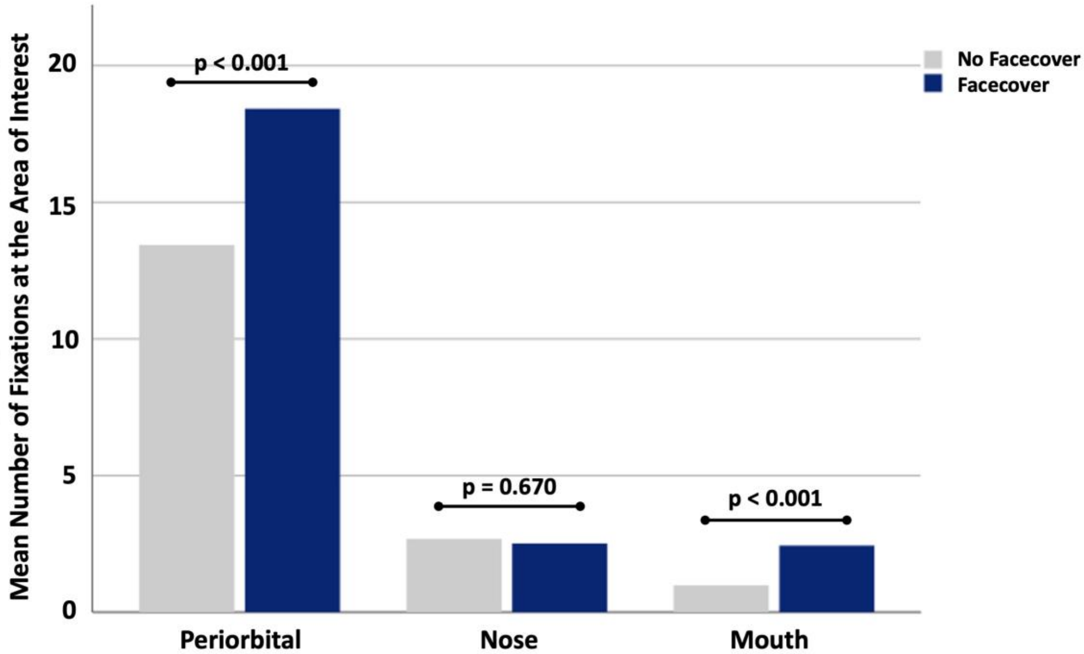

Mean Time Of Fixation at the Area of Interest / Seconds
6.00
5.00
4.00
3.00
2.00
1.00
0.00
p < 0.001
p < 0.001
p < 0.001
Periorbital
Nose
Mouth
No Facecover
Facecover

Figure 6



Mean Number of Fixations at the Area of Interest
0
5
10
15
20
p < 0.001
p = 0.670
p < 0.001
No Facecover
Facecover
Periorbital
Nose
Mouth