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# **Look me in the eyes! A pre-registered eye-tracking study investigating the visual attention and affective reactions to faces with a visible difference**

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## **Abstract**

This research aims to determine how disfigurement alters visual attention paid to faces and to examine whether such a potential modified pattern of visual attention to faces with visible difference were associated, in turn, with perceiver's stigmatizing affective reactions. A pilot study ( $N = 38$ ) and a pre-registered experimental eye-tracking study ( $N = 89$ ) were conducted. First, the visual explorations of faces with and without disfigurement were compared. The association of these visual explorations with affective reactions were investigated next. Findings suggest that disfigurement impacts visual attention toward faces; attention is not merely attracted to the disfigured area but it is also diverted particularly from the eye area. Disfigurement also eases disgust-related, surprise-related, anxiety-related, and, to a lesser extent, hostility-related affective states. Exploratory interaction effects between attention to the eyes and to the disfigured part of the face revealed a hybrid effect on disgust-related affect and an increase in surprise-related affect when participants fixated more upon the disfigured area and fixated less upon the eyes. Thus, perceiver's attention is captured by disfigurement and also diverted from face internal features which seems to play a role in the affective reactions elicited.

**Keywords:** Facial disfigurement, Eye-tracking, Visual attention, Affective states.

## **1. Introduction**

Living with a facial disfigurement may be a devastating social experience leading to psychopathologies (e.g., depression, anxiety; Van Loey & Van Son, 2003). Beyond exceptional although detrimental outcomes (e.g., bullying, hate crimes; Changing Face, 2021) these stigmatized people have to overcome challenges in most of their social encounters (e.g., naked stares, curiosity, teasing; Macgregor, 1990). Many people living with a visible difference suffer from their condition because they have to deal with the gaze of others as much as with the expression of others' emotions which are often negative (e.g., anxiety, disgust) but can also be "positive" (e.g., sympathy) and still remind those affected of their stigmatized condition (Bonanno & Choi, 2010; Macgregor, 1990). This study aims to further explore the way people with no disfigurement pay attention and emotionally react to faces with facial disfigurement.

### **1.1. Investigating how faces with visible difference are looked upon**

Faces form a unique category of visual objects, which play important roles (e.g., biological functions, communication, transmission of social signals; for a review see Hugenberg & Wilson, 2013). Little is known about the impact of disfigurement on face perception whilst authors argue that this visible stigma could be particularly difficult to deal with (see Bruce & Young, 2012; Hugenberg et al., 2016).

Whether it is because of their emotional, social and biological importance, faces are conceptualized as the most important stimuli for social interactions (Hugenberg & Wilson, 2013). The processing of faces is supported by specialized distributed networks within the brain (e.g., fusiform face area; Kanwisher, 2000), faces are detected quickly and capture people's attention compared to other objects (Langton et al., 2008; M. B. Lewis & Edmonds, 2003; Ro et al., 2001; Theeuwes & Van der Stigchel, 2006). This face expertise has been attributed to the ability to process faces configurally (Maurer et al., 2002). This typical process of normal face perception matters as it may contribute to perceiving the humanness on a human face (Hugenberg et al., 2016).

In order to explore visual attention paid to faces, researchers have been using eye-tracking technologies, which enabled them to know where and how people look at faces (Bruce & Young, 2012). Based on the assumption that people gaze more often and longer on more important sources of information (see Rahal & Fiedler, 2019), different cognitive processes can be investigated through eye tracking measures, notably information weighting or processing depth, with total dwell time (i.e., total time spent fixating on a specific location) or time to first fixations. Using eye-tracking technology, the importance of internal expressive features when viewing a face to get useful information (i.e., eyes, nose, mouth) was demonstrated (Min et al., 2017). Specifically, Vo and colleagues (2012) demonstrated that participants stared at the eyes more when watching a photograph of a face making eye-contact, the mouth when the target was speaking and the nose when the target was moving fast. Eyes have received special interest as they are supposed to be a rich source of information (e.g., regarding mental states; Baron-Cohen et al., 1997) and not only as a result of their saliency (Birmingham et al., 2009a).

Despite a great deal of research on the perception of regular faces and although disfigurement stigma is supposed to interfere in faces processing (Hugenberg & Wilson, 2013), little is known about the perception of faces with disfigurement. Nevertheless, some studies have used eye-trackers to investigate attention distracted by the disfigured part of a face. For example, some research works have highlighted how attention is captured by a crooked nose (Godoy et al., 2011), a scar on the cheek (Madera & Hebl, 2012), cleft lips (Dindaroğlu et al., 2017), malocclusion in general (Wang et al., 2016), nasal deformities (van Schijndel et al., 2015), and facial paralysis (Ishii et al., 2016; for a review see Asaad et al., 2020). Ishii and colleagues (2009) demonstrated that facial deformities do not solely attract attention but they also engender a different pattern of visual attention. Yet, as they used scan paths that are difficult to interpret in terms of underlying cognitive processes (Rahal & Fiedler, 2019) and as they did not investigate the impact of this change on the stigmatizing reactions, their findings would benefit from further investigation.

## **1.2. Affective reactions to faces with visible difference**

Affective reactions have been the most studied public stigma reactions to facial disfigurement (see A. Stone & Potton, 2014). People living with facial disfigurement testify to strong emotional

reactions (Macgregor, 1990). More particularly, based on the testimonies of people with disfigurement (including his own), Partridge (1998) described a set of affective states that the perceivers may express, when communication goes wrong between people with and without facial disfigurement. He summarized these affective states in the acronym "SCARED (SCARED meaning "Sorry or Shocked, Curious or Confused, Anxious, Repelled, Embarrassed, Distressed").

From the perspective of the perceivers, various affective states have been evidenced, including negative emotions (i.e., disgust, fear, anger, shame, guilt, sadness, pity), but neutral and positive emotions too (i.e., curiosity, surprise, sympathy, compassion; Blascovich et al., 2001; Shanmugarajah et al., 2012; A. Stone & Potton, 2014). A specific feature lies in the expression of negative emotions. Indeed, Stone & Potton (2014) noticed that negative emotions were evidenced but only in a condition of high anonymity, which underlines how studies examining affective reactions to facial disfigurement have to carefully consider self-presentation biases to limit their impact on the report of affective states. Further, research mixing qualitative and quantitative studies was designed in order to better understand the affective dimension in the public stigma of facial disfigurement (Rasset et al., 2020; Rasset, Mange, et al., 2021). In an initial study, Rasset and colleagues (2020) asked participants to provide all the affective reactions they could feel while meeting an individual with a facial disfigurement. The researchers used a self-presentation paradigm (i.e., a paradigm varying instructions to present oneself in a good vs. bad light; Jellison & Green, 1981) to ease socially undesirable affective states. In a second study, the affective states have been reduced to a six-factor typology comprising sympathy-related, surprise-related, neutrality-related, anxiety-related, disgust-related, and hostility-related affective states (Rasset, Mange, et al., 2021). On the whole, ambivalent affective reactions are evidenced towards individuals presenting a facial disfigurement.

### **1.3. Visual attention and stigmatizing affective reactions to visible differences**

Concerning stigmatizing *cognitive* reactions, research has suggested a causal link such that the way people look upon disfigurement influences the way they react to it. For instance, Madera and Hebl (2012) compared the attention paid to faces in an interview context to explore the outcomes of this

attentional bias. Their study revealed that the attention distracted by disfigurement impaired the memory, which lowered the rating of the applicant with facial disfigurement.

Yet, concerning stigmatizing *affective* reactions, the impact of visual attention is not well understood. To our knowledge, only one study investigated the relationships between visual attention and the stigmatizing affective reactions. In an eye-tracking study, Stone and Potton (2019) notably revealed that 1) disfigurement elicited negative emotions and 2) heightened attention on the disfigured part of the face was related to the intensity of the negative emotional experience reported. Their findings are supported by previous research showing that attention and emotion are related (for a review, see Kaspar & König, 2012). For instance, there is an attentional bias towards disgust-inducing words (Charash & McKay, 2002), and visual attentional capture of surprising stimuli (for a review, see Horstmann, 2015). In contrast, there is a paucity of research showing that attention may be influenced by emotional arousal (for a review, see Fenske & Raymond, 2006). As an exception to the above, researchers have demonstrated that when asked to focus on targets, people devalue the stimuli they had to ignore, showing that the orientation of the attention influences the preferences (Raymond et al., 2005). Accordingly, the change in the visual attention towards faces with disfigurement could heighten affective reactions, especially the attentional capture of facial disfigurement could foster its devaluation.

Stone and Potton's (2019) work unveiled possible links between visual attention towards disfigurement and stigmatizing affective reactions. Nevertheless, since they considered the disfigured part of the face in an isolated manner, they did not investigate the changes in the way the perceivers explore faces as a whole. Faces with disfigurement actually elicit heightened attention on the disfigured area but probably also weaken attention on other usually important parts (i.e., internal expressive features: eyes, nose, mouth). Affective states may thus positively correlate with attention on the disfigured part, negatively correlate with attention on the important central features, especially the eyes (Kawakami et al., 2014), or a combination of both. In line with this assumption, when expanding upon their reexamination of previous data, Madera and Hebl (2019) discussed a possible interruption in "normal face processing" to explain the impact of facial disfigurement on stigmatizing reactions. Thus, stigmatizing affective reactions to facial disfigurement may be related to a global change in the way

people look at faces bearing a disfigurement rather than to the attentional capture triggered by facial disfigurement.

The aim of this research was thus to show that the perception of a facial disfigurement changes the regular perception of human faces, which is related to the stigmatizing affective reactions to faces with facial disfigurement.

#### **1.4. Overview of studies and hypotheses**

Both pilot and pre-registered experimental eye-tracking studies were conducted to analyze gaze toward faces with disfigurement and its impact on affective states. In the pilot study, we compared the impact of faces with and without disfigurement on visual attention. We hypothesized that facial disfigurement would change visual attention towards faces. Specifically, we assumed that more visual attention would be given to the disfigurement location when facing someone with a visible facial difference and the opposite pattern would arise for facial central features (eyes, nose, lips) and especially for the eyes (Kawakami et al., 2014). In the pre-registered study, we compared the impact of faces with and without disfigurement on affective states that they trigger. We expected that faces with visible difference would elicit more disgust-related, anxiety-related, hostility-related, surprise-related, and less sympathy-related and neutrality-related affective states (see A. Stone & Potton, 2019). Further, we assumed that visual attention plays a mediation role in the relationship between disfigurement and the perception of affective states. Specifically, we expected not only quicker and longer visual attention to the disfigured part of the face but also slower and shorter visual attention to other important parts of the face (i.e., eyes, nose, lips) would mediate the effect of faces with facial disfigurement on affective states.

## **2. Pilot study**

The pilot study examined effects of the presence of a disfigurement on visual attention to faces. The participants' visual fixations were recorded while they were looking at different faces with and without disfigurement.

## **2.1. Method**

### **2.1.1. Participants**

Forty-eight undergraduate students volunteered to take part in the study without financial compensation. Seven participants were withdrawn due to calibration errors and three were withdrawn since they reported having a disfigurement. The remaining thirty-eight participants comprised 28 females (mean age = 20.30 years;  $SD = 2.21$ ). Sample size in the present article was based on Stone and Potton (2019), who used eye tracking to examine associations between attention in the area of disfigurement and emotions. A post hoc power analysis was conducted using the G\*Power software package (Buchner et al., 2017) based on the smallest effect size (of a hypothesized effect) found in the study. The sample size of 38 was used as a basis for the statistical power analysis. For a medium effect size ( $d = .70$ ) and standard parameters of  $\alpha = .05$ , the post hoc power analysis indicated a power to detect obtained effects  $1 - \beta = .99$ , for a  $t$  test for difference between two dependent means.

### **2.1.2. Stimuli**

The faces used in this experiment have been selected based on a pretest. A database containing faces was designed to assess the impact of disfigurement on visual attention. Our aim was to create a database of at least 16 faces. Indeed, we sought to show our participants faces with and without disfigurement (2 types of faces), when controlling for sex of the face (2 sexes) and side of the disfigurement (2: left or right). We therefore intended to generate a database comprising at least  $2 \times 2 \times 2 = 8$  faces, each one of which could be presented with and without a disfigurement (2 sets = 16 faces). Therefore, we took pictures of 21 men and women in closely cropped portraits (head and top of shoulders). All had given their permission for their picture to be used and modified for research purposes. All targets were asked to display a neutral facial expression and to look straight at the camera. The images were cropped to 300 X 300 pixels. The original faces have been modified using Adobe Photoshop (Adobe Systems, San Jose, California) to put a burning scar-like disfigurement on either their

left or right cheek. We obtained a total of 42 faces<sup>1</sup>. The same face could thus be either presented with or without disfigurement.

In order to obtain a uniform sample of pictures, we pilot-tested the photographs on dimensions inferred automatically from face perception (see Saminaden et al., 2010) and on plausibility with a separate sample of 41 students (mean age = 19.46 years,  $SD = 1.41$ ,  $F = 33$ ). We divided our initial database of 42 faces in two counterbalanced sets. In this way, in each set, participants could see faces, the half of which presented a disfigurement, while the other half did not; half of them belonged to women, half of them belonged to men. For faces with disfigurement: half of the faces presented a disfigurement pattern on the left cheek, while half presented a disfigurement on the right one. Such precautions were taken to control for any effect of sex, specificity or lateralization of face perception. Participants were asked to estimate the age, rated attractiveness (1 “not attractive at all”, 7 “very attractive”), gender (1 “not feminine at all”, 7 “very feminine”; 1 “not masculine at all”, 7 “very masculine”), positive versus negative expressions (1 “very negative expression”, 4 “neutral expression”, 7 “very positive expression”) and about the extent to which they believed that each photograph had been modified (1 “not at all”, 7 “very much”). Since our goal was to make comparisons between the same faces with and without disfigurement, we decided to select the faces based on their realness and not on their other characteristics. On the 21 faces presenting a disfigurement, we decided to keep only those that were evaluated as being less modified than the average of the photographs (i.e., those with negative Z-score, each mean score being under the threshold of 4). On the initial number of photographs, 20 remained (i.e., 10 faces in their original and disfigured condition). These photographs were evaluated as being globally equivalent on all other criteria.

### ***2.1.3. Material and Measures***

We decided to use an eye-tracking technology, which is an unobtrusive and direct technique that allows researchers to not rely exclusively on self-report measures which are biased by social desirability when it comes to judging people with facial disfigurement (Rahal & Fiedler, 2019; A. Stone

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<sup>1</sup> These pictures have been created by a graphic designer who made several proposals of disfigurement for each face. A small study ( $N = 12$ ) was conducted in order to select the most plausible disfigurement for each face.

& Potton, 2014). Eye movements were recorded using a Tobii X3-120 Eye-tracker (SR Research Ltd.), with a sampling rate of 120 hz (it returns a location every 8.33 ms). To classify these samples (raw data) and constitute either a fixation or a saccade (there is no motion so we assume there is no smooth pursuit), we applied an algorithm based on a velocity threshold called “I-VT Fixation Filter” (I-VT stands for Identification - Velocity Threshold). The default values chosen by Tobii in the I-VT implementation are as follows: VT = 30°/s, Maximum Angle between fixations = 0.5°, and the Minimum duration of fixation = 60 ms<sup>2</sup> (Tobii Technology, 2012). Experimental recordings were preceded by a nine-point calibration procedure implemented in the Tobii Studio software. Participants were seated at a typical viewing distance of about 65 cm (head restraint was not used, since the Tobii system does not require it).

Eight Areas of Interest (AOIs) were manually drawn for the hairline, forehead, eyes, nose, target cheek, other cheek, lips and chin on each of the face displays. AOIs were hand drawn based on Fincher (2019). All features were defined as separate nonoverlapping AOIs (see Figure 1).

The following eye-tracking variables were selected<sup>3</sup>:

*Total dwell time* (i.e., the sum of all dwell times in the one and same AOI over a trial). For each AOI, the mean total dwell times (in seconds) were calculated by averaging the total dwell times of all stimuli, distinguishing disfigured and original faces.

*Time to first fixation* (i.e., the time period from entering the AOI until the first fixation is made). For each AOI, the mean time to first fixation was calculated by determining, relative to the onset of the trial, how long it took for participants to initially fixate in an AOI with lower values representing a faster orientation of the gaze. If an AOI was not fixated in the 5 s window, we gave it a value of 5 for the time

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<sup>2</sup> One may argue that another requirement could be that saccades occur at least 100 ms after image onset, since fixations with shorter latencies may reflect saccades or anticipatory eye movements (e.g., (Gao et al., 2014). Yet, since 1) we were interested in comparing the amount of attention between each condition (with and without disfigurement) but not between the areas, 2) this deletion was not planned, 3) this deletion is not routinely made in the field (or not specified), we decided to keep the first 100 ms. Nevertheless, we tested this additional requirement on our data and observed no change. Additional analyses are available upon request.

<sup>3</sup> Initially, we also conducted our analyses on the eye-tracking indicator “proportion of fixations” - i.e., the occurrence with which an AOI is looked at. As this indicator was highly correlated with the “total dwell time”, we decided to only present the results of the total dwell time in this article. Results with proportions of fixation are available as supplementary materials on [https://osf.io/ybvpa/?view\\_only=5b77a73587094a9f9c22881c72f6289a](https://osf.io/ybvpa/?view_only=5b77a73587094a9f9c22881c72f6289a).

to first fixation analyses. The mean time to first fixation for each AOI was calculated separately for disfigured and original faces.

These eye-tracking variables have been selected due to the different inferences that they allow with regard to attention, and could thus reinforce the assumption of a change in visual attention if evidenced. Indeed, beyond being common measures in the field (for a review, see Asaad et al., 2020), the total dwell time can be regarded as an indicator of processing depth and effort, whereas time to first fixation is an indicator of information weighting (Rahal & Fiedler, 2019).

#### ***2.1.4. Procedure***

Participants were recruited directly on the campus by the experimenter. They volunteered to participate and provided an informed consent. All participants were naïve to the hypotheses of the experiment. All participants were tested individually in a focus room. After the eye-tracking calibration, they were left alone until the end of the procedure.

During the training phase, participants viewed four faces (2 men and 2 women) of celebrities to familiarize them with the task. Then, during the experimental phase, they were presented 10 faces. As we did with the photographs selection of the pretest, we divided our initial database of 20 faces in two counterbalanced sets. In this way, participants in each set could see faces, half of which presented a disfigurement, while the other half did not; half of them were women faces, while the other half were men faces. For faces with disfigurement: half of the disfigurement were placed on the left cheek, half of them were placed on the right one. Such precautions were taken to control for any effect of sex, specificity or lateralization of face perception.

Each trial consisted of the following sequence: a fixation cross in the center of the screen and displayed for 2 seconds, then the face displayed for 5 seconds. So as to sustain their attention without biasing their visual exploration towards any specific feature, we asked the participants to rate the extent to which each person was considered as being fully human by people in general<sup>4</sup>. Each trial lasted approximately 10 seconds. The length and location of the participants' visual fixations were recorded

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<sup>4</sup> Although there was no hypothesis formulated regarding this measure, we planned exploratory analyses that could not be run following a problem in data recording.

for each AOI while they viewed each face. After providing socio-demographic information, participants were fully debriefed and thanked.

### 2.1.5. Statistical analysis

A mixed within-participant design was employed. The within-participant factors were type of face (original vs. disfigured) and Area of Interest (AO: 8 areas). Statistical analyses were performed using Jasp software (Jasp Team, 2020). A 2 (Type of face: original, disfigured) X 8 (AOI: hairline, forehead, eyes, nose, target cheek, other cheek, lips, chin) repeated measures ANOVAs were run on each eye tracking variables. Greenhouse-Geisser corrections were used to correct for analyses that violated the assumption of sphericity.

## 2.2. Results

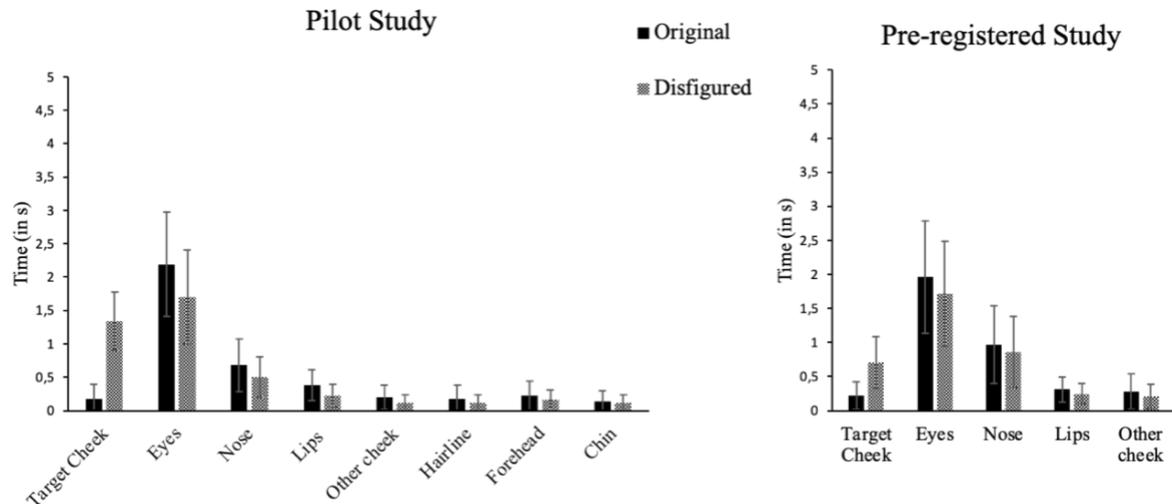
**Figure 1.** Panel left illustrates a schematic of the regions of interest used in analysis. Panel right illustrates Heatmaps of faces with(out) disfigurement. Heatmaps have been generated based on fixation counts. See the online article for the color version



There was a main effect of Type of face on the total dwell time, a main effect of AOI on the total dwell time and an interaction between Type of face and AOI (see Table 1). Simple effects tests revealed that – as expected – the target cheek was fixated upon for longer durations when the face included a disfigurement than when it was presented in its original condition (see Figure 2). The opposite

pattern emerged for eyes, nose, other cheek and lips but no effect was evidenced for hairline, forehead, nor chin. A bigger effect size was observed for eyes compared to nose, other cheek and lips.

**Figure 2.** Mean total dwell time occurring in each AOI in both studies, with standard deviations.



There was no effect of Type of face on the time to first fixation (see Table 1). There was a main effect of AOI on time to first fixation and an interaction between the Type of face and AOI. Simple effects tests revealed – as expected - that the targeted cheek received a quicker look when the face was presented with a disfigurement than when it was presented its original condition (see Figure 3). The opposite pattern emerged for eyes, nose, other cheek, and lips but no effect was evidenced for hairline, forehead, nor chin. A bigger effect size was observed for lips compared to eyes, nose and other cheek.

**Table 1.** Means (Standard Deviations) of eye-tracking variables for each AOI depending on the type of face evaluated in Pilot Study. Results of repeated measures ANOVA are also included.

AOI	Hairline	Forehead	Eyes	Nose	Target Cheek	Other cheek	Lips	Chin	All
<b>Type of face</b>									
<b>Total dwell Time.</b> Main effect of Type of Face: $F(1, 37) = 11.04, p < .01, \eta^2_G < .001$									
Original	0.17 (0.21)	0.22 (0.22)	2.19 (0.78)	0.68 (0.39)	0.18 (0.21)	0.20 (0.18)	0.38 (0.23)	0.14 (0.16)	0.52 (0.74)
Disfigured	0.12 (0.12)	0.16 (0.15)	1.70 (0.70)	0.50 (0.30)	1.34 (0.44)	0.11 (0.13)	0.23 (0.17)	0.12 (0.12)	0.53 (0.67)
All	0.15 (0.17)	0.19 (0.19)	1.94 (0.78)	0.59 (0.36)	0.76 (0.68)	0.15 (0.16)	0.31 (0.21)	0.13 (0.14)	
<b>Simple effect test</b>									
	$F = 2.59$	$F = 3.12$	$F = 30.06$	$F = 16.92$	$F = 318.23$	$F = 8.85$	$F = 16.16$	$F = 0.75$	
	$p = .12$	$p = .08$	$p < .001$	$p < .001$	$p < .001$	$p < .01$	$p < .001$	$p = .39$	
	$d = 0.26$	$d = 0.29$	$d = 0.89$	$d = 0.67$	$d = 2.89$	$d = 0.48$	$d = 0.65$	$d = 0.14$	
<b>Time to First Fixation.</b> Main effect of Type of Face: $F(1, 37) = 0.48, p = .49, \eta^2_G < .001$									
Original	4.27 (0.82)	3.75 (0.96)	0.58 (0.59)	1.03 (0.89)	4.03 (1.01)	3.95 (0.73)	2.87 (1.03)	4.19 (0.83)	3.08 (1.63)
Disfigured	4.45 (0.57)	4.02 (0.82)	0.98 (0.89)	1.34 (0.90)	1.00 (0.57)	4.34 (0.72)	3.85 (0.84)	4.40 (0.74)	3.05 (1.70)
All	4.35 (0.71)	3.89 (0.90)	0.78 (0.78)	1.19 (0.90)	2.51 (1.73)	4.14 (0.75)	3.36 (1.05)	4.29 (0.79)	
<b>Simple effect test</b>									
	$F = 2.47$	$F = 2.88$	$F = 19.58$	$F = 5.12$	$F = 262.86$	$F = 10.40$	$F = 32.34$	$F = 3.00$	
	$p = .12$	$p = .10$	$p < .001$	$p = .03$	$p < .001$	$p = .003$	$p < .001$	$p = .09$	
	$d = 0.25$	$d = 0.27$	$d = 0.72$	$d = 0.37$	$d = 2.63$	$d = 0.52$	$d = 0.92$	$d = 0.28$	

Note. Values for total dwell time and time to first fixation are in seconds. Contrary to total dwell time, lower scores indicate more attention for time to first fixation. Time to first fixation for the eyes and nose has to be considered carefully because for some faces the participants were asked to focus of these areas at the onset of each image.

### **2.3. Discussion**

As expected, participants gazed more quickly and longer at the cheek when it included a disfigurement. Interestingly, people also gazed more slowly and for less time at the eyes, nose, cheek without disfigurement and lips, whereas no effect was evidenced for hairline, forehead, or chin. The patterns of gaze in the pilot study replicated former studies showing that facial disfigurement affects attentional allocation (Boutsen et al., 2018). Yet, changes in visual attention were not limited to the location of the disfigurement but rather expanded to the internal expressive features of the face. After the disfigured area, the effect was stronger for the eyes as previously evidenced for different pathologies in other studies (e.g., Meyer-Marcotty et al., 2011). Following Stone and Potton (2019), we decided to go beyond the attention paid to the disfigurement and further explore the affective reactions to photographs showing people with disfigurement potentially associated with the attentional bias evidenced in this pilot study. Specifically, we explored the link between the visual attention paid to the internal features of the face (eyes, nose, mouth, target cheek and other cheek) and affective states.

## **3. Pre-registered study**

The pre-registered study examined the mediating role of visual attention paid to faces with and without disfigurement on stigmatizing affective reactions. More specifically, this study was designed to replicate the impact of facial disfigurement on the allocation of visual attention towards the internal features of the face found in the pilot study and to determine if the formerly evidenced changes were related to affective reactions to facial disfigurement. The participants' visual fixations were recorded while they viewed faces with and without a disfigurement at which time they had to estimate the affective reactions that the faces they were seeing might trigger in others.

### **3.1. Method**

#### **3.1.1. *Participants***

Ninety-nine participants volunteered to take part in the study without any financial compensation. Seven participants were withdrawn due to calibration errors and three were withdrawn

since they reported having a disfigurement. The remaining 89 participants comprised 52 women and 37 men ( $M = 19.83$  years;  $SD = 1.79$ ).

G\*Power (Buchner et al., 2017) was used to calculate a priori sample size, using a power of 95% for a large effect size of  $f = 0.40$  (A. Stone & Potton, 2019). This study was preregistered at [https://osf.io/ybvpa/?view\\_only=5b77a73587094a9f9c22881c72f6289a](https://osf.io/ybvpa/?view_only=5b77a73587094a9f9c22881c72f6289a).

### **3.1.2. Material**

Since our experimental design required each face to be presented 18 times (i.e., one presentation for each affective state), using too many stimuli would have lengthened the duration of the experimental procedure and potentially exhausted the participants. Therefore, following formerly used procedures (A. Stone & Potton, 2019), we selected four faces in our picture database (two men and two women in both disfigured and original conditions). To avoid a possible intergroup bias based on age (our target sample was made up of university student, i.e., young people of college-age), we decided to choose faces in the upper middle age range of our database constituted from our pre-test ( $M = 38.67$ ,  $SD = 14.32$ ). Faces were in the middle of the expression range ( $M = 4.10$ ,  $SD = 1.21$ ). Perception of gender was homogeneous (for the female faces:  $M = 6.62$ ,  $SD = 0.16$ ; for the male faces:  $M = 6.75$ ,  $SD = 0.23$ ). Faces were perceived as similar on attractiveness ( $M = 3.40$ ,  $SD = 0.52$ ). Only five of the eight AOI drawn in the pilot study were used in the pre-registered study (eyes, nose, mouth, target cheek and other cheek), retaining the exact same size. Eye movements were recorded using the same Tobii X120 Eye-tracker.

### **3.1.3. Measures**

The same eye-tracking variables were selected (total dwell time and time to first fixation). As disfigurement did not impact visual attention toward hairline, forehead, and chin in the pilot study, only five AOIs were kept to gain statistical power in the pre-registered study (i.e., eyes, nose, target cheek, other cheek, and lips).

Participants were asked to report their perception of 18 different emotions which the faces may trigger (see Rasset, Montalan, & Mange, 2021): sympathy-related (i.e., sympathy, benevolence, tenderness; Cronbach's  $\alpha = .83$ ), anxiety-related (i.e., fear, anxiety, apprehension;  $\alpha = .90$ ), surprise-related (i.e., surprise, astonishment, curiosity;  $\alpha = .79$ ), hostility-related (i.e., contempt, hate, hostility;  $\alpha = .83$ ), disgust-related (i.e., disgust, repulsion, nausea;  $\alpha = .87$ ) and neutrality-related (i.e., neutrality, calm, indifference;  $\alpha = .70$ ). Participants had to report "to which extent most people that see the person on the photograph may experience" the written emotion on a numeric scale of 1–7 (corresponding to: 1- "totally disagree", 4 - "neither agree nor disagree", 7 - "totally agree"). A hetero-perception formulation was chosen to reduce social desirability which may bias the participants' responses (for a similar procedure, see Louvet et al., 2009). As people infer how other people would react based on their own reactions (Nickerson, 1999), this strategy was used to encourage participants to report their emotional reactions without trying to emphasize desirable ones at the expense of less desirable ones.

#### ***3.1.4. Procedure***

The procedure was globally the same as that of the pilot study except for the instructions given to the participants. Indeed, each trial consisted of the following sequence: a fixation cross in the center of the screen displayed for 2 seconds, then a face displayed for 5 seconds. Then the participants were asked to report the extent to which they estimated that people facing this person may feel one of the above-mentioned affective states. Each face was presented 18 times in fixed random order, once for each affective state, bringing the total of trials to 72. Each trial lasted approximately 10 seconds. The length and location of the participants' visual fixations were recorded for each AOI while participants were viewing each face. After providing socio-demographic information, participants were fully debriefed and thanked.

#### ***3.1.5. Statistical analysis***

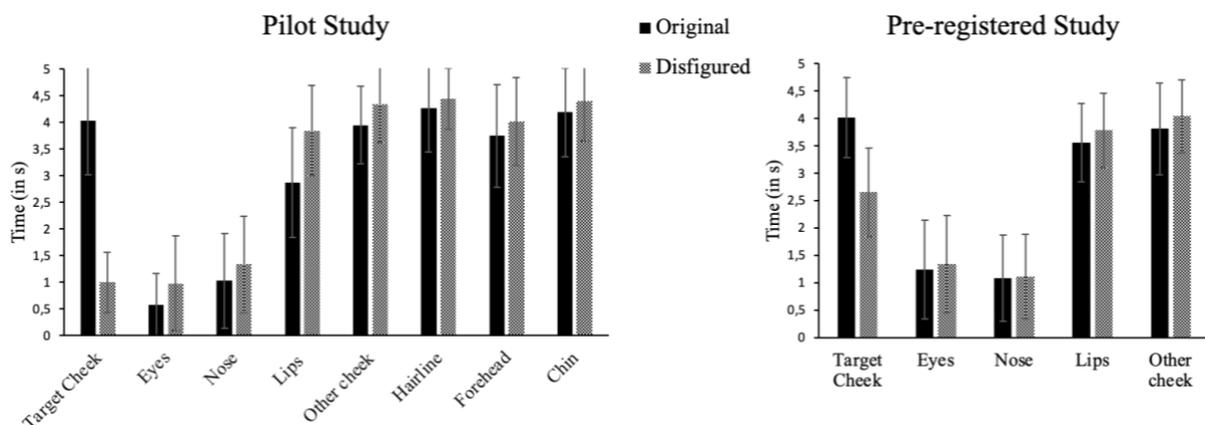
Several analyses were run. First, the hypothesized impact of disfigurement on visual attention was tested. For that purpose, a 2 (Type of face: original, with disfigurement) X 5 (AOI: eyes, nose, target

cheek, other cheek, lips) repeated measures ANOVAs was run on each eye tracking variables. Greenhouse-Geisser corrections were used to correct the analyses that violated the assumption of sphericity. Second, the hypothesized impact of disfigurement on affective states was tested. For that purpose, a 2 (Type of face: original, with disfigurement) X 6 (Type of emotion: sympathy-related, surprise-related, neutrality-related, anxiety-related, disgust-related, hostility-related) repeated measures ANOVA was run. Finally, the relationship between affective states and visual attention was explored through regression analyses.

### 3.2. Results

#### *Impact of disfigurement on visual attention*

*Figure 3. Mean time to first fixation occurring in each AOI in both studies, with standard deviations.*



There was no effect of Type of face on the total dwell time (see Table 2). There was a main effect of AOI on total dwell time and an interaction between Type of face and AOI. Simple effects tests revealed that – as expected – the targeted cheek was fixated for longer durations when the face included a disfigurement than in its original condition (see Figure 2). The opposite pattern emerged for eyes, nose, other cheek and lips. Similarly to the pilot study, a bigger effect size was observed for eyes compared to nose, other cheek and lips showing the stable negative impact disfigurement has on visual attention towards the eye area.

**Table 2.** Means (Standard Deviations) of eye-tracking variables for each AOI depending on the type of face evaluated in Pre-registered Study. Results of repeated measures ANOVA are also included.

AOI	Eyes	Nose	Target Cheek	Other cheek	Lips	All		
<b>Type of face</b>								
<b>Total dwell Time.</b> Main effect of Type of Face: $F(1, 88) = 0.44, p = .51, \eta^2_G < .001$								
Original	1.96 (0.82)	0.97 (0.57)	0.22 (0.20)	0.28 (0.26)	0.31 (0.18)	0.74 (0.82)	Main effect of AOI $F(1.53, 134.36) = 167.13$ $p < .001$ $\eta^2_G = .63$	
Disfigured	1.72 (0.77)	0.86 (0.52)	0.71 (0.38)	0.21 (0.18)	0.25 (0.15)	0.75 (0.72)		
All	1.84 (0.80)	0.91 (0.54)	0.47 (0.39)	0.24 (0.23)	0.28 (0.17)	0.75 (0.77)		
<i>Simple effect test</i>	$F = 40.74$ $p < .001$ $d = 0.68$	$F = 12.63$ $p < .001$ $d = 0.38$	$F = 325.58$ $p < .001$ $d = 1.91$	$F = 18.84$ $p < .001$ $d = 0.46$	$F = 31.32$ $p < .001$ $d = 0.59$			Interaction effect $F(2.37, 208.42) = 98.12$ $p < .001$ $\eta^2_G = .07$
<b>Time to First Fixation.</b> Main effect of Type of Face: $F(1, 88) = 60.64, p < .001, \eta^2_G = .01$								
Original	1.24 (0.90)	1.08 (0.79)	4.02 (0.73)	3.81 (0.84)	3.56 (0.72)	2.74 (1.52)	Main effect of AOI $F(1.93, 169.84) = 319.54$ $p < .001$ $\eta^2_G = .71$	
Disfigured	1.34 (0.89)	1.11 (0.78)	2.65 (0.81)	4.04 (0.67)	3.78 (0.68)	2.53 (1.43)		
All	1.29 (0.90)	1.09 (0.78)	3.33 (1.02)	3.92 (0.77)	3.67 (0.70)	2.66 (1.48)		
<i>Simple effect test</i>	$F = 5.47$ $p = .02$ $d = 0.25$	$F = 0.21$ $p = .64$ $d = 0.05$	$F = 456.72$ $p < .001$ $d = 2.26$	$F = 16.39$ $p < .001$ $d = 0.43$	$F = 19.59$ $p < .001$ $d = 0.47$			Interaction effect $F(3.40, 299.42) = 147.86$ $p < .001$ $\eta^2_G = .13$

*Note.* Values for total dwell time and time to first fixation are in seconds. Contrary to total dwell time, lower scores indicate more attention for time to first fixation. Time to first fixation for the eyes and nose has to be considered carefully because for some faces the participants were asked to focus of these areas at the onset of each image.

There was a main effect of Type of face on the time to first fixation, a main effect of AOI on the time to first fixation, and an interaction between Type of face and AOI (see Table 2). Simple effects tests revealed that – as expected - the targeted cheek was gazed at more quickly when the face presented a disfigurement than when it was presented in its original condition (see Figure 3). The opposite pattern emerged for eyes, other cheek, and lips, but no effect emerged for the nose.

### **Impact of disfigurement on affective states**

There was no effect of Type of face on affective state perception. There was a main effect of Type of emotion and an interaction between Type of face and Type of emotion (see Table 3 for details of all analyses and descriptive statistics). Simple effects tests revealed that – as expected – surprise, disgust, anxiety, and – to a lesser extent - hostility were more strongly endorsed when the face included a disfigurement than when the face was presented in its original condition. The opposite expected pattern emerged for neutrality, but no difference was evidenced for sympathy.

**Table 3.** Means (Standard Deviations) of affective states measures depending on the type of face evaluated in Pre-registered Study. Results of repeated measures ANOVA are also included.

Affective state	Sympathy-related	Surprise-related	Neutrality-related	Anxiety-related	Disgust-related	Hostility-related	All		
<b>Type of face.</b> Main effect: $F(1, 88) = 2.60, p = .11, \eta^2_G < .001$									
Original	4.53 (0.92)	2.38 (0.89)	4.91 (1.03)	2.19 (1.08)	1.80 (0.82)	2.08 (0.96)	2.98 (1.57)	Main effect of Emotion $F(2.59, 227.54) = 121.33$ $p < .001$ $\eta^2_G = .37$	
Disfigured	4.55 (1.05)	4.45 (1.51)	3.45 (0.95)	3.33 (1.21)	3.54 (1.35)	2.36 (1.01)	3.62 (1.40)		
All	4.54 (0.99)	3.41 (1.61)	4.18 (1.23)	2.76 (1.27)	2.67 (1.42)	2.22 (0.99)			
<i>Simple effect test</i>	$F = 0.02$ $p = .87$ $d = 0.02$	$F = 127.86$ $p < .001$ $d = 1.20$	$F = 106.30$ $p < .001$ $d = 1.09$	$F = 65.12$ $p < .001$ $d = 0.85$	$F = 134.97$ $p < .001$ $d = 1.21$	$F = 4.79$ $p = .02$ $d = 0.23$			Interaction effect $F(3.05, 268.19) = 72.25$ $p < .001$ $\eta^2_G = .23$

### Relationship between visual attention and affective states

First, in order to examine correlations between emotion perception and the indicators of visual attention, scores for all measures were computed by considering the difference score of disfigured faces minus original faces means (for a similar procedure, see A. Stone & Potton, 2019). Higher (positive) scores systematically indicate greater emotion perception / attention to faces with disfigurement whereas lower (negative) scores refer to greater emotion perception / attention to original faces. Only small correlations emerged between emotion perception and visual attention to the targeted cheek, indicating that the longer participants concentrated on the disfigurement, the less they expressed neutrality and the more they expressed surprise when viewing a disfigured face vs. original face (see Table 4).

**Table 4.** Means (Standard Deviations) and correlations (Bravais-Pearson's  $r$ ) between and of eye-tracking variables difference scores for each AOI and affective states difference scores in Pre-registered Study.

AOI	Sympathy-related	Surprise-related	Neutrality-related	Anxiety-related	Disgust-related	Hostility-related	$M (SD)$
<b>Total dwell time</b>							
Eyes	.10	-.08	.23*	-.04	-.02	-.03	-0.23 (0.34)
Nose	.01	.06	-.26	-.02	.11	.03	-0.11 (0.28)
Target cheek	.07	.30***	-.35***	.13	.15	.03	0.49 (0.25)
Other Cheek	-.23*	-.13	.10	.06	-.04	-.05	-0.07 (0.15)
Lips	-.16	-.13	.10	.14	-.04	.00	-0.06 (0.10)
<b>Time to first fixation</b>							
Eyes	.13	-.02	-.14	-.08	.01	-.15	0.10 (0.39)
Nose	-.04	.14	.11	-.04	-.04	-.04	0.03 (0.54)
Target cheek	.07	-.30***	.35***	-.06	-.15	-.09	-1.37 (0.60)
Other Cheek	.09	.02	-.06	-.06	.07	.11	0.23 (0.53)
Lips	.19	.15	-.21*	-.09	.04	-.11	0.21 (0.46)
<b><math>M (SD)</math></b>	0.02 (1.34)	2.07 (1.73)	-1.46 (1.34)	1.14 (1.33)	1.74 (1.44)	0.28 (1.20)	

Note. Higher (lower) values indicate either positive (negative) correlations between eye-tracking variables and affective states for disfigured faces. \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .

We decided not to run the pre-registered mediational analysis because of a lack of power. Specifically, our correlations were globally not high enough and our sample size ( $N = 89$ ) was too small to obtain a satisfactory statistical power, even for a mediational analysis computed on the basis of our strongest correlation (i.e.,  $r = .40$ ;  $1 - \beta = .16$ ; Schoemann et al., 2017).

### *Exploratory analyses*

Linear regressions with interaction analyses were conducted in order to go beyond the main effect of visual attention on each AOI in isolation. Indeed, we hypothesized that the impact of heightened attention to the disfigured part of the face had on affective reactions could depend on the other parts that were also attentionally neglected, such as the eyes. Since we recorded measures on five AOIs, numerous combinations were possible. As we were interested in the impact of disfigurement and as we had shown that attention was mainly diverted from the eye region, we decided to investigate this specific interaction and its associations with affective reactions. We used the scores computed for the correlational analyses.

Considering the surprise-related affective state, results showed a significant effect of total dwell time difference scores on the target cheek region (see Table 5 for details). The association indicated that the more participants stared at the disfigured part of the face, the more they reported surprise-related affective states watching disfigured faces. A marginally significant interaction effect also occurred revealing that this effect was amplified when participants stared less at the eyes of the disfigured faces. Considering disgust-related state affect, an interaction occurred, revealing a hybrid effect. The more participants stared at the disfigured part of the face, the more they reported disgust-related affective states though the effect was present only when they stared less at the eyes of those faces<sup>5</sup>.

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<sup>5</sup> To go further in these exploratory analyses, we have also investigated the moderating role of the other AOIs, which were not significant.

**Table 5.** Linear regression coefficient table, total dwell time difference scores on AOI as independent variables, and heightened affective states difference scores as dependent variable in Pre-registered Study.

	<b>Model Summary</b>	<b>t</b>	<b>p</b>	<b>β</b>	<b>95% CI</b>
<b>Disgust</b>	$R^2 = .07, F(3,85) = 2.12, p = .10$				
Intercept		11.09	<.001***		
Target cheek		0.95	.35	0.10	-0.11 ; 0.32
Eyes		-0.19	.85	-0.02	-0.23 ; 0.19
Target cheek x Eyes		-2.07	.04*	-0.29	-0.56 ; -0.01
<b>Surprise</b>	$R^2 = .12, F(3,85) = 3.83, p < .05$				
Intercept		11.37	<.001***		
Target cheek		2.41	.02*	0.25	0.04 ; 0.46
Eyes		-0.55	.58	-0.06	-0.26 ; 0.14
Target cheek x Eyes		-1.67	.10†	-0.22	-0.49 ; -0.04

*Note.* Higher (lower) values indicate either positive (negative) correlations between eye-tracking variables and affective states for disfigured faces. † $p < .10$ , \* $p < .05$ , \*\*\* $p < .01$ .

### 3.3. Discussion

The pre-registered study replicates the impact of disfigurement on visual attention towards faces evidenced in the pilot study. Disfigurement had a negative impact on attention that is usually allocated to the eye regions. Moreover, disfigurement impacted perceptions of disgust-related, surprise-related, anxiety-related, and, to a lesser extent, hostility-related affective states. In our pre-registered study, disfigurement did not impact sympathy-related affective states. Indeed, the participants did not expect significantly less sympathy for faces with a disfigurement than for faces without a disfigurement. This result was unexpected since we tried to lessen potential social desirability biases. Participants did not report more sympathy either, maybe because they already displayed high scores of sympathy for the other faces. Put differently, individuals expressed less neutrality, more surprise, disgust, anxiety, and hostility and as much sympathy when viewing faces with a disfigurement. These results support the idea that physical stigma often elicits ambivalent reactions (see Dovidio et al., 2000; Weiner et al., 1988).

Like Stone and Potton (2019), we found small correlations between attention paid to the disfigured part of the face and affective states of surprise and neutrality (a negative correlation for the latter), but we did not find any link with the other affective states. Although disfigurement influences both attentional and affective reactions, we cannot affirm that both reactions are directly correlated. One may argue that, contrary to Stone and Potton (2019), we did not manipulate disfigurements severity.

Nevertheless, as affective reactions towards disfigurement were clearly elicited, we doubt that these correlations would occur only for severe disfigurement and not for a mild one. Moreover, because of the hetero-perception instruction, one may argue that participants expressed affective states that did not truly reflect how they actually felt. Yet, this instruction has been successfully used by other authors (e.g., (Louvet et al., 2009b) and even if participants were not expressing their own affective states, these reactions still reflected social stigma. That is, participants may have expressed stigma at a social rather than individual level (i.e., through cultural representations) which is still of high interest for our research purpose.

#### **4. General Discussion**

The aim of this research was to investigate cognitive and affective reactions towards people living with a visible difference. Specifically, in order to broaden the results obtained by Stone and Potton (2019), we wanted to explore how these processes might relate to each other. We hypothesized that visibly different faces should engender a different pattern of visual attention, which should be related, in turn, with affective experience. In two studies, we have demonstrated that disfigurement impacts the way individuals explore faces. Disfigurement also impacts perceptions of disgust-related, surprise-related, anxiety-related, neutrality-related, and, to a lesser extent, hostility-related affective states. Nevertheless, a few weak direct correlations among these cognitive and affective reactions were evidenced. Both the impact of disfigurement on the visual exploration of faces, and the impact of a change in visual attention towards faces with disfigurement will be discussed.

First, the impact of disfigurement on the visual exploration of faces has to be considered carefully. While showing modifications in the time to first fixation and total dwell time on disfigured faces, we highlighted changes in information weighting, in information depth and efforts made to process faces with disfigurement (Rahal & Fiedler, 2019). Attention is not merely attracted to the disfigured area but it is also diverted from the other areas, notably the eyes. We have known for a long time that individuals gaze preferentially at the eye area (e.g., Janik et al., 1978). For example, people gaze longer at the eye area of their ingroup members vs. outgroup members (e.g., Kawakami et al., 2014). The eyes play key roles (Itier, 2015). For example, from others' gaze direction, we infer the

relative importance of objects in the environment (see Hugenberg & Wilson, 2013). At a neural level, research has shown that eyes are particularly relevant for the configural processing of faces (Itier et al., 2007). As facial disfigurement not only attracted attention to the disfigured area but also diverted it from other facial features, including the eyes, it may have violated the typical configuration of features, jeopardizing face perception as a whole (Schwarzer et al., 2005). It is noteworthy that failure in processing a face in a face-like manner is also called “perceptual dehumanization”, which has detrimental outcomes for the targets (Bernard, Gervais, et al., 2018; Fincher, 2019; Haslam & Loughnan, 2014). As well, researchers using fMRI have found evidence of a possible neural mechanism underlying dehumanization of people with facial disfigurement (Hartung et al., 2019; Workman et al., 2020). Thus, further research should explore the dehumanization process of people living with a visible difference as a result of a loss in eye-contact or a change in face processing as this may - at least partly - explain the antisocial behaviors that people living with a visible difference sometimes have to endure (Changing Face, 2021).

Second, the impact of this change in visual attention towards faces with disfigurement on the affection reactions they elicit is unclear. Based on previous work, we hypothesized that visual attention would mediate the relationship between disfigurement and stigmatizing affective reactions, as it does between disfigurement and other stigmatizing reactions (Madera & Hebl, 2012). The results of this research rather show that interactions between attention paid to different parts of the face and disfigurement may influence affective reactions. In two studies we showed that disfigurement did not merely attract visual attention to its location on a face, but also diverted gaze from internal features, including the eyes. In our exploratory analyses, we investigated a moderating role of visual attention to the eyes on the impact of visual attention to the disfigured area on affective reactions towards the face. We showed that the interaction of attention towards these two elements might be critical. For example, it seems that faces with disfigurement elicit disgust only when people stare at the disfigurement without looking at the eyes. As we did not experimentally manipulate gaze and as we did not plan this analysis, the role of this moderation is tentative. This loss in eye-to-eye contact hypothesis should thus be better investigated in future studies. More generally, and in line with the weak correlations observed, the direction of the effect also has to be discussed. A higher number of studies show the reverse effect of

the one we hypothesized in this research, i.e., that emotions can influence visual attention (for a review, see Kaspar & König, 2012). For instance, unconscious negative priming influences the observer's gaze pattern (Hirschberger et al., 2010). It is possible that viewing the first face with disfigurement influenced the emotional reactions that, in turn, influenced the subsequent visual patterns. Nevertheless, in real settings, people start by seeing the disfigurement before reacting to it. Thus, in line with the two-factors theory of emotions (Schachter & Singer, 1962), it is also possible that disfigurement acted as a stimulus fostering an undifferentiated physiological arousal, and that the emotion elicited in turn influenced gaze behavior. However, experimental investigations of these alternative assumptions are needed to arbitrate between these various possibilities.

#### **4.1. Potential limitations and future directions**

There are variables that were not assessed in this study that may have had an influence, including those related to facial disfigurement, the perceiver, and the context. First, characteristics of the facial disfigurement may play a role. For instance, the perceived severity of the disfigurement and its location on the face can have an influence on the affective reactions (Shanmugarajah et al., 2012; A. Stone & Potton, 2019). As the results of this research highlight the major role of attention to the eyes, the impact of a disfigurement located on the eyes area warrants consideration. One could think that such disfigurements hinder the strategies developed by the perceiver aimed at reducing the impact of the disfigurement. Further studies are thus needed to highlight this issue. As our studies compared faces in their original setting vs. disfigured faces, some affective states may have been elicited by the mere presence of a mark on the targeted face (e.g., curiosity). Although previous research has shown that the salience of disfigurement alone does not fully explain the impact on perceivers' reactions, future research would benefit from showing disfigurement-specific effects on affective states in comparison to visible non-stigmatizing cues (Boutsen et al., 2018). Because we used a relatively small number of stimuli, it will be necessary to replicate this work with other images in order to attest the stability of the effect.

Second, considering the perceiver, several dispositional variables may be influential. As outlined earlier, social desirability is known to bias responses to questionnaires about the emotions felt

while perceiving people with a facial disfigurement (A. Stone & Potton, 2014). We tried to circumvent this bias by using a hetero-perception formulation, which has limitations. Further research is needed to highlight these affective states with measures upon which people do not have much control, such as physiological indexes (e.g., cardiovascular reactivity; Blascovich et al., 2001). Although promising, the lack of specificity of these measures requires researchers to combine them in order to show a single affective response, which is even more problematic for stimuli that elicit varied affective states. However, the impact of social desirability bias highlights the role of motivations in the acknowledgment of stigmatizing affective reactions and raises questions about the impact of variables such as attitudes toward disfigurement, which should be evaluated in future research. Some disorders may also have an influence on visual attentions and stigmatizing affective reactions, e.g., neurodevelopmental disorder such as the autism spectrum disorder (Duan et al., 2020) and might be incorporated within future work.

Finally, the context may also be influential. We have shown that the eyes were less deeply processed when a disfigurement was added to a face, but our material was exclusively made up of photographs. Since the facial feature capturing the perceivers' interest varies according to the context, future studies would benefit from replicating this experiment while using dynamic situations for example such as videos (see Vo et al., 2012). Future studies investigating real interactions are also needed (e.g., with wearable eye-trackers).

## **4.2. Implications**

By deepening our understanding of public stigma, this research has broad implications. First, interfacing with their social environment may be quite challenging for people with a facial disfigurement and a better understanding of reactions of their perceivers can help manage interactions. For that purpose, social skills training programs have been developed notably in order to ease social interactions (see A. Clarke, 1999; see also the work done by charity Changing Faces). Second, to anticipate one's own reactions is also crucial for people who may interact with people bearing a facial disfigurement and who do not want to discriminate against them. Acknowledging one's reactions, understanding the impact they may have on people with facial disfigurement in order to regulate them, can be crucial to ease the relationships, especially in situations of integration of people with disfigurement. Finally, this research

also provides evidence that training fostering eye-contact deserves further attention, as this training could ease social interactions for both people with FD and people without FD.

## **5. Conclusion**

Among the stigmatizing reactions that people living with facial disfigurement have to endure, two that are especially difficult to deal with are stares and manifestations of affective reactions. A better understanding of these reactions is thus needed in order to improve the participation in the social life of visibly different people. Our findings stress the issue of a global change in the way people with visibly different faces are perceived. In this regard, the effect of an eye-to-eye contact loss may be especially detrimental. Further considerations are thus needed in order to know if an eye-to-eye contact retrieval could benefit social interactions with visibly different people.

## **Ethics**

Ethical approval was obtained from the local institutional review committee of the laboratory of CRFDP – University of Rouen Normandy (N° 2019–06-A). Every participant gave their informed consent to participate in the studies.

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## **Open Practices**

All data and materials have been made publicly available via the Open Science Framework and can be accessed at this link: [https:// osf.io/ybvpa/?view\\_only= 5b77a73587094a9f9c22881c72f6289a](https://osf.io/ybvpa/?view_only=5b77a73587094a9f9c22881c72f6289a). All stimuli that the communicators generated for the experiments and reported in this article are available

upon request from the authors. The design and analysis plans for the experiments were pre-registered at the Open Science Framework and can be accessed at <https://osf.io/x7sqy>.

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