Face Mask and Emotion Discrimination:

A Duchenne Smile Study

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Abstract

This project efforts to investigate the impact of face masks in emotion discrimination. More specifically, this influence was meticulously observed on the judgement of happiness. Is known that this emotion is mainly expressed by the smile. Therefore, the paradigm was constructed around two types of smiles: Duchenne – considered as a happy genuine expression, and the non-Duchenne - which embrace a range of deliberate /fake smiles – contemplated as social and polite smiles. It was hypothesized that the faces covered with the protective masks would reveal a less accurate discrimination than the unmasked faces. Align to this perspective, it was assumed that the masked non-Duchenne smile would be the most impaired, predicting the lowest accuracy proportions. This premise was formulated starting from the assumption that when covering the main clue (the smile), which supports most of a happiness discrimination, a decrease to classify this smile as a happy expression would be expected. Therefore, this research carried out three studies. In Study 1 (N = 29), participants responded two discrimination judgments for masked and unmasked faces: (1) happiness discrimination from other emotions and (2) whether the happy emotion was a genuine expression or not. Happy faces of Duchenne and non-Duchenne were presented mixed with each other, so it was assumed that the high accuracy discrimination responses from the experiment, were a consequence from how the faces were displayed - which could have provoked a greater ease to discriminate the smiles, since there is a distinct contrast between them. Consequently, Study 2 (N = 32) was designed to verify if the responses were not affected by the appearance´ configuration, that could facilitate the judgment by contrasting the smiles. Hence, the smiles were displayed separately in two different blocks, representing happiness. Three additional blocks were added to analyze mask impact and discrimination for fear, anger, and sadness. Considering the current context, empathy and anxiety measures were incorporated to this project, aiming to examine if the discriminations were associated to these variables, and consequently, influenced by the present setting. Primarily, the results indicated a decrease in emotion perception when faces appear covered by protective masks. The discrimination accuracy was lower for masked faces, but not statistically significative for anger and fear. A difficulty to judge the masked non-Duchenne smile was detected in all the judgements. For this type of smile the only clue to a happiness expression is the smile, and when covered by the face mask, it confirms the that lack of this main sign impact happiness discrimination. On contrary, the Duchenne smile revealed a great level of sensitivity, with and without the mask, highlighting the importance of the *orbicularis oculi* in the happiness discrimination. Additionally, sadness, when compared to the other emotions, revealed a substantial decrease in emotion discrimination. This variation was evident when the faces appeared with and without mask, indicating a significant lower accuracy when the faces were partially covered.

Keywords: Face Mask; Emotion Discrimination; Genuine Emotion; Duchenne Smile; Happiness.

Resumo

Foi investigado o impacto das máscaras faciais na discriminação emoção. Mais especificamente, essa influência foi observada no julgamento da felicidade. Sabe-se que essa emoção é expressa principalmente pelo sorriso. Portanto, o paradigma foi construído em torno de dois tipos de sorrisos: Duchenne – considerado como uma expressão genuína, e o não-Duchenne – que abrange uma gama de sorrisos deliberados/falsos, contemplados como sorrisos sociais. Consequentemente, foi investigado se os sorrisos cobertos por máscaras revelariam uma redução na discriminação, quando comparado aos sorrisos que não foram cobertos pela máscara. Alinhado a essa perspectiva, assumiu-se que o sorriso não-Duchenne seria o mais prejudicado, especialmente na presença da máscara, prevendo as menores proporções de precisão. Essa premissa foi formulada a partir da suposição de que ao cobrir a pista principal (o sorriso), que suporta a maior parte de uma discriminação da felicidade, seria esperada uma diminuição na classificação desse sorriso como uma expressão feliz. Por isso, esta pesquisa realizou dois estudos. No Estudo 1 (N = 29), os participantes responderam a dois julgamentos de discriminação por rostos com e sem a presença da máscara: (1) discriminação da felicidade de outras emoções e (2) se a emoção feliz era uma expressão genuína ou não. Rostos felizes de Duchenne e não-Duchenne foram apresentados misturados entre si, por isso supunha-se que as respostas de discriminação de alta precisão do experimento, eram uma consequência de como os rostos eram exibidos - o que poderia ter provocado uma maior facilidade para discriminar os sorrisos, uma vez que há um contraste distinto entre eles.Consequentemente, o Estudo 2 (N = 32) foi concebido para verificar se as respostas não foram afetadas pela configuração da aparência, o que poderia facilitar o julgamento. Assim, os sorrisos foram exibidos separadamente em dois blocos diferentes, representando a felicidade. Três blocos adicionais foram adicionados para analisar o impacto da máscara e a discriminação por medo, raiva e tristeza. Os resultados indicaram uma diminuição na percepção das emoções quando os rostos aparecem cobertos por máscaras. A precisão da discriminação era menor para rostos mascarados, mas não estatisticamente significativa para raiva e medo. A dificuldade de julgar o sorriso não-Duchenne com a presença da máscara foi detectada em todos os julgamentos. Para este tipo de sorriso, a única pista para uma expressão de felicidade é o sorriso, e quando coberto pela máscara facial, confirma a falta desse signo principal impacta a discriminação da felicidade. Pelo contrário, o sorriso de Duchenne revelou um grande nível de sensibilidade, com e sem a máscara, destacando a importância dos *orbicularis oculi* (AU6) na discriminação da felicidade. Além disso, a tristeza, quando comparada com as outras emoções, revelou uma diminuição substancial da discriminação emoção. Essa variação ficou evidente quando os rostos apareceram com e sem máscara, indicando uma menor precisão significativa quando os rostos estavam parcialmente cobertos.

Palavras-chave: Máscara; Discriminação de Emoções ; Emoção Genuína; sorriso de Duchenne.

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Emotions are primarily related to the biological state (e.g., nervous system, cognition) and social behavior. Emotion - and the experience of an emotion – occur in complex organisms and regulate their relationship with society and culture. Many facets are involved in emotion expression; physiological reactions (e.g., heartrate, sweating) and expressive behavior (e.g., face, body and vocal postures). The ability to correctly identify these aspects, and thereby recognize the intentions expressed from specific emotions, plays an essential role in communication and, in evolutionarily means, was crucial for survival. Therefore, reading emotions are important for social and individual purposes (Darwin, 1872).

Humans are susceptible to react emotionally to facial stimuli (Dimberg, 1997) and particularly, respond with a set of facial muscles activations to certain physiognomies (Dimberg, 1982; 1997). Ekman et al. (1978) was a pioneer in conducting a study among different cultures, where the main objective was the evaluation and classification of emotional facial expression. The author´ study summarizes certain emotions as universally recognizable and proposed that those are not expressed and recognized only as a form of cultural learning, but as an innate human emotional expression. To Ekman, emotions can be measurable and are physiologically distinct. The research examined six basic universal emotions: surprise, sadness, happiness, fear, anger, and disgust.

As said formally, emotions are essential to social and individual purposes (Darwin, 1872), and the smile plays a valuable part in this relation. Smiles are associated to happiness, and even though people express them when they feel positive emotions (Ekman, 1973), this expression can be display for positive social intentions, which are necessary for establishing and preserving social bonds (Fridlund 1991; 2002). Such expressions (social smiles) might include the “greeting” smile (Eibl-Eibesfeld 1972) that occurs without essentially a reaction of personal enjoyment (Fridlund 1991; 2002), being produce to a social maintenance and courtesy. A smile is linked to a pleasing interaction, and that explain why people have a propensity to produce them frequently and voluntarily (Krys et al., 2016). This expression, though, can effortlessly be faked (Mehu, 2011) and, consequently, the perceiver should process and examinate their spontaneity (Ruan et al, 2020).

The authors, Frank and Ekman (1993), following this approach, stipulated key differences between felt emotional smiles (e.g., genuine expressions) and false smiles, that intentionally shown a simulate enjoyment (e.g., posed expressions). Experimental studies

indicated the existence of distinct smiles (Ekman et al., 1990, Ekman and Davidson, 1993), and mainly contrasted that the manifestation of a genuine smile, differently from the other types, required the activation of two specific facial muscles; *orbicularis oculi* (periocular muscular region) and *major zygomatic (*cheek muscle region). This expression was identified as Duchenne's smile (Ekman et al., 1990), and distinctively from the other smiles (non-Duchenne smiles), is the only genuinely happy expression to activate the *orbicularis oculi.*

Perception of Emotions

It has been hypothesized that the human visual system has evolved for a significant portion under social restraints, which suggests that vision could be more 'social' in nature than formerly assumed (Adams & Nelson., 2011). Wilhelm et al. (2014), categorizes the "perception of the expression of facial emotion" as the ability to visually analyze the contour of muscles and facial movements. This aptitude occurs in order to distinguish an emotion and classify it to a particular expression. As expressions are assumed to be an innate manifestation from human emotions (Ekman et al, 1978) also, it is believed, we have a memory for facial emotions – along with the ability to encode, store and recover in long-term memories (Wilhem, 2014).

Humans seem to be highly competent in detecting, perceiving and recognizing faces (Bruce & Young, 1986), even though faces are complex and demand an extensive processing, comparing to other forms of perception (Leopold & Rhodes, 2010). Before classifying an emotion, we go through the holistic visual process. Face processing is considered to occur holistically because it is integrated into a unit, both configural and featural information (Hole, 1994). Therefore, holistic processing is understood as the integration of individual characteristics of a face into an interdependent representation, rather than a perception of a fragmentary features (Maurer et al., 2002). Simplifying, faces are characterized by multiple features (e.g., mouth, eyes) but they are seen as gestalts or whole units (Maurer et al., 2005; Tanaka and Farah, 1993), hence they are processed holistically. Although recognition accuracy is significantly higher when faces are seen as a whole (*gestalt*), observers can still process and recognize isolated characteristics. However, when only a few features are exposed, without the whole face, it can weaken the accurate perception of an emotion and identity (Tanaka & Farah, 1993).

Holistic processing decreases the accurate recognition of a target through a composite effect design. When align two different faces together, it is detected an impairment in identifying a familiar person based on the top half, even when instructed to ignore the bottom half. Therefore, composite face effect offers an experimental paradigm that supports the study and characterization of face recognition processes (Garcia-Marques et al., 2015). Besides identification, emotion recognition can be also strongly reduced when the holistic process is prejudice by covering part of the face (e.g., covered with mask (Freud, 2020; Carbon , 2020), or cover with niqab (Fischer et al., 2012)). Aligning with emotion recognition of facial expression, another study conducted by Wegrzyn, et al. (2017) found that the observers mainly focus on the eye and mouth regions to effectively recognize an emotion. Mostly, the focus on this specifically two areas, permitted the identification of sadness and fear (support on the eyes) and happiness (focused on the mouth).

In this matter, recent studies evaluate the impact of face mask in social interaction since it is a demand to use in daily spaces to contain the spread of the pandemic virus Sars-cov-19. Authors of two new studies, Freud (2020) and Carbon (2020), added protective masks, partly covering faces, to evaluate the impact in identification and emotion recognition. Most of the covered faces presented a decrease in the performance of facial perception, particularly in holistic processing, and consequently in facial recognition and emotional expression. In this line, this current study investigates the impact of the mask in recognizing emotions, specifically, focusing on the impact of two types of smiles, Duchenne and non-Duchenne smile.

Classification of Facial Expressions

Despite the importance of holistic process, each face feature plays a specific role. The authors, Ekman & Friesen (1975) suggest that the face can be divided into three regions: (1) eyebrows and forehead; (2) region of the eyes, eyelids, and the root of the nose; (3) lower face, including the cheeks, mouth, nose, and chin. This system was based on the idea that, these regions, largely motor-independent of each other, may have a small autonomous contribution to the facial communication. For example, the lower face plays a role in language, verbalizing, moving the lips, while the upper face, adding a visual part of the speech, reveals semantic emphasis and contours of intonation stress (Ekman & Friesen, 1975).

Emotions display information about internal emotive and mental states. Those are expressed by specific facial expressions (Ekman and Friesen, 1978). Facial action coding (FACS) translates facial muscle movement into muscle patterns (FACS; Ekman & Friesen, 1978). The action units are discrete movements of some part of the face and can be performed by more than one muscle, though, some groups of muscles always act as a unit (Rinn, 1984). FACS is a manual that documents all the perceptible "action units" (AU) that the face generates, through the muscle nucleus, for each of the common emotional expression (Rinn, 1984). For example, a happy emotion can increase the *zygomatic* muscles compared to the neutral baseline, sadness increases activity mainly the *corrugator* muscles, and the expression of anger can mark the activity of the *anguli oris depressor* muscle (Schwartz, 1982).

Another procedure to classify and identify an emotion is by using electromyography (EMG). This instrument is used to measure muscles activation patterns, as it can capture visually undetectable muscle spasms. The electrodes are positioned on the left side of the participants' faces and record the activity of the muscle in specific (Fridlund e Cacioppo, 1986). EMG may also be able to capture emotional experiences that may not be reflected in self- reports (Brown & Schwartz, 1980).

Genuineness of Emotion Expression and Recognition.

The expression of emotions can be intensified, diminished, masked, simulated, or neutralized (Lander, 2020). Therefore, their manifestation arises from genuine feelings, or, as said previously, is produced with a purpose, usually directed as a social response to a specific context. The 'display rules´, which theorize those social responses, are seized early in life and support the individual to regulate, in different contexts and cultures, the most appropriate and assertive emotional expression to specific settings (Ekman & Friesen, 1969).

Beside the motive of emotional facial expressions, those two types differ in other aspects. For example, a spontaneous emotion, expressed as a reaction congruent to a specific emotional state, usually is displayed with regularity and symmetry. However, posed expressions, which are revealed in the absence of congruent emotional state (e.g., smiling when angry) and purposely shown by the producer (Weiss, Blum and Gleberman, 1987), differ in speed and irregularity (Hess and Kleck, 1990).

This contrast can also be described by the emotion recognition process. Interestingly, emotions provoked by a spontaneous stimulus are expected to be perceived and identified as genuine expressions. Differently, posed expressions - without a natural incitement of a real

emotion response – are unlikely to be perceived as genuine (Dawel et al., 2017). Previous scientific research, for capturing facial emotion expressions, actors were asked to pose a specific emotion. Therefore, without a real stimulus to elicit the expression, their facial expression was shown accordingly to what they expected the facial expression of the chosen emotion would look like. Also, in this line, the actor also would be asked to pose specific facial expression based on the configuration of FACS´ muscle activation (Ekman & Friesen, 1978). However, some researchers make use of a different strategy of capturing the emotion, in a non-posed way, in order to capture genuine expressions - which occur spontaneously by an emotional experience (McClellan, Johnston, Dalrymple-Alford & Porter, 2010).

In this concept, a differentiation from a genuineness of an expression and its recognition was discussed by Rinn (1984). The author reported the existence of two brain pathways linked to facial expression. Voluntarily induced facial movements, use different pathways of upper motor neurons, compared to emotionally induced movements. Impulses for voluntary movements come from the cortical motor strip and from the course to the facial nucleus through the pyramidal tract (specifically, corticobulbar projections). Impulses for genuine emotional facial movements emanate from a more primitive motor system known as the extrapyramidal motor system. This dissociation, between voluntary and emotional facial movements, can be demonstrated by disruption or disturbance caused by neurological damage (Rinn,1984).

A neurological event can be understood in the case of facial paralysis. Depending on the damage to the motor part of the facial representation in the right hemisphere, the patient may present, when trying to produce a posed smile, a unilateral smile. That means, only one side obeys the stimulus of reproducing this emotion. When the smile is genuine, spontaneous, this expression is shown bilaterally, which is, the two sides of the face form the complete smile (DeJong, 1979). This was also confirming by Ekman (1981) where a series of experimental results indicate that posed expression and genuine expression differ in muscle activation and apex in different speeds. Spontaneous expressions innervate muscles relatively symmetrically and simultaneously. On the other hand, in the premeditated actions, the asymmetries were found to be lateralized, showing more intensity on one side of the face. Genuine actions were more symmetrical, requested actions. (Ekman et al., 1981).

In addition to the expression of true emotions coming from networks other than those posed, neural activity when judging these facial expressions is also distinct. For example,

genuine smile has a higher activity in the limbic area than judging a non-genuine smile. A study conducted by McLellan (2012) assessed through yes/no responses if the person was feeling the emotion targeted. The results showed increased activity during the observation of genuine displays compared to happy displays, more specifically, in the left medial upper frontal gyre and in the middle cingulate cortex bilaterally.

In addition to the referred findings, a study conducted by Dawel (2017) attempted to analyze if the judgments of the expressions´ genuineness, from distinct face bases – which designed mixed strategies to capture facial expressions - were impaired. The results emphasized that, even if the expressions were reproduced by the exact units of muscle actions (such as reproducing an emotion via FACS), the expressions were less likely to be seen as genuine. Hence, this finding was support by the theory that, deliberate expressions - not provoked by true feelings – despite reproduced by the exact muscle activations, were classify as non-genuine (Dawel, 2017). This highlights the possibility of inferring that the judgment of an expression can be influenced by the means from which emotion are expressed. Summarizing, the motive of the expression, genuinely or intentioned, influence the observer´s judgment.

Duchenne smile.

The genuine smile, derived from feelings of happiness, and expressed involuntary, is called the smile of "Duchenne" (named after the French physiologist, Guillaume Duchenne de Boulogne, n. 1806-d. 1875).

Although experimental studies indicate the existence of distinct smiles (Ekman et al., 1990, Ekman and Davidson, 1993) the manifestation of a genuine smile requires specifically the activation of two facial muscles: AU6 *orbicularis oculi* (periocular muscular region) and AU12 *major zygomatic* (cheek muscle region). This expression was identified as Duchenne's smile, and according to FACS, is coded as an AU 6+12 arrangement. (Ekman et al., 1990). If the activation of these muscles is sufficiently sharp, visible changes in the face may be observed. Periocular muscle pulls the outer corners of eyebrows slightly down, creates bagging below the eyes and generates wrinkles to the corners of the eyes. The cheek muscle pulls the corners of the lips upwards at an angle towards the cheekbones (Ekman et al., 1990).

The Duchenne smile hypothesis is that smiles that involve eye constriction (AU6) are the product of genuine positive emotion. Additional types of smiles, also known as non-Duchenne smiles, do not involve the activation of *orbicularis oculi* (AU6) and are usually

classified as fake or related to negative emotions. Besides that, is difficult to fake the Duchenne mark (AU6). Generally, people can control AU12 autonomously, whereas only a few (i.e., 20%) can autonomously control AU6 (Frank and Ekman, 1993, Ekman et al.,1990).

According to some previous literature, the capacity to correctly distinguish between genuine and posed smiles is not common. Normally, the level of accuracy to recognize a genuine smile is around 55% - 70% (Frank et al., 1993; Gosselin et al., 2002, Boraston et al., 2008). There is also a difference in intensity. Such distinction was observed by Gunnery et al (2013), that Duchenne smiles are typically more intense than non-Duchenne smiles. Furthermore, previous findings show that the Duchenne smile is perceived more positively than smiles that lack the cheek raiser activation, known as the Duchenne marker (Frank and Ekman 1993; Thibault et al. 2009). Additionally, a meta-analysis conducted by Gunnery and Ruben (2016), investigated the perception of Duchenne and non-Duchenne smiles across studies. Some expressive results indicate that Duchenne smiles provoke by emotions and produced Duchenne smiles are rated more positively (i.e., authentic, genuine) than non-Duchenne smiles. The variance between Duchenne and non-Duchenne smiles was superior when smiles were elicited naturally rather than through posing paradigms.

Complementing this genuineness discrimination hypothesis, a study conducted by Ruan et al (2020) presumed that the mouth movement, may be reliable indicator of the Duchenne smile, but only after a training task focusing on recognize smiles. However, the AU6 alone was a strong indicator for genuine smiles, the participants, were inept to take this hint into full consideration. Focusing on AU6 ‘’revealed no effect, not because of a lack of attention, but rather because the participants seemed perceptually unable to detect AU6 and use it to help them recognize genuine smiles. Therefore, the result proposed that the perceptual-attentional hypothesis can explain smile genuineness recognition. With that we hope to analyze in this study the effect of the face mask when recognizing a happy emotion, by forcing the attention to only the eye region to identify a happy expression - and if is genuine or not. Although the AU6 is the main mark to identify the Duchenne smile, it is strong enough to be distinguish the genuineness from other smiles – considering that with 70 % of the face is covered, including the mouth?

At last, Williams et al. (2001) studied the cognitive strategies working during smile genuineness recognition, centering on eye fixation. Results revealed that participants gave more attention (i.e., for a longer duration) to AU6 when judging facial expressions (i.e.,

happiness, sadness, and fear) as happy. This shows value of allocating attention to AU6 when looking for to enhance smile recognition. According to Dinehart et al., (2005), the AU6 activation may largely suggest a superior emotional intensity, but might not provide as a means of distinguishing a smile's spontaneity, since many strong negative expressions also include AU6, such as sadness and pain. Through this, we also analyze in this study if happiness and other emotions (neutral, sad, anger, surprise) were correctly discriminate from each other, considering a higher level of difficulty by implementing the face mask covering the mouth region – which could be crucial to distinguishing a smile's spontaneity from other negative expressions include AU6, such as sadness (Dinehart et al., 2005).

Empathy and Emotional Facial Expressions

Social interactions are fundamentally processed by a social cognition. This specificity, incorporates the ability to comprehend ourselves and others, considering beliefs, thoughts, and feelings (Smeets, Dziobek, & Wolf, 2009) . Empathy and facial emotion recognition are examples from the many aspects that incorporates social cognition, which regulate humans behavior and comprehension in consonance with the environment (Cusi, Nazarov, Holshausen, Macqueen, & McKinnon, 2012).

Empathy is a multifaceted phenomenon. Rogers (1975), in defining the concept of empathy, understood that the person, when elaborating perceptions about the world, becomes empathic when perceive the internal frame of reference of the other. This understands, to feel and perceive the feelings and thoughts from other being. Therefore, individuals are presumed to empathize with others by simulating their feelings and mental states (Rymarczyk et al., 2019).

The assertive ability in the recognition of emotional facial expressions is one of the first steps towards an empathic response (Blairy et al., 1999). Primary research has found positive interactions between self-reported emotional empathy and expression recognition (Martin et al., 1996, Riggio et al., 1989, Gery et al., 2009). The findings suggest that empathy is a combination of basic social skills Riggio et al., (1989). Recognition of facial expressions requires rapid judgment with little conscious effort. Research has linked accurate recognition of the valence of briefly presented facial expressions to self-reported emotional empathy (Martin et al., 1996).

Besides empathy involved in emotion recognition, for Preston and Wall (2002), emotional empathy suggests - considering that one understands what the other is feeling - an

existence of emotional contagion, that is the experimentation of the same emotion by the other. Emotion contagion can be understood as a primitive form of empathy, as process by which the subject imitates and synchronizes the emotional states of others, based on their facial expression, vocalization, or posture (Hatfield, Cacioppo, & Rapson, 1994).

Pandemic Context

Implementation of Face Masks.

With the arrival of the pandemic caused by COVID-19, the effort to contain the spread of the virus introduced the use of protective masks, opened a new perspective on facial and emotion recognition. Freud et al. (2020), examined the impact of the face mask in the way faces are perceived. Manly, a decrease in facial perception performance and a qualitative change in the way faces are perceived was detected, particularly in holistic processing.

Recent studies emphasize that the implementation of masks caused a disturbance recognize emotions. Carbon (2020) tested this impact for different emotions. The participants judged the emotional expressions displayed by 12 different faces. Each face was randomly presented with six different emotions (angry, disgusted, fearful, happy, neutral, and sad). The expressions were displayed while being entirely visible or partly hidden by a face mask. As a result, emotional reading was greatly impaired by the presence of the mask, scoring lower accuracy and lower confidence in the evaluation of the displayed emotions. Happy, sad, and angry faces were highly mistaken as neutral. Therefore, emotion recognition was prejudicated, except for fearful and neutral faces.

Align with this subject, according to Fischer et al. (2012), when occluding the bottom part of the face, specially the mouth, an important feature for the recognition of many emotional expressions, and in particular happiness, a decrease on the face perception is expected. The author analyzed the impact of niqab in emotion recognition, in order to explore the absence of expressive cues and the impact of circumstantial cues on the perception of emotions. The faces were either fully visible, covered by a niqab, or partially visible (control condition) and expressed anger, shame, and happiness. The results indicated that perception of emotions is largely affected by the lack of expressive cues. Covering the lower part of the face effects in the perception of less happiness in happy displays. Partially hidden the important clues, as the smile in the non-Duchenne smiles, we aim to investigate if this expression was

identified among the participants as a happy expression when was presented with the protective mask.

Another study with face covered by mask was conducted by Grundmann, Epstude, and Scheibe (2021). It was noticed that participants were less likely to accurately categorize an emotion expression on a masked (vs. unmasked) face. Furthermore, face masks reduced perceptions of closeness. Emotion recognition predicts prosocial behavior through empathy (Bailey et al., 2018), thus, if the emotion recognition is reduced, we could also expect that prosocial behavior may be less expected.

While face masks may effectively curb the spread of COVID-19, they have collateral consequences for social and emotional inferences. Face masks reduce emotion recognition accuracy which tends to be exacerbated for older adults, weaken the perceived of closeness, and increase perceptions trustworthiness, likability, and closeness for targets expressing negative emotions Grundman, Epstude, and Scheibe (2021). These results emphasize the face masks' impacts on social functioning and these changes could have social implications, with significant impact on daily tasks and forms of interaction (Freud, 2020).

Pandemic as a Possible Stressor.

When assessing empathy and recognition of emotions, it is important to consider that any variance in anxiety and arousal emotions – especially in the stressful social context such as the pandemic environment – can and affect social performance (Duesenberg, 2016). Thereby, we hypothesized that the COVID-19 could implicate on the stress levels by fear, for example. Tibi-Elhanany and Shamay-Tsoory (2011) observed that individuals with high social anxiety scores demonstrate greater empathic abilities, which accentuates the possibility that social environments may have an impact on social cognition. Hence, it was presumed that fear and anxiety of the virus could affect the emotion discrimination.

Emotion recognition of faces can be seen as a more basic skill which is crucial to interact properly with the environment (Adolphs, 1999). The process underlying social cognition can be distorted under conditions of stress, as do many human attentional, perception, and response mechanisms (Staal, 2004). A study conducted by Barel and Cohen (2018) investigated the influence of psychosocial stress on the recognition of facial emotional expressions. Two investigational groups: stress (exposure to the Trier Social Stress Test) and control. Members of both groups complete a facial emotion recognition test. Results revealed that while stress improved the accurate recognition of anger, happiness, surprise, and

neutral/calmness, it decreased the recognition of fear and had no effect on the recognition of sadness and disgust (Barel & Cohen, 2018).

Considering the previous findings, we also attached to our experiment questionnaires which measure anxiety traces, in order to considered if the current context would interfere in the participant´s performances in recognizing emotions, especially in differing the Duchenne form the non-Duchenne smile. Since, high social anxiety scores demonstrate greater empathic abilities (Tibi-Elhanany and Shamay-Tsoory, 2011), this current experiment investigated if other control measures (e.g., empathy, anxiety) were correlated with empathic scores and accuracy in discriminating emotions.

Project Overview

Reflecting the impact of mask in emotion discrimination, this study focuses on happiness discrimination. Hence, this research was based in the classification of two types of smiles considered to be expressions of happiness: the genuine smile, known as Duchenne; and all the other social smiles, considered to be not genuine, namely non-Duchennes (Ekman et al., 1990; Frank and Ekman et al., 1993; Ekman and Davidson, 1993). Thereby, first, was evaluated the impact of partially covering the face in emotion discrimination, supported by former studies (Carbon, 2020; Grundmann, Epstude, and Scheibe, 2021). Secondly, knowing that the cheek raise and eye contraction (AU 6+12 arrangement) is the Duchenne mark (Ekman et al., 1990), and reinforced by the evidence that the mouth is a valuable indication to recognize a happy expression (Fischer et al, 2011), this current study was designed to identify whereas the type of smile was impaired in correct happiness discrimination, and restricted by protective masks. Acknowledging that, Study 1 investigated happiness discrimination and the impact of the face mask in these judgments. Specifically, it was expected that the non-Duchenne smile would be the most impaired by the face mask, because, as these smiles do not contract the upper face muscles, as the genuine smile do, they would be less considered to be a happy expression.

Persistent and expanding from this approach, a second judgment was added to Study1, the genuineness happiness discrimination. For Raul et al., (2020), although the Duchenne mark (AU6) was strong indicator for genuine smiles, the participants, were inept to take this hint into full consideration when classifying the genuineness of the smile. Also, Williams et al. (2001) noticed that participants gave more attention (e.g., for a longer period) to AU6 when judging facial expressions (happiness and sadness), as happy. This reveals a valuable

strategy in allocating attention to AU6 when expect to improve smile recognition. A previous meta-analysis conducted by Gunnery and Ruben (2016), observed that the Duchenne smiles are more rated as genuine and authentic, than the non-Duchenne smile. On contrary to this results, to Bolzani Dinehart et al., (2005), the AU6 activation may largely suggest a superior emotional intensity, but might not provide as means of distinguishing a smile's spontaneity. Supported by these previous findings, the second judgment investigated the genuine judgment of Duchenne and non-Duchenne smiles, as the effect of the face mask in these responses.

Considering the current pandemic context, empathy and anxiety measures were incorporated to this project, aiming to examine if the discriminations were associated to these variables, and consequently, influenced by the present setting. Align to that, the judgments´ responses were correlated with control measures (empathy; anxiety traits; fear and anxiety from COVID-19). This design was based on previous literature. Primary research has found positive interactions between self-reported emotional empathy and expression recognition (Martin et al., 1996; Riggio et al., 1989; Gery et al., 2009), and this findings suggest that empathy is a combination of basic social skills (Riggio et al.,1989). The current stressful environment, caused by the pandemic and social restriction, was considered in this research, aligned, and expecting to influence the results of the control measures. The hypotheses were founded in former results which revealed that stress influenced the accurate emotion recognition. Specifically, improved the recognition of anger, happiness, surprise, and neutral/calmness, decreased the recognition of fear, and had no effect on the recognition of sadness and disgust (Barel & Cohen, 2018). Therefore, this present project, hypothesize that the pandemic environment could affect the response discrimination, in meanings of empathy, anxiety, and fear. Establish on the belief that, as emotion recognition predicts prosocial behavior through empathy (Bailey et al., 2018), and thus, if the emotion recognition is reduced, prosocial behavior may be less expected.

As in Study 1, happy faces of Duchenne and non-Duchenne were presented mixed with each other, it was considered that this arrangement could benefit the accurate discrimination of the genuine smile, since there was a distinct contrast with the non-genuine smile. Thereby, the aim of Study 2 was test if the discrimination would be affected by this means. So, in the second experiment, Duchenne and non-Duchenne were presented separately in different blocks. Additionally, blocks to discriminate other emotions were added. Thus, was possible to evaluate the impact of mask in other emotions (fear, anger, and sadness).

Therefore, considering the previous references and this project´ objectives, the hypotheses were formulated.

Hypotheses.

Study 1.

Judgment 1: happiness discrimination from other emotions.

Hypothesis 1: The Duchenne is smile is presumed to be more discriminated as a happy expression than the non-Duchenne smile.

Hypothesis 2: It is expected that the mask would decrease emotion discrimination.

Hypothesis 3 (Main Hypothesis): Is anticipated that the presence of the mask would interfere differently in the discrimination for the two types of smiles and would be specially reduced for the non-Duchenne faces.

Judgment 2: genuine happiness discrimination

Hypothesis 4: It is expected that the mask would impair the discrimination of genuineness of the smiles.

Study 2.

The same hypotheses from the first judgment of Study 1, were tested. Although, the main reason was to evaluate if the context which the smiles appear, would cause the same responses.

Hypothesis 5: The presence of the mask influences the discrimination of other emotions (anger, sadness, and fear)?

Empathy and Complementary Measures.

Hypothesis 6: The pandemic setting could affect the response discrimination, in meanings of empathy, anxiety, fear of COVID-19?

Study 1

The aim of this study was investigating the happiness and genuineness discrimination relatively to the Duchenne and non-Duchenne smiles, and the presence of the face mask on these responses. This experiment was design with two different judgments. In the first, the

Happiness Discrimination, the purpose was to discriminate happy faces from other expressions (neutral, sad, fear and anger). Subsequently, in the second judgment, Genuine Happiness Discrimination, the participants needed to classify if the happy expression from the first assignment was genuinely happy or not genuinely happy.

Method

Participants

Twenty-nine students (*N* = 29, 24 females and five males, age *M* = 20,65, *SD* = ,667*)* were recruited from ISPA - *Instituto Universitário,* received complementary hour credits for their participation, which are require as part of their academic curriculum. One female participant was excluded from the experiment for reacting with an aleatory response pattern. By this, only the data from 28 individuals were consider. The informed consent was agreed before the experiment and approved by the ethic committee, considering that another experiment with similar content was approved priory this one.

Design

The participants judged four blocks, each one with 48 trials. Each block presented happy Duchenne x happy non-Duchenne x neutral x other emotions (fear, sadness, and anger). Half of the faces were presented with mask and the other half without ask, and the stimulus were shown in an aleatory way. The design was two factors within subjects. In total the participants did 192 trials (4 emotions x mask x 24 replicas).

Material

Apparatus.

The stimuli were presented via E-Prime 2.0 (Psychology Sofware Tools, Pittsburgh, PA) on a 24-inch monitor (100Hz) with a resolution of 1280×720, 60 cm distant from the participant. All the photographs were subjected to digital processing for format, resolution, and tone standardization; converted to grayscale, matched for luminance and contrast, and converted to a pattern size. For this experiment, masks were added on the faces by an editor program.

Databases.

For this study, pictures of faces expressing different emotions were taken from three different database (*The Chicago face database, 2015; Radboud Faces Database RafD, 2010*; *Warsaw set of emotional facial expression pictures, 2015)* – each database used distinct methods to capture emotions. From the *Chicago face database,* a total of 44 faces were selected for this experiment (which 12 faces for happy non-Duchenne smile, 20 neutral faces, eight happy Duchenne, two fear and two anger faces). The *Radboud Faces Database RafD* had a total of 32 faces selected (seven faces for happy non-Duchenne smile, 11 neutral faces, four happy Duchenne, four sad faces, three fear and three anger faces). From the *Warsaw set of emotional facial expression pictures* we used 28 faces (one face for happy non-Duchenne smile, nine neutral faces, eight happy Duchenne, four sad faces, three fear and three anger faces).

Figure 1. Faces of emotional expressions selected and edited for the experiments. From left to right: happy Duchenne's smile; happy represented by the non- Duchenne smile; neutral f; sad; anger; and fear on the far right. The masks were added for the experiments. (The Chicago Face Database, 2015; Radboud Faces Database RafD, 2010; Warsaw set of emotional facial expression pictures, 2015).

One hundred and four faces (unmasked) were selected from the three databases, and copies from each one of those faces were made and added masks, totalizing 208 faces displayed in the study. From this total amount, 40 faces were classified as happy Duchenne smile (20 masked, 20 unmasked) and another 40 were classified as happy non-Duchenne smile (20 masked, 20 unmasked). The other emotions were added as distractors to this

experiment.: 80 neutral faces (40 masked and 40 unmasked); 16 sad faces (eight masked, eight unmasked); 16 angry faces (eight masked, eight unmasked); and 16 fear faces (eight masked, eight unmasked).

Figure 2. Duchenne and non-Duchenne faces. Above is the expression of happiness represented by the Duchenne smile, and the non-Duchenne smile. One observes the muscles activation for the respective smiles. Correspondingly, the genuine smile requires activation of two facial muscles: *orbicularis oculi* (periocular muscular region) and zygomatic *major (muscle region* of the cheek). The masks were applied by edition for the experiments (The Chicago Face Database, 2015; Warsaw set of emotional facial expression pictures, 2015).

The methodology we used to classify the Duchenne and Non-Duchenne was via Facial Action Coding System (FACS; Ekman & Friesen, 1978), with a group of independent judges that classified the accuracy of the expressions. The FACS is a manual that documents of all perceptible "action units" (AUs) that the face is adept of generating through muscular core. Action units are discrete movements of some part of the face and can be performed by more than one muscle, even though, some groups of muscles always act as a unit (Rinn, 1984).

There is experimental indication that distinct smiles exist (Ekman et al., 1990, Ekman and Davidson, 1993). The manifestation of a genuine smile requires the activation of two facial muscles, orbicularis oculi (periocular muscle region) and zygomaticus major (cheek

muscle region). This expression has been identified as the Duchenne smile (Ekman et al., 1990). If the activation of these muscles is sharp enough, noticeable changes can be seen in the face. According to FACS, this is coded as an arrangement of AU´s 6+12. Periocular muscle pulls the outer corners of the eyebrows faintly downwards, creates bagging below the eyes and generates wrinkles to the corners of the eyes. Cheek muscle pulls lip corners up at an angle towards the cheekbones (Ekman et al., 1990). Additional types of smiles, also known as non-Duchenne smiles, do not involve the activation of orbicularis oculi.

Questionares.

Empathy Measure.

Índice de Reactividade Interpessoal (Mark Davis, 1983; Portuguese Adaptation - Teresa Limpo, Rui A. Alves & São Luís Castro, 2010):

This 24 questions index is based on a multidimensional conception of empathy. It is constructed on four subscales: perspective taking (the tendency to spontaneously adopt the psychological point of view of others); empathic concern (measures "other-oriented" feelings of sympathy and concern for unfortunate others); personal distress (measures "self-oriented" feelings of personal anxiety and unease in tense interpersonal settings); fantasy (tendencies to transpose themselves imaginatively into the feelings and actions of fictitious characters in books, movies, and plays).

***Complementary Measures*.**

These methods were collected as a complement for this research. The present study investigates emotion recognition in face expressions, and by that, it was hypothesized that empathy levels could be influencing this discrimination. When evaluating empathy and emotion recognition, is important to consider that an increase in anxiety and emotion arousal – especially in stressful social context as the pandemic environment - could affect social performances (Duesenberg, 2016). Individuals high in social anxiety scores demonstrate higher empathic abilities, which accentuates the possibility that social settings could have an impact on social cognition (Tibi-Elhanany and Shamay-Tsoory, 2011). Considering this, is prudent to evaluate the actual context, and that is the reason why other two questionnaires were added to the experiment.

Anxiety Measure: STAI – Trait Anxiety Inventory (Portuguese adaptation - Silva & Correia, 1998): The State-Trait Anxiety Inventory (STAI).

One of the most used instruments to quantify subjective components related to anxiety. There is a scale that assesses anxiety as a state (STAI-E) and another that accesses anxiety as a trait (STAI-T). For this experiment only 10 questions from the trait inventory were used, which evaluated the anxiety trait that refers to a more stable aspect related to the propensity of the individual to deal with greater or lesser anxiety throughout his life (Cattell & Scheier, 1961). All the answers should be rated from 1 (*Do not describe me well*) to 5 (*Describe me very well*).

Control-measures Covid-19 (Loureiro, Garcia-Marques & Bártolo (2020) Control Measure Covid-19).

This 4-question survey aims to understand the perception of some measures related to the new coronavirus. This is part of an investigation that will be submitted for approval. The answers go from a 7-point scale about mostly about fear and anxiety: How do you evaluate the protective measures taken against COVID-19? ; What level of anxiety do you feel in environments characterized as PROTECTED from COVID-19? ; What level of fear do you have of COVID-19?; How much anxiety do you feel when thinking about COVID-19?

Procedure

Participants arrived at the lab Willian James Center for Research in groups (between six and eight), totalizing four sessions to collect the data. After signing the informed consent form, participants were asked to sit in front of a computer screen on an individual boot where the guidelines were presented on the computer screen. The experiment was conducted during the COVID-19 pandemic, when legal obligations, to wear masks and social distancing, were in demand in Portugal. In the first part, the participants answer to the judgments and then after responded to the questionnaires.

Before the experiment, there was a training phase to make trails of the evaluation and be familiarize with the task. Four different faces were displayed with the objective to indicate whether the person in the image is happy or not happy. At each evaluation (between images) a small "+" sign appeared in the center of the screen briefly.

Discrimination Judgments.

This experiment had two judgments. The first judgment was the Happiness Discrimination; the purpose of this task was to test the perception of emotions in people wearing protective masks, more specifically, the discrimination of happy faces from other

expressions (neutral, sad, fear and anger). The second judgment was the Genuine Happiness Discrimination: the participants needed to discriminate if the happy expression from the first assignment was genuinely happy or not genuinely happy.

Judgment 1. Happiness Discrimination (from other expressions).

Images of individuals with face uncovered or covered by a protective mask were presented. The goal was to indicate whether the person in the image was happy or not happy. Answering not happy, it would change to a different image. However, if the answer was happy, it would be directed to the second judgement: Genuine Happiness Discrimination.

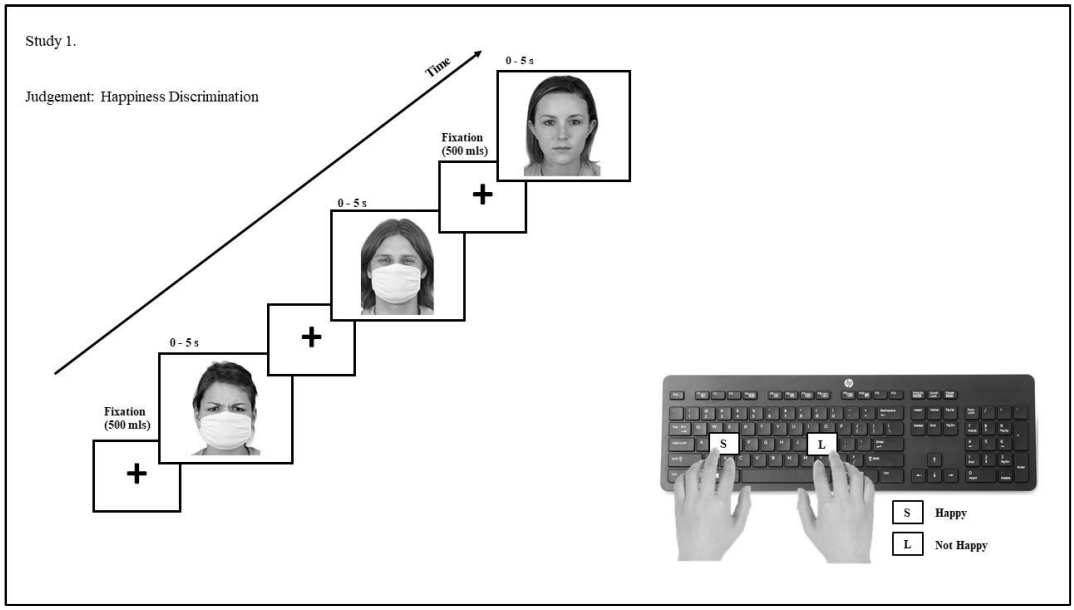

Figure 3. Experimental Design of Study 1: Judgment 1.

Judgment 2. Genuine Happiness Discrimination (discriminating the truthfulness of the smile).

The participant was required to judge if the expression from the first judgment was genuinely happy or not genuinely happy.

Questionnaires.

After finalizing the emotion discrimination, three questionnaires followed to be answered: Interpersonal Reactivity Index (Mark Davis, 1983; Portuguese Adaptation - Teresa Limpo, Rui A. Alves & São Luís Castro, 2010), STAI – State-Trait Anxiety Inventory

(Portuguese adaptation - Silva & Correia, 1998) and Control-measures Covid-19 (Loureiro, Garcia-Marques & Bártolo ,2020). The whole experimental session took approximately 25 minutes.

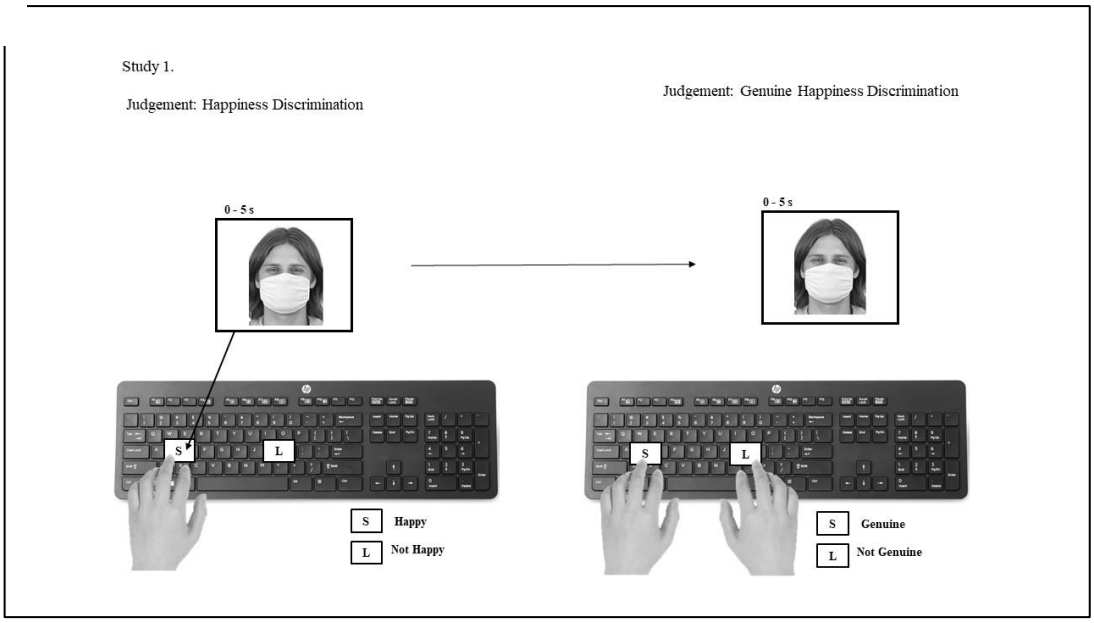

Figure 4. Experimental Design of Study 1: Judgment 1 and 2.

Dependent Measures.

Signal detection theory: sensitivity (d´-prime) and criterium (c)

According to signal detection theory, there are two processes involved in facial emotion perception: a sensory process and a cognitive decision process (Green and Swets, 1966; Macmillan and Creelman, 2005).

The sensory process is calculated by sensitivity - which is the capacity to discern one facial emotion from another facial emotion - calculated as d´-prime. This process defines how well the viewer can pick the correct stimuli while avoiding the incorrect ones. When the d´ prime is higher than zero, the level of hits (when the sign is present and is identified) is bigger than the false alarms (when there is only noise and there is an answer) means a higher sensibility to discriminate the stimulus from the noise (Van der Kellen, 2008).

The cognitive decision process is measured by response criterion - propensity to judge a facial emotion as a specific emotion and calculated as ‘c’- tendency to make a certain decision with the evidence they have received from the sensory process. If this criterion is less

than zero, the criterion is characterized as liberal and presents a higher level of false alarms. If the criterion is higher than zero, is characterized as conservative, and presents lesser false alarms. When the criterion is equivalent to zero, it is suggested an unbiased judgement (Van der Kellen, 2008).

Statistical analysis

For this experiment we applied the repeated measures analysis of variance (ANOVA). Sensitivity and response criterion for facial emotion discrimination were calculated as d-prime and c, according to signal detection theory, and examined as dependent variables. We used Pearson's correlation analysis to examine associations between dependent variables and the questionnaire variables – empathy and complementary control measures. Statistical significance was set at 0.05.

Results

Judgment 1: Happiness Discrimination from Other Emotions.

The purpose of this task was to discriminate happy faces from other expressions (neutral, sad, fear and anger).

Hits and False Alarms.

To analyze the hit proportions, it was measured the interaction from the smiles (Duchenne and non-Duchenne smile) and the presence of the mask (Mask x No Mask).

As was expected, the Duchenne smile (M=.98, SD=.01) revealed the highest proportion of hits when comparing to the non-Duchenne smile (M=.77, SD=.02) This finding is statistically significant and validate the first hypothesis (F (1,27) =171.2, p<.0001, η^2p=.86).

Corroborating with the second hypothesis, the unmask smiles (M=.95, SD=.01) revealed a superior effect on the hit proportion, in comparison to the masked smiles (M=.80, SD=.02) when discriminating happiness (F (1,27) =86.2, p<.0001, η^2p=.76).

The main hypothesis suggested that the mask would impact the discrimination for the two types of smiles, assuming to be reduced for the non-Duchenne. It was observed a significant interaction between the type of smiles (Duchenne and non-Duchenne smile) and the presence of the mask (with and without) (F (1,27) = 61.8, p<.0001, η^2p=.69). Particularly, the result demonstrated an impairment in the non-Duchenne discrimination. The hit

distribution between non-Duchenne with and without the mask (*M*=.30, *SD*=.03) was higher than the difference between Duchenne with and without the mask (*M*=.01, *SD*=.01). Statistically, these findings corroborate with the main hypothesis (*t*-test (*t* (27) =8.71, *p*<.001, *d*=1.65); *t*-test (*t* (27) =2.17, *p*=.039, *d*=.41), that the face mask weaken the correct discrimination, and the type of smile could be differently impact by it, specifically the non-Duchenne, which is confirmed to be the most affected.

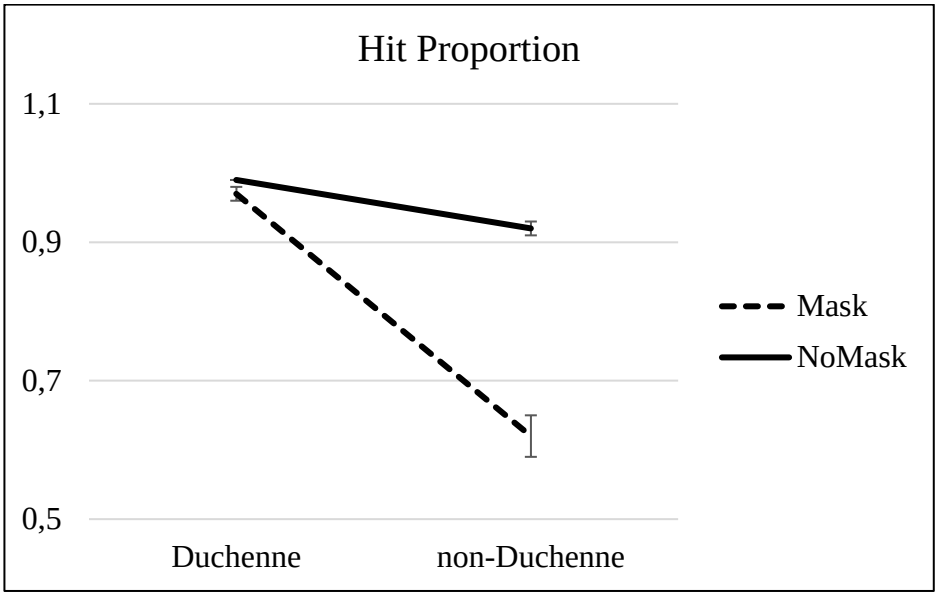

Figure 5. Study 1. Judgment 1: Hit Proportion. The figure illustrates the hit proportion from masked and unmasked Duchenne, and non-Duchenne. The differences between the means are statistically significant.

For the false alarms, it was measured the interaction from neutral faces and other emotions (anger, fear, sadness) and the presence of the mask (Mask ; No Mask).

There was a significant interaction between the false alarm proportion for neutral faces and other emotions (*F* (1,27) =17.9, *p*<.0001, η^2p=.40). Although the false alarm proportion was higher for neutrals (*M*=.11, *SD*=.03) comparing to the other emotions (*M*=.02, *SD*=.01), no interaction between masked (*M*=.07, *SD*=.02) and unmasked faces (*M*=.06, *SD*=.02) was observed (*F* (1,27) =1.46, *p*=.23, η^2p=.05). By this means, no statistically significative difference was noticed between the false alarm distribution when discriminating neutral faces and other emotions with and without the mask (*F* (1,27) =.00, *p*=1.00, η^2p=.00).

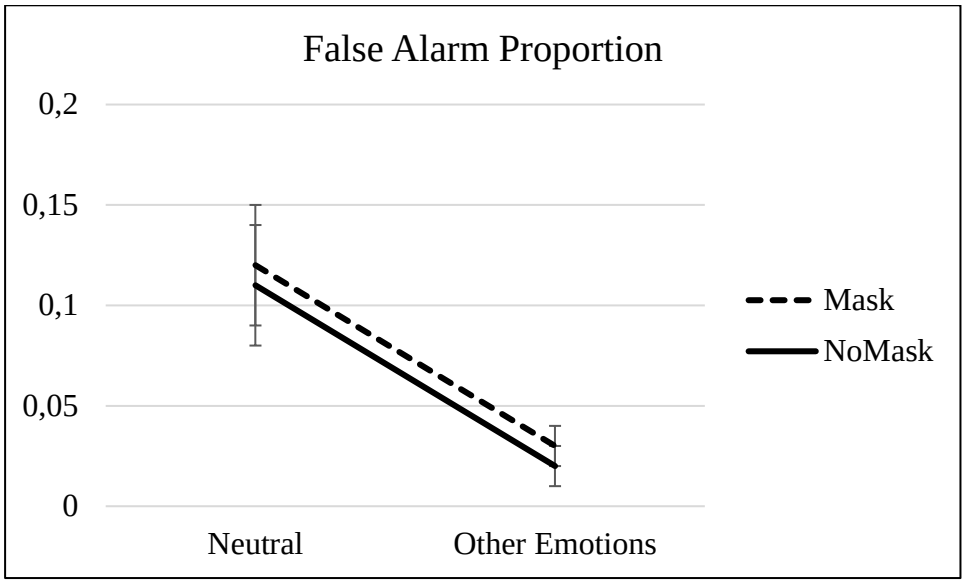

Figure 6. Study 1. Judgment 1: False Alarm Proportion. The figure illustrates the false alarm proportion from masked and unmasked neutral and other emotions (anger, sad and fear). The differences between the means are not statistically significant.

STD Indexes.

To analyze the proportions for the Signal Detection Theory Indexes (d-prime and c), it was considered the interaction from the smiles (Duchenne; non-Duchenne) and the presence of the mask (Mask ; No Mask).

Sensitivity in discrimination (d-prime).

The Duchenne smile (*M*=3.24, *SD*=.13) demonstrated a superior discrimination when comparing to the non-Duchenne smile (*M*=2.30, *SD*=.11), and this result confirming the first hypothesis (F (1,27) =252.1, p<.0001, η^2p=.90).

Corroborating with the second hypothesis (F (1,27) =44.7, p<.0001, η^2p=.62), when discriminating happiness, the mask (*M=2.43, SD=.11*), caused a decrease on the discrimination proportion, compared to the unmasked faces (*M*=3.11, *SD*=.13).

The main hypothesis suggested that the mask would impact the discrimination for the two types of smiles, assuming to be reduced for the non-Duchenne. It was observed a significant interaction between the type of smiles (Duchenne and non-Duchenne smile) and

the presence of the mask (with and without) (F (1,27) =64,5, p<.0001, η^2p=.70), supporting the main hypothesis.

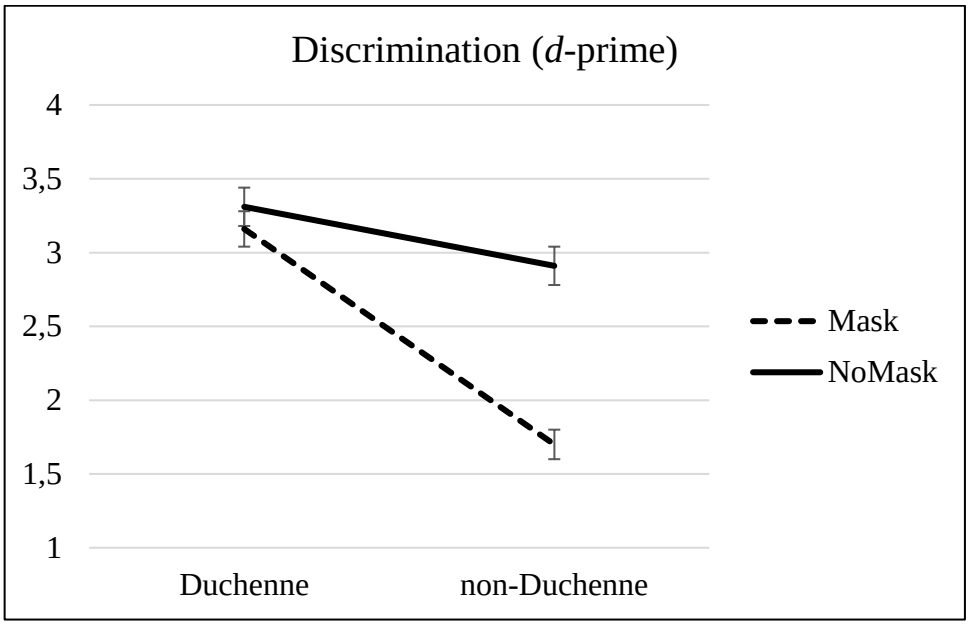

Figure 7. Study 1. Judgment 1: Discrimination (d-prime). The figure illustrates the discrimination (d´) proportion from masked and unmasked Duchenne and non-Duchenne. The differences between the means are statistically significant.

The major distinction was the sensibility to discriminate non-Duchenne smile with mask (M=1.70, SD=.10) which revealed the lowest proportion level - indicative of an elevated number of false alarms. Hence, this suggests that more mistakes were made to recognize the masked non-Duchenne smile as a happy expression. Statistically, this finding corroborate with the main hypothesis : non-Duchenne smile with mask (M=1.70, SD=.10) and without mask (M=2.91, SD=.13) presented a difference in the sensibility to discriminate (t-test (t(27)=8.65, p<.001, d=1.63) M=1.22, SD=.14), where the mask signify the probabilities to make more mistakes when judging non-Duchenne as a happy expression. As a contrast, the Duchenne smile revealed the highest level of sensitivity, with mask (M=3.16, SD=.12) and without mask (M=3.31, SD=.13), and the results indicated no significative variance in discriminating this expression as a happy emotion, thus, no direct effect of the mask in the response accuracy (t-test (t (27) =1.53, p=.13, d=-.29) M=.15, SD=.09). Therefore, this finding express elevated percentage of hits and low levels of false alarms, highlighting that

even when the face is partially covered, the Duchenne smile is easily judged as a happy expression.

Response Criteria (c).

It was observed a liberal criterium for Duchenne smile (M=-.23, SD=.06), compared to the non-Duchenne smile (M=.24, SD=.08). Thereby this difference was statistically significant (F (1,27) =252.1, p<.0001, η^2p=.90).

Examining the impact of the face mask, it was found a significant difference (F (1,27) =16.7, p<.0001, η^2p=.38) between the masked (M=.14, SD=.08) and unmasked smiles (M=-.13, SD=.07).

Overall, it was analyzed the interaction between the smiles (Duchenne and non-Duchenne) and the presence of the mask (Mask; No Mask). The contrasts between the distributions were statistically significant (F (1,27) =64.5, p<.0001, η^2p=.70), demonstrating a difference in the response criteria between the smiles, covered and uncovered by a face mask.

The main effect was for the masked non-Duchenne, which in particularly, presented a conservative criterium, signifying a higher tendency to omissions and a decrease of mistakes (false alarms). Therefore, this means a wakened propensity to identify the stimulus - when this was presented as a masked non-Duchenne - as a happy expression, explaining the high levels of omissions. Statistically, the difference in the response criteria for non-Duchenne smile (Mask: M=.50, SD=.09; No Mask: M=-.03, SD=-.08) was relevant (t-test (t (27) =6.15, p<.001, d=1.16) M=3.16, SD=.12), confirming that the mask directly impacts the response criteria distribution, for this smile. Additionally, and confirming our hypothesis - that the mask influences the judgment of the type of smile - the Duchenne faces pointed no significative bias considering the response criteria (Mask: M=-.23, SD=.06; No Mask: M=-.23, SD=.06), and, therefore, was no statistically difference between masked and unmask Duchenne faces (t-test (t (27) =-.00, p=.96, d=.00).

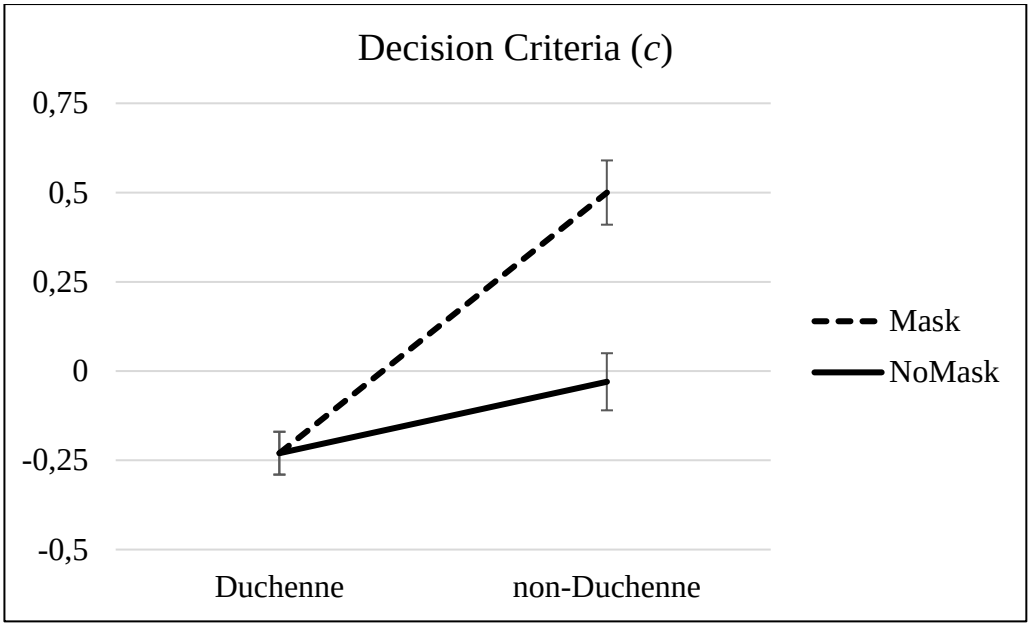

Figure 8. Study 1. Judgment 1 : Decision Criteria (c). The figure illustrates the Decision Criteria (c´) proportion from masked and unmasked Duchenne and non-Duchenne with and without the mask. The differences between the means are statistically significant.

Empathy and Complementary Measures.

The correlation between empathy, complementary measures (anxiety traits; fear and anxiety of COVID-19) and the emotion discrimination, was calculated by the Detection Theory Signal Indexes, respectively, discrimination (d-prime) and response criteria (c). Hence, it was considered this interaction with the smiles (Duchenne; non-Duchenne) and the presence of the mask (Mask; No Mask). The data analysis was estimated by the Pearson´s correlation.

STD Indexes.

Sensitivity in discrimination (d-prime).

According to the results from Study 1, there was two moderate negative correlations between empathy and the discrimination of masked smiles. A negative and statistically significance association was observed between the empathy and discrimination of Duchenne faces with mask (r=-.41; *p*=.02). Equally, the masked non-Duchenne, a negative and a significance correlation was notice with empathy (r=-.44; *p*=.01). There was not a statistically significance association between empathy and discrimination for unmasked Duchenne (r=-

.16, *p*=.39) and non-Duchenne (r=-.15, *p*=.44). These outcomes suggest that the judgment for the masked smiles, Duchenne and non-Duchenne, is negatively correlated with empathy. While these were the findings for masked smiles, there was no significance correlation between empathy and discrimination from the unmasked faces.

There was no expressive association for the anxiety traits (STAI) and the COVID-19 measures (fear and anxiety) with the discrimination of happiness from other emotions, indicating no correlation between these variables and discrimination, whereas the faces were shown with or without the mask.

Table 1.

Judgment 1. Pearson's Correlation: Discrimination (d´).

		IRI	STAI	COVID -19	
		Empathy	Anxiety	Fear	Anxiety
Mask					
	Duchenne	-.41*	-.11	-.14	-.01
	N-Duchenne	-.44*	-.32	-.18	-.13
No Mask					
	Duchenne	-.16	-.01	-.01	.02
	N-Duchenne	-.15	.02	.02	.17

Note. The values correspond to the discrimination between mask, smiles and control measures.: IRI = *Interpersonal Reactivity Index* (Mark Davis, 1983; Portuguese Adaptation - Teresa Limpo, Rui A. Alves & São Luís Castro, 2010*)*; *STAI = State-Trait Anxiety Inventory* (Portuguese adaptation - Silva & Correia, 1998); *Control-measures Covid-19* (Loureiro, Garcia-Marques & Bártolo ,2020).

*p < .05

Response Criteria (c).

It was observed one moderate negative correlation between empathy and the response criteria. This association was notice in the response criteria for masked Duchenne (r=-.37; *p*=.05).

Although, this association was found for this masked smile, the unmasked Duchenne indicate no statistically significant implication with empathy (r=-.11, *p*=.57). For the non-Duchenne smile, no statistically significance for empathy and the response criteria was found, for masked (r=-.28; *p*=.14) and unmasked faces (r=-.09; *p*=.61). The results imply a negative relationship between empathy and the response criteria for the Duchenne smile covered with the mask.

There was no expressive association for the anxiety traits (STAI) and the COVID-19 measures (fear and anxiety) with the response criteria of happiness from other emotions, indicating no correlation between these variables, whereas the faces were shown with or without the mask.

Table 2.

Judgment 1. Pearson's Correlation: Response Criteria.

		IRI	STAI	COVID -19	
		Empathy	Anxiety	Fear	Anxiety
Mask					
	Duchenne	-.37*	-.10	-.09	-.18
	N-Duchenne	-.28	-.02	-.05	-.05
No Mask					
	Duchenne	-.11	.03	.03	-.00
	N-Duchenne	-.09	-.04	.00	-.13

Note. The values correspond to the response criteria between mask, smiles and control measures.: IRI = *Interpersonal Reactivity Index* (Mark Davis, 1983; Portuguese Adaptation - Teresa Limpo, Rui A. Alves & São Luís Castro, 2010*)*; *STAI = State-Trait Anxiety Inventory* (Portuguese adaptation - Silva & Correia, 1998); *Control-measures Covid-19* (Loureiro, Garcia-Marques & Bártolo ,2020).

*p < .05

Judgment 2: Genuine Happiness Discrimination.

The participants were required to discriminate if the judgment of the happy expression from the first assignment was a genuinely or not a genuinely happy expression.

Hits and False Alarms.

To analyze the hit proportions, it was considered the interaction from the Duchenne smile and the presence of the mask (Mask ; No Mask).

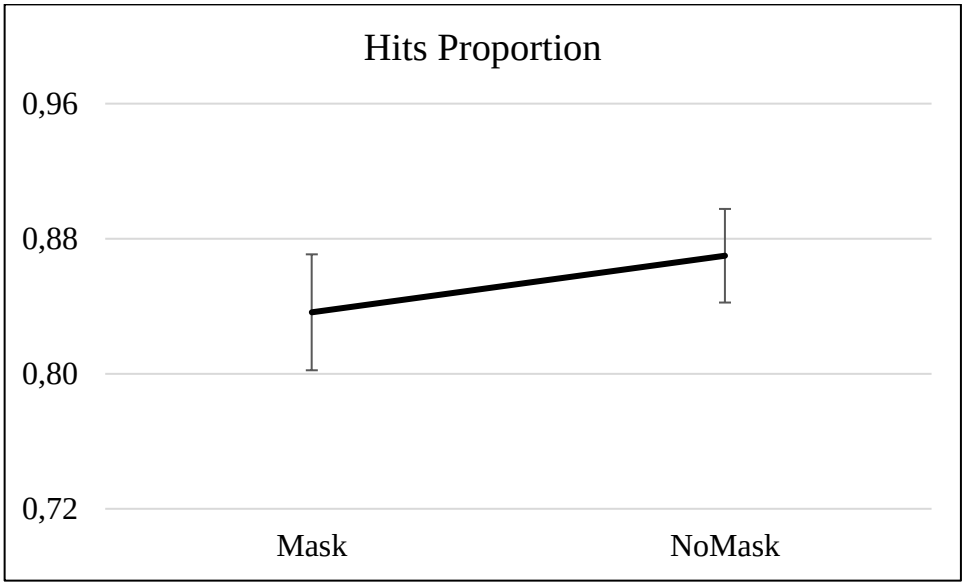

Figure 9. Study 1. Judgment 2 : Hit Proportion. The figure illustrates the hit proportion from masked and unmasked Duchenne faces. The differences between the means are not statistically significant.

Considering the hit proportion from Duchenne, masked (*M*=.84, *SD*=.33) and unmasked (*M*=.87, *SD*=.03), we tested with a Repeated Measure ANOVA, for a significant variance in distinguishing this specific smile as genuine. Interpretating this outcome, it can be postulate that, although the hit proportion was slightly higher for the unmasked faces, there was not a statistically difference on the hit proportion between Duchenne smile with and without the mask (*F* (1,27) =1.24, *p*=.27, η^2p=.04). Thus, as no variation was detected when discriminating this expression with and without the mask, it can be suggested that the mask was not an obstacle for determining the Duchenne smile as a genuine expression of happiness.

To analyze the false alarm proportions, it was considered the interaction from the non-Duchenne smile and the presence of the mask (with and without). Respectively, the

distribution of false alarms for the masked non-Duchenne (*M*=.49, *SD*=.06) were slightly superior to the non-Duchenne without the mask (*M*=.41, *SD*=.05). Even though there were additional mistakes in identifying the non-Duchenne smile with mask as a non-genuine expression of happiness, there is no statistically significative difference in differentiating this smile as genuine or not genuine (*F* (1,27) =2.28, *p*=.14, η^2p=.07), demonstrating that the mask did not influence statistically in the response levels of mistakes. Therefore, it can be implied, that the results did not present a meaningful effect from the face masks when classifying the non-Duchenne.

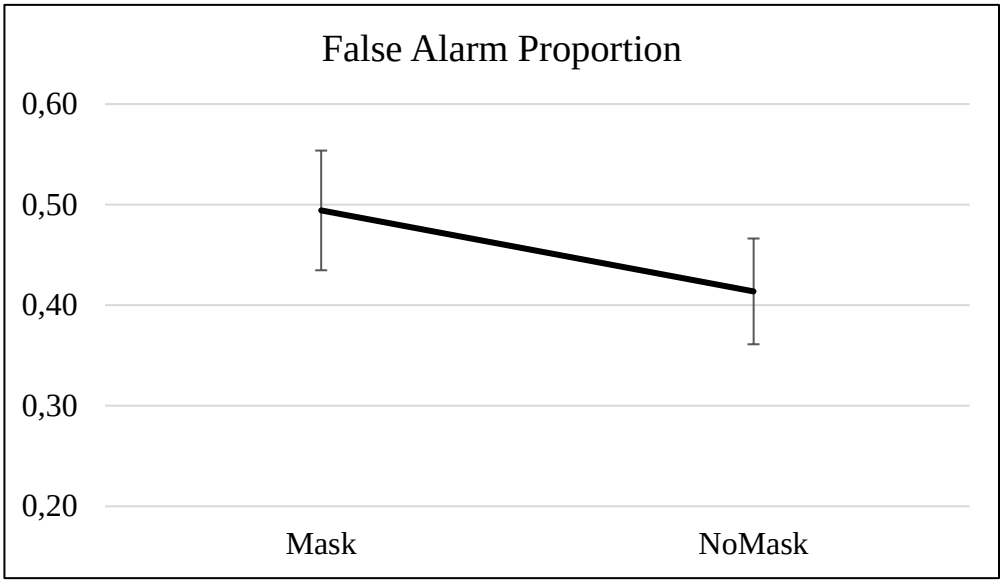

Figure 10. Study 1. Judgment 2: False Alarm Proportion. The figure illustrates the false alarm proportion from masked and unmasked non-Duchenne. The differences between the means are not statistically significant.

STD Indexes.

To analyze the proportions for the Signal Detection Theory Indexes (d-prime and c), it was considered the interaction from the Duchenne smile and the presence of the mask (Mask ; No Mask).

Sensitivity in discrimination (d-prime).

Here it was estimated the discrimination between the Duchenne faces with and without the mask, where the aim was to judge this expression as a genuine or not a genuine emotion. Although the sensibility was superior for the masked Duchenne (*M*=1.78, *SD*=.26) compared

to Duchenne without the mask (*M*=1.34, *SD*=.27), this variation did not reveal a statistically value (*F* (1,27) =2.46, *p*=.12, η^2p=.08). Summarizing, the results expose no difference in the sensibility to discriminate the Duchenne smile as a genuine expression of happiness, understanding that the mask was not relevant and had no impact on the accurate responses. This finding indicates no decrease in the capacity to classify this smile, meaning that even if the face was partially occluded, and more import the mouth was covered, still, the discrimination was not impaired. Therefore, it confirms that the Duchenne mark (AU6, *orbicularis oculi*) may have played as an essential clue for these outcomes.

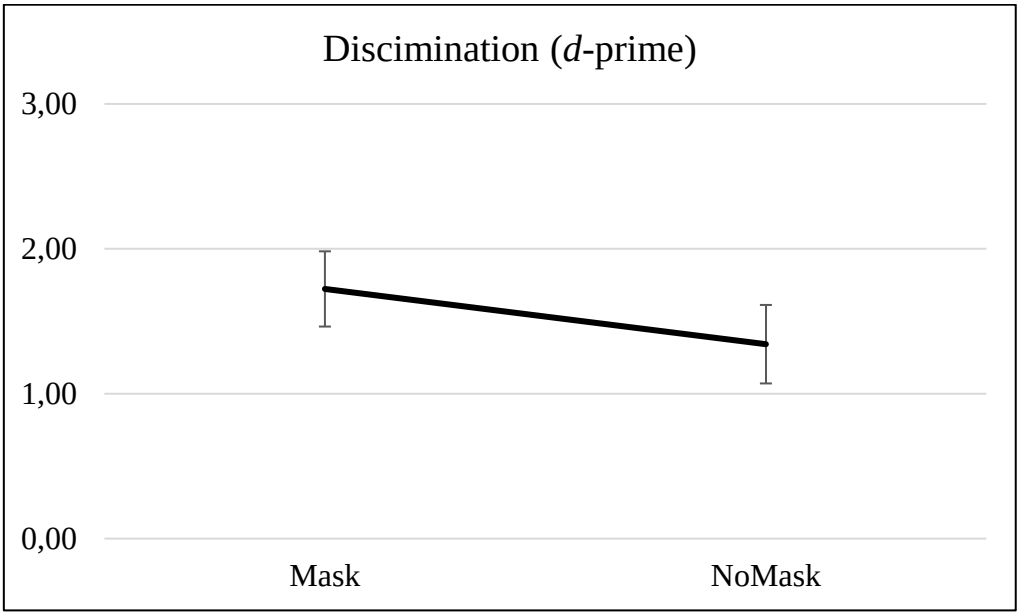

Figure 11. Study 1. Judgment 2: Discrimination (d-prime). The figure illustrates the discrimination (d´) proportion from masked and unmasked Duchenne. The differences between the means are not statistically significant.

Response Criteria (c).

For the response, the variations between the distributions are not statistically significant (*F* (1,27) =1.05, *p*=.31, η^2p=.03), which implies no substantial differences in the response criterium for masked Duchenne (*M*=-.48, *SD*=.07) and unmasked Duchenne (*M*=-.56, *SD*=.09) faces. The criteria responses were liberal, indicating more false alarms when the subjects needed to discriminate the genuineness of this smile for unmasked Duchenne.

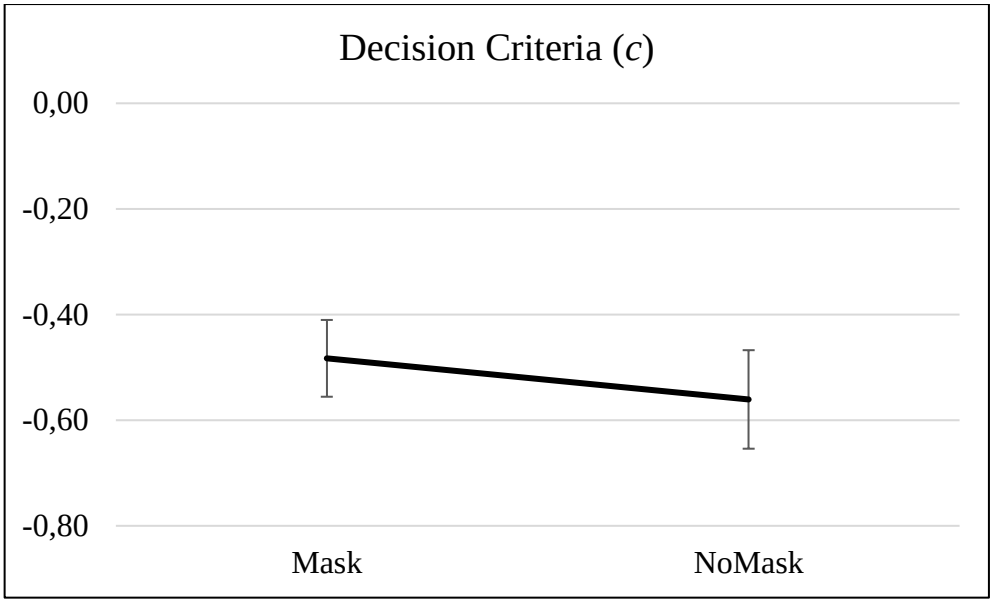

Figure 12. Study 1. Judgment 2: Decision Criteria (c). The figure illustrates the Decision Criteria (c´) proportion from masked and unmasked Duchenne faces. The differences between the means are not statistically significant.

Empathy and Complementary Measures.

The correlation between empathy, complementary measures (anxiety traits; fear and anxiety of COVID-19) and the emotion discrimination, was calculated by the Detection Theory Signal Indexes, respectively, discrimination (d-prime) and response criteria (c). Hence, it was considered this interaction with the smiles (Duchenne ; non-Duchenne) and the presence of the mask (Mask; No Mask). The data analysis was estimated by the Pearson´s correlation.

STD Indexes.

Sensitivity in discrimination (d-prime).

Respectively, the results do not imply a correlation between the empathy and sensibility in discriminating genuine happiness with mask (r=.21, *p*=.264) and without the mask (r=.24, *p*=.20). Also, no association was observed for anxiety traits (with masked faces: r=-.13, *p*=.48; with unmasked faces: r=-.11, *p*=.56) and the COVID-19 measures (fear and masked faces (r=.11, *p*=.57); fear and unmasked faces (r=.11, *p*=.56); anxiety and masked faces (r=.18, *p*=.34); anxiety and unmasked faces (r=-.01, *p*=.94), signifying no relation between those variables and genuine happiness discrimination.

Table 3.

Judgment 2. Pearson's Correlation: Discrimination.

		IRI Empathy	STAI Anxiety	COVID -19 Fear	Anxiety
Mask Duchenne &	N-Duchenne	.21	-.13	.18	.11
No Mask Duchenne &	N-Duchenne	.24	-.11	-.01	.11

Note. The values correspond to the discrimination between mask and control measures: IRI = *Interpersonal Reactivity Index* (Mark Davis, 1983; Portuguese Adaptation - Teresa Limpo, Rui A. Alves & São Luís Castro, 2010*)*; *STAI = State-Trait Anxiety Inventory* (Portuguese adaptation - Silva & Correia, 1998); *Control-measures Covid-19* (Loureiro, Garcia-Marques & Bártolo ,2020).

Therefore, these data implies that the control measures had no significant impact in the discrimination of the second judgment, and specially, the mask did not correlate at any level with these variables. The findings do not validate the hypothesis, which the pandemic environment could affect the response discrimination for genuineness, in meanings of empathy, anxiety, fear and stress. Particularly, invalidate that the genuine discrimination of an emotion could be associated with empathy, considering that we linked this variable with emotion recognition.

Response Criteria (c).

For the response criteria, the results do not imply a correlation with the empathy when discriminating genuine happiness with mask (r=.28, *p*=.13) and without the mask (r=.22, *p*=.25). Also, no association was observed for anxiety traits (with masked faces: r=-.80, *p*=.67; with unmasked faces: r=-.09, *p*=.62) and the COVID-19 measures (fear and masked faces (r=.05, *p*=.77); fear and unmasked faces (r=.01, *p*=.94); anxiety and masked faces (r=.16, *p*=.41); anxiety and unmasked faces (r=-.07, *p*=.64). Therefore, these data implies that

the control measures had no significant impact in the response criteria for the second judgment, and specially, the mask did not correlate at any level with these variables.

Table 4.

Judgment 2. Pearson's Correlation:Response Criteria.

		IRI Empathy	STAI Anxiety	COVID -19 Fear	Anxiety
Mask Duchenne &	N-Duchenne	.28	-.80	.05	.16
No Mask Duchenne &	N-Duchenne	.22	-.09	.01	-.07

Note. The values correspond to the response criteria between mask and control measures: IRI = *Interpersonal Reactivity Index* (Mark Davis, 1983; Portuguese Adaptation - Teresa Limpo, Rui A. Alves & São Luís Castro, 2010*)*; *STAI = State-Trait Anxiety Inventory* (Portuguese adaptation - Silva & Correia, 1998); *Control-measures Covid-19* (Loureiro, Garcia-Marques & Bártolo ,2020).

Duchenne Smile in Happiness Discrimination and Genuine Happiness Discrimination.

It was investigated the interaction for the Duchenne responses, and mask interaction, respectively for happiness discrimination (Judgment 1) and genuine discrimination (Judgment 2). The aim was to comprehend the perception of this smile in terms of the judgments.

STD Indexes.

To analyze the proportions for the Signal Detection Theory Indexes (d-prime and c), it was considered the interaction from the Duchenne smile and the presence of the mask (Mask ; No Mask) between the judgments.

Sensitivity in discrimination (d-prime).

A significative difference between the discrimination of Duchenne smile and the happiness discrimination judgment (*M*= 3. 21; *SD* = .13) and genuine happiness

discrimination (*M*= 1.72; *SD* =.26) was confirmed (*F* (1,27) =34.98, *p*=<.001 η^2p=.56). The presence of the mask between the happiness judgment (*M*= 3,16; *SD*= .12) and the genuine judgment (*M*= 1.34; *SD*= .27) was statistically significant (*F* (1,27) =3.88, *p*=.05 η^2p=.12). The interaction from the discrimination of the Duchenne smile and the presence of mask between the judgments, happiness discrimination (*M*=3.23; *SD*=.12) and genuineness discrimination (*M*=1.53; *SD*=.26), was not significative (*F* (1,27) =.80, *p*=.37 η^2p=.02).

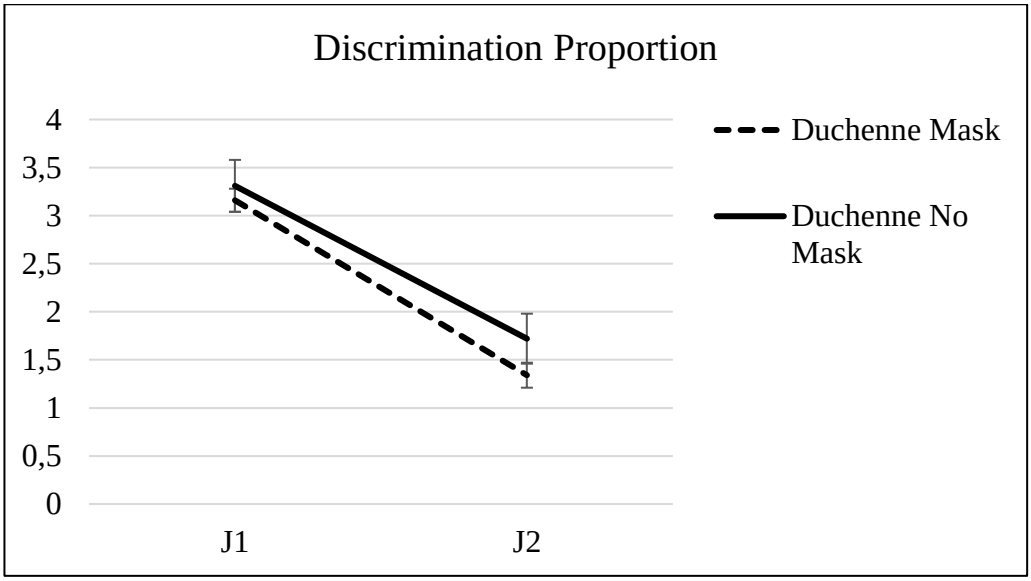

Figure 13. Study 1. Judgments´ Interaction for Duchenne Smile: Discrimination (d-prime). The figure illustrates the discrimination from masked and unmasked Duchenne faces between happiness discrimination judgment (J1) and genuineness happiness discrimination judgment (J2).

Response Criteria (c).

A significative contrast between the response criteria from the Duchenne smile and the happiness discrimination judgment (*M*= -.23. *SD*=.06) and genuine happiness discrimination *(M*=-.56; *SD*=.09) was confirmed (*F* (1,27) =8.39, *p*=.007 η^2p=.23). The variation for the response criteria between the presence of the mask and the judgments, happiness discrimination (*M*=-.23; *SD*=.06) and genuine discrimination (*M*=-.48; *SD*=.07) was not statistically significant (*F* (1,27) =.71, *p*=.40 η^2p=.02). Hence, no interaction was detected for the discrimination of Duchenne smile and the presence of mask between the happy (*M*= -.23, *SD*=.06) and genuine happy judgments (*M*= -.52, *SD*=,08). Hence, this result was not statistically significative (*F* (1,27) =.65, *p*=.42 η^2p=.02).

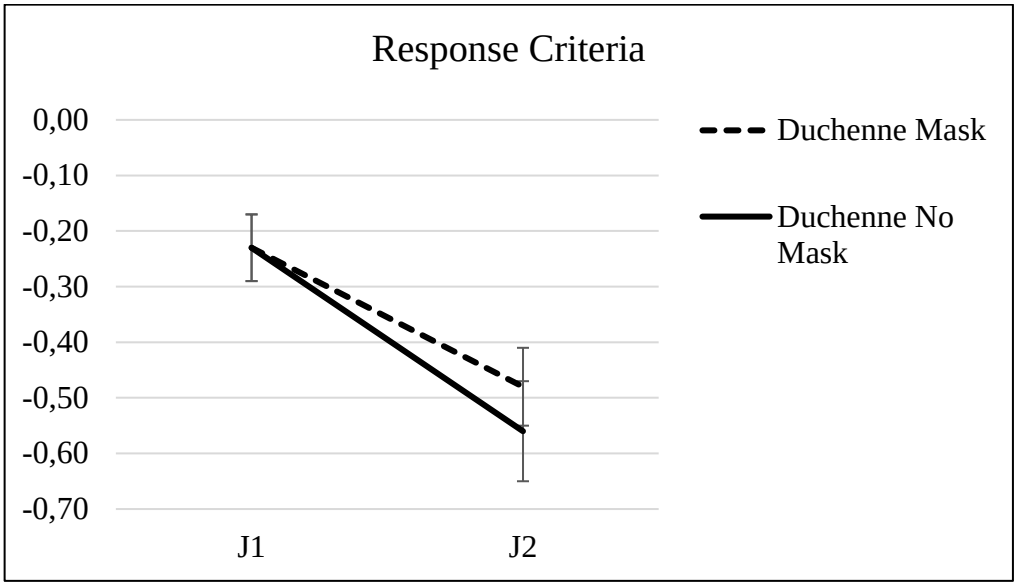

Figure 14. Study 1. Judgments´ Interaction for Duchenne Smile: Response Criteria (c). The figure illustrates the response criteria proportions from masked and unmasked Duchenne faces between happiness discrimination judgment (J1) and genuineness happiness discrimination judgment (J2).

Discussion

Judgment 1: Happiness Discrimination from Other Emotions.

Overall, as expected, when discriminating happiness from other emotions, the Duchenne smile presented higher levels of accuracy when comparing to the non-Duchenne smile; These findings confirm our first hypothesis. Moreover, was anticipated that the mask would diminish the discrimination, thereby the second hypothesis was validated by this interaction between the presence of the mask (Mask; No Mask). Corroborating with the main hypothesis, that the type of smile could be impact by the face mask, it was noticed a significant difference between discrimination the type of smile and the use of mask, diminishing, especially, the discrimination of the non-Duchenne smile.

This weakened discrimination for the masked non-Duchenne faces, indicates a high level of false alarms, suggesting that this smile was recognize as a non-happy emotion, and signifying the impact of the mask. As the mouth region is the main clue for recognizing happiness, and more specifically, the non-Duchenne smile, the disturbance is cleared caused by the mask. Covering the lower part of the face showed a decrease in recognizing the non-

Duchenne smile as a happy expression, and since the eye region is not considered to be activate in this non-genuine happy expression, and was no clue lest for discrimination, this expression was significatively affected. On contrary, the Duchenne smile maintained the high levels in discrimination, with and without the mask, suggesting the eye region, had a great impact in the responded accuracy for discriminating this smile as a happy emotion. The high levels of hits and very low levels of false alarms, demonstrating that even with the face covered, the Duchenne smile is easily judge as a happy expression.

A variation in the response criteria between the smiles, covered and uncovered by a face mask, was similarly linked. The main effect was for non-Duchenne with mask. The subjects had difficulty in identifying, when this stimulus was presented (non-Duchenne with mask), as a happy expression, explaining the high levels of omissions.

Once analyzing the control measures, the results revealed that the discrimination of the masked smiles (Duchenne and non-Duchenne) smile had a negative correlation with empathy. Therefore, these findings do corroborate with the hypothesis, which assumed that empathy would be correlated with the happiness discrimination. It can be presumed that the participants with high empathy level were trying harder to consider the face mask in the judgment process, and that obstacles lead them to the lower their response accuracy.

The outcomes also pointed a negative correlation between empathy and the response criteria for the Duchenne smile covered with the mask. For the anxiety traits (STAI) and the COVID-19 measures (fear and anxiety) there was no correlation found between the variables, eliminating the expectation that the presence of mask could have an impact in this relation. These findings rejected our hypothesis that the pandemic environment could impact on the response discrimination, for anxiety, and fear and stress of COVID-19.

Though this judgment corroborated with the discriminating hypotheses, it may perhaps indicate a limitation from the study. Hence, it was presumed that the discrimination, namely from Duchenne and non-Duchenne faces, high accurate levels could be elicited by the interspersed appearance order in the experience, which could facilitate the discrimination. Thus, a new study (Study 2) was design, where the Duchenne and non-Duchenne faces were separated in distinct blocks (Happy Duchenne and Happy non-Duchenne) to test if there was any significant contrast in discrimination that could arise from the order of appearance. Additionally, blocks with other emotions (anger, fear, and sadness) were added to this second study in order to investigate the emotion discrimination and mask impact, as previous studies

showed in the literature. In Study 2, was tested the indices of discrimination and response criterion, as was in Study 1.

Judgment 2: Genuine Happiness Discrimination.

The results from the genuine discrimination judgement, suggests no variation in discriminating the Duchenne smile with and without the mask, implying that the mask was not an obstacle for judging this smile as a genuine expression of happiness. In this judgment, the false alarms were calculated based on the non-Duchenne smile. By the levels of false alarms for non-Duchenne smile, there was not a suggestive difference when judging it´s genuineness, also indicating that the mask did not impact statistically in the response levels of mistakes for this smile. Hence, it was observed no difficulty to discriminate the smiles. Considering that the mouth area was covered by the mask, these outcomes confirmed that the Duchenne mark (AU6, *orbicularis oculi*) may have played as an import clue in this response accuracy.

In the response criteria, the interaction between Duchenne with and without the mask had no significant variation. It was detected a liberal response indicating more false alarms when the subjects discriminated the genuineness of this smile. It implies a more mistakes when discriminating genuineness with and without the mask. This impression can also be supported by the response time in the second judgment, that was responded faster than the first, which means that the participants took more time to discriminate happiness from other emotions, than discriminating the genuineness of the smiles.

The association with the measures of empathy, anxiety traits, COVID-19 fear, COVID-19 anxiety, revealed no significant impact in this discrimination, and specially, the mask did not correlate at any level with these variables. These findings rejected our hypothesis that the pandemic environment could impact on the response discrimination for genuineness, in meanings of empathy, anxiety, fear and stress.

Duchenne Smile in Happiness Discrimination and Genuine Happiness Discrimination.

A significative contrast was observed for the discrimination of Duchenne smile between the judgements. The smile revealed higher levels of discrimination when participants were required to evaluate the expression as happiness. Although, when the purpose was to evaluate the genuineness of the smile, a reduce capacity to discriminate the smile as authentic was presented. This result was equally observed on the response criteria proportions, whereas

the high levels of mistakes occur specially for the genuine discrimination. Additionally, it was observed an impact of the face mask in the discrimination, specially decreased for the second judgment.

Study 2

This study was design to investigate if the context of appearance of the smiles influenced on the level of discrimination. Hence, in this experiment the Duchenne and non-Duchenne faces were separated in distinct blocks (Happy Duchenne and Happy non-Duchenne) to test if there was any significant contrast in discrimination that could arise from the order of appearance. The purpose of this experiment was to discriminate the target emotions, objected in the beginning of each block, with the faces shown in the experiment and the impact of the face mask. The same hypotheses from Study 1 were examined, however, was also observed whether the use of face masks affect the discrimination from other emotions: anger, fear and sadness. Therefore, five blocks were added for discrimination: Happy Duchenne; Happy non-Duchenne; Anger; Fear; Sadness. To reconfirm the hypotheses from Study 1, it was analyzed the interaction between the smiles (Happy Duchenne Block x Happy non-Duchenne Block) and the presence of the mask (Mask x No Mask). Searching to respond to the hypothesis from Study 2, it was examined the interaction between the five blocks (respectively the target emotions) and the presence of the mask (Mask x No Mask).

Method

Th same material from Study 1 was used in this experiment. The procedure was change by a distinct judgment assignment as the participants were different from the first study. The participants should indicate if the faces expressed the emotion from the one indicated in the beginning of the block.

Participants

Thirty-two (twenty-five females and 7 males, age M = 19.2, SD = 1.19*)* from ISPA - *Instituto Universitário*, received complementary hour credits for their participation, which are require as part of their academic curriculum. The informed consent was agreed before the experiment and approved by the ethic committee, considering that another experiment with similar content was approved priory this one.

Design

The faces were exhibited with mask and without mask, and the stimulus were displayed in an aleatory order. The design was two factors within subjects. In total the participants did 290 trials (5 emotions x mask x 58 replicas). for the experiment, participants did five blocks to test the perception of emotions in people using protective masks. Each block had a main emotion to be discriminate. They were respectively: Block Happy non-Duchenne (20 happy non-Duchenne faces, 20 neutral faces, 18 faces of other emotions); Block Happy Duchenne (20 happy Duchenne faces, 20 neutral, 18 other emotions; Block Fear (20 fear faces, 20 neutral, 18 other emotions; Block Sad (20 sad faces, 20 neutral, 18 other emotions; Block Angry (20 angry faces, 20 neutral, 18 other emotions), totalizing 58 trials for every block.

Material

Same as Study 1.

Procedure

Participants arrived at the lab Willian James Center for Research in groups (between six and eight), totalizing four sessions to collect the data. After signing the informed consent form, were asked to sit in front of a computer screen on an individual boot and all guidelines would be presented on the computer screen. The experiment was conducted during the COVID-19 pandemic when legal obligations, to wear masks and social distancing, were imperative in Portugal. In the first part, the participants answer to the judgment and then after responded to the questionnaires.

Before the experiment, there was a training phase to make trails of the evaluation and to be familiarize with the assignment. After that, for the experiment itself, participants did five blocks to test the perception of emotions in people using protective masks. Each block had a main emotion to be discriminate – happy Duchenne, happy non-Duchenne, sad, angry and fear - totalizing 58 trials for every block.

Discrimination Judgment.

The aim of the second study was to test if the effect is not dependent of a clear contrast of order (that could have happened in Study 1). So, the focus of Study 2 is to mislead the contrast effect. For that, five different blocks were to be judge: happy had two blocks, one with Duchenne faces and another with non-Duchenne faces, as the other emotions – anger, sadness and fear - also had their respective blocks. In this experiment there is no second

judgment. Another reason for this study was the elevated discrimination rate in Study 1, so the faces now appear in shorter time than in the first experiment (500ms).

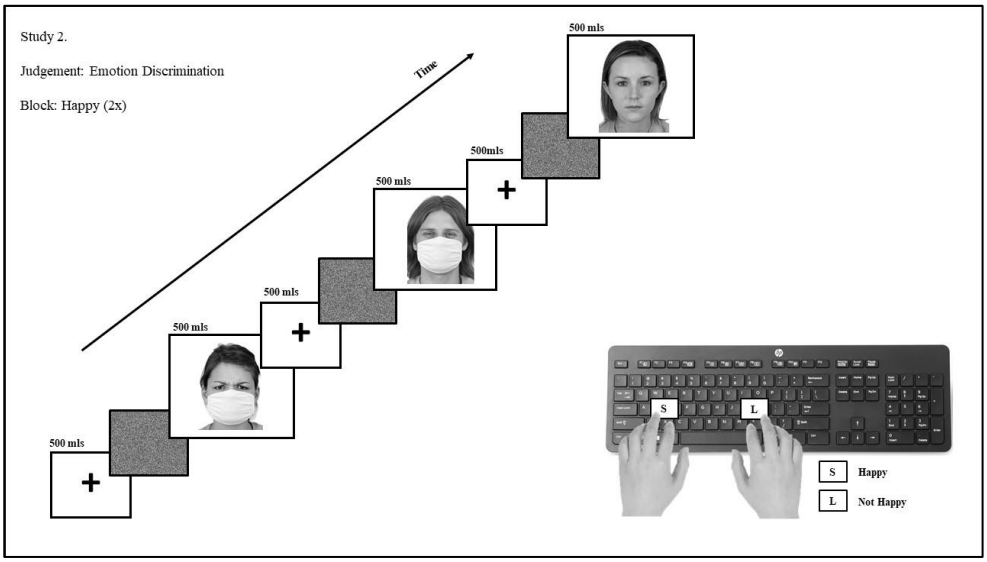

Figure 15. Experimental Design of Study 2.

Emotion Discrimination

Images of people with different face expressions ware presented in different blocks. Half of the images were with the face uncovered or with face covered by a protective mask. Five blocks (happy (x2), angry, sad and fear) were presented and in each block the participants had to identify a specific emotion. In the beginning of every block was indicated which emotion the participant had to identify. Hence, the assignment was to say if the face presented expressed or not the emotion indicated in the beginning of the block.

In each evaluation a small sign (+) appeared briefly in the center of the screen (500 ms). Next comes an image of a person presenting different expressions, with mask or without mask, which will remain on the screen for brief moments (500 ms). Following that, a screen with a noise image appears and the participant needed to answer if the expression corresponded or not with the emotion indicated in the beginning of the block. In each block the participants made a set of evaluations, then to the next block.

Questionnaires.

After finalizing the emotion discrimination task, 3 questionnaires followed to be answered*:* *Interpersonal Reactivity Index* (Mark Davis, 1983; Portuguese Adaptation - Teresa

Limpo, Rui A. Alves & São Luís Castro, 2010*), STAI – State-Trait Anxiety Inventory* (Portuguese adaptation - Silva & Correia, 1998) and *Control-measures Covid-19* (Loureiro, Garcia-Marques & Bártolo ,2020). The whole experimental session took approximately 25 minutes.

Dependent Measures

Same as Study 1.

Results

First, the results were analyzed within the smiles and the presence of the mask (Mask; No Mask) for the happy blocks (Duchenne; non-Duchenne). Secondly, it was investigated this interaction with all the blocks (Duchenne; non-Duchenne; fear; anger; sadness) and the presence of the mask.

Hits and False Alarms.

As was expected, the Duchenne smile (M=.91, SD=.02) revealed the highest proportion of hits when comparing to the non-Duchenne smile (M=.75, SD=.02) This finding is statistically significant and validate the first hypothesis from Study 1 (F (1,31) =56.2, p<.0001, η^2p=.64).

Corroborating with the second hypothesis, the unmask smiles (M=.92, SD=.01) revealed a superior effect on the hit proportion, in comparison to the masked smiles (M=.73, SD=.03) when discriminating happiness (F (1,31) =59.7, p<.0001, η^2p=.65).

The main hypothesis from Study 1 suggested that the mask would impact the discrimination for the two types of smiles, assuming to be reduced for the non-Duchenne Further, in Study 2 it was observed a substantial contrast between the hit proportion between masked and unmasked faces for both happy blocks (Duchenne and non-Duchenne), and these differences are statistically significant (F (1,31) =41.9, p<.0001, η^2p=.57), which corroborate with the finding from the previous study.

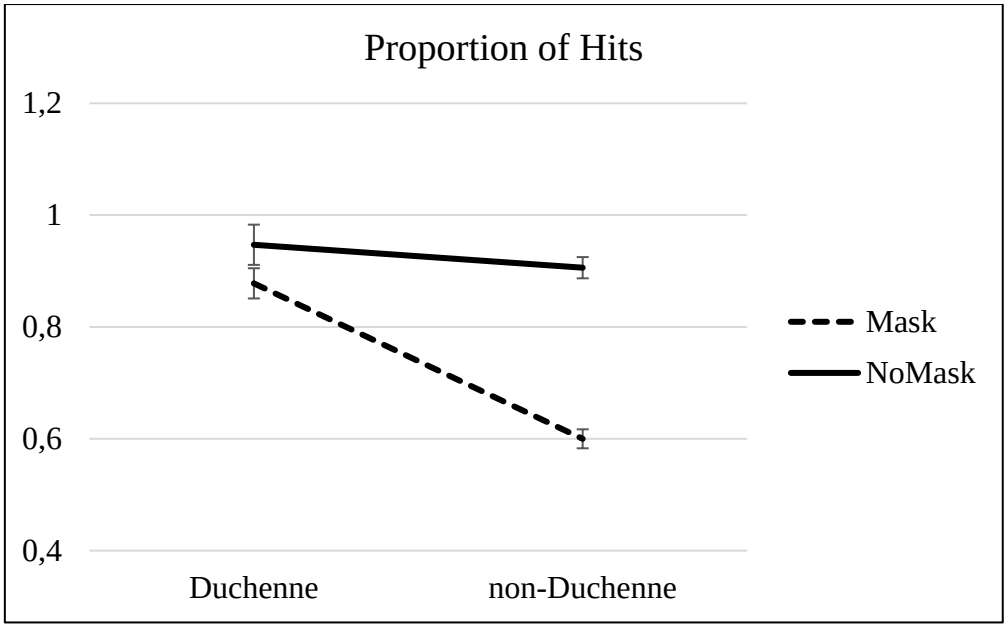

Figure 16. Study 2. Hit Proportion: Happy Blocks (Duchenne; non-Duchenne) and Neutral. The graphic illustrates the hit proportion of each block, from masked and unmasked faces: Duchenne, non-Duchenne. The differences between the means are statistically significant.

The five blocks (Happy Duchenne, Happy non-Duchenne, Fear, Anger and Sadness) presented a superior hit proportion when discriminating unmasked (*M*=.90, *SD*=.02) from masked faces (*M*=.80, *SD*=.03) The elevated percentage of correct responses without the mask can indicate a highly potential to recognize emotions, which is waken by the presence of face mask, leading to a decrease in discrimination accuracy when the face is partially occult. This difference was found to be statistically significant (F (1,31) =22.2, p<.0001, η^2p=.41). This finding corroborates with the main hypothesis of Study 2, which the mask impacts the discrimination of other emotions.

The main contrasts were found for the non-Duchenne smile covered with the mask, which revealed the lowest proportion of hits (*M*=.75, *SD*=.02). Oppositely, the emotion with the higher amount of hits was the Duchenne without the mask (*M*=.91, *SD*=.02). Within the means inside the blocks, sadness also had a considerable variation between masked (*M*=.80, *SD*=.03) and unmask faces (*M*=.88, *SD*=.02), signaling a lack of precision when discriminating sad faces covered with mask. Similarly, it was detected that the non-Duchenne block had the most substantial difference between the means (Mask: *M*=.60, *SD*=.03; No

Mask: *M*=.90, *SD*=.01), and this result goes along with the findings in Study 1, as the hypothesis, that the discrimination of non-Duchenne smile whit the mask is highly impaired.

There was no expressive relation in discriminating fear (Mask: *M*=.88, *SD*=.03; No Mask: *M*=.90, *SD*=.02) and anger (Mask: *M*=.85, *SD*=.02; No Mask: *M*=.87, *SD*=.02) and the presence of the mask.

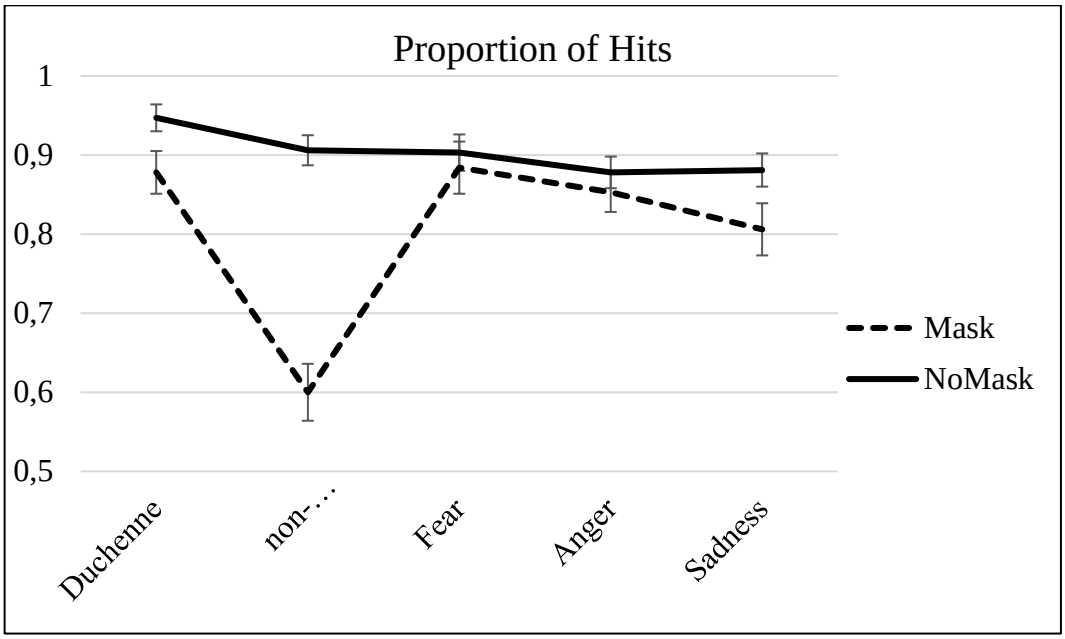

Figure 17. Study 2. Hit Proportion: Blocks with Neutral. The graphic illustrates the hit proportion of each block, from masked and unmasked faces: Duchenne, non-Duchenne, anger, fear, sad. The differences between the means are statistically significant.

For the false alarms, the Duchenne smile (*M*=.06, *SD*=.02) revealed the lowest proportion when comparing to the non-Duchenne smile (*M*=.09, *SD*=.02), although this finding is not statistically significant (*F* (1,31) =1.63, *p*=.21, η^2p=.05). Although there was no distinction between the smiles, a interaction was detected for the presence of the mask (Mask: *M*=.10, *SD*=.05; No Mask: *M*=.05, *SD*=.01) and is statistically significant (*F* (1,31) =12.8, *p*<.0001, η^2p=.29). Thereby, the interaction between the two smiles (Duchenne x non-Duchenne) and the presence of the mask (Mask ; No Mask), revealed no significant interaction in the false alarm proportion (*F* (1,31) =.13, *p*=.71, η^2p=.00).

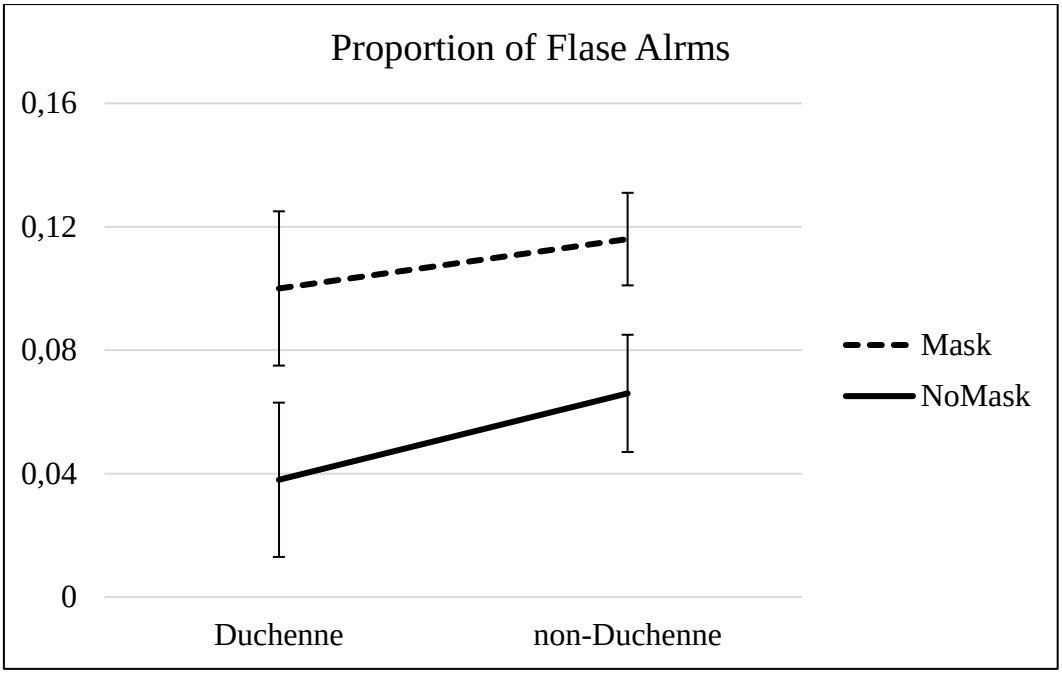

Figure 18. Study 2. False Alarm Proportion: : Happy Blocks. The graphic illustrates the false alarm proportions from masked and unmasked faces for the blocks: Happy (Duchenne), Happy (non-Duchenne). The differences within the means are not statistically significant.

The contrast between the target emotions was significative (F (4,124) =8.45, p=<.001, η^2p=.21). The false alarms proportion was superior for the masked faces (Mask: M=.10, SD=.02; No Mask: M=.07, SD=.01), and this finding is statistically significant (F (1,31) =6.61, p=.01, η^2p=.17). Between the blocks, all the emotions had higher level of false alarms for masked faces, except anger (Mask: M=.06, SD=.02; No Mask: M=.06, SD=.02), which revealed no significative bias towards masked and unmasked faces. From the blocks, fear was the emotion with the lowest percentage of false alarms (M=.04, SD=.01). The number of mistakes was distinctively elevated for masked and unmasked sadness (M=.16, SD= .03) and this may possibly indicate a difficulty in recognizing and identifying this specific emotion. statistically when comparing all the target emotions and the presence of the mask, there was not a statistically difference amongst them (F (4,124) =1.16, p=.33, η^2p=.03).

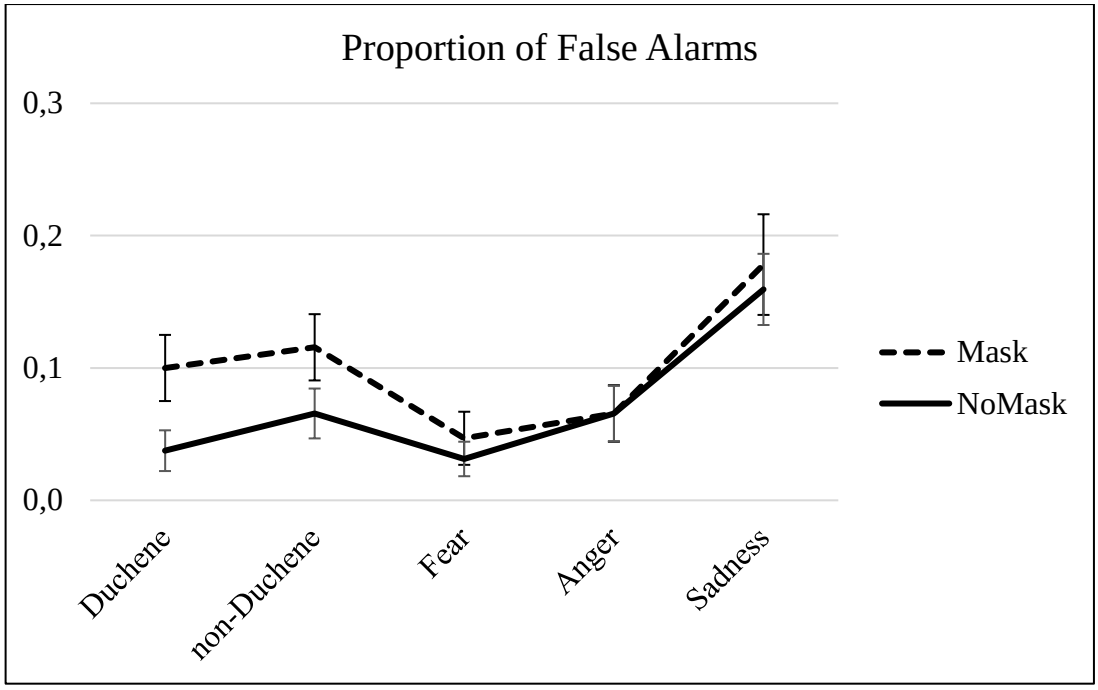

Figure 19. Study 2. False Alarm Proportion: Blocks with Neutral. The graphic illustrates the false alarm proportion from masked and unmasked faces for the blocks: Happy (Duchenne), Happy (non-Duchenne), Anger, Fear, Sadness. The variations between the means are not statistically significant.

STD Indexes.

To analyze the discrimination, it was considered the interaction from the smiles (Duchenne ; non-Duchenne smile) and the presence of the mask (Mask; No Mask).

Sensitivity in discrimination (d-prime).

The Duchenne smile (M=3.08, SD=.13) revealed the highest levels of discrimination when comparing to the non-Duchenne smile (M=.2.32, SD=.14) This finding is statistically significant and validate the first hypothesis from Study 1 (F (1,31) =62.4, p<.0001, η^2p=.66

Corroborating with the second hypothesis, the unmask smiles (M=3.21, SD=.12) revealed a superior discrimination, in comparison to the masked smiles (M=2.18, SD=.15) when discriminating happiness (F (1,31) =61.1, p<.0001, η^2p=.66).

The main hypothesis from Study 1 suggested that the mask would impact the discrimination for the two types of smiles, assuming to be reduced for the non-Duchenne Further, in Study 2 it was observed a substantial contrast between the discrimination between

masked and unmasked faces for both happy blocks (Duchenne and non-Duchenne), and these differences are statistically significant (F (1,31) =10.8, p=0.03, η^2p=.25), which corroborate with the finding from the previous study.

The masked non-Duchenne detained the lowest sensitivity distribution (M=1.63, SD=.14), and this reduced sensitivity reveals a high level of false alarms (providing the wrong answer - e.g., saying it was not a happy emotion when actually was a happy emotion). This uncertainty can be explained by the lack of clue in the region area for the non-Duchenne smile, which holds the main clue on the mouth area). Additionally, was observed that the unmasked non-Duchenne (M=3.01, SD=.13) showed a far higher level of correct discrimination, by this provoking the largest proportion difference inside the blocks.

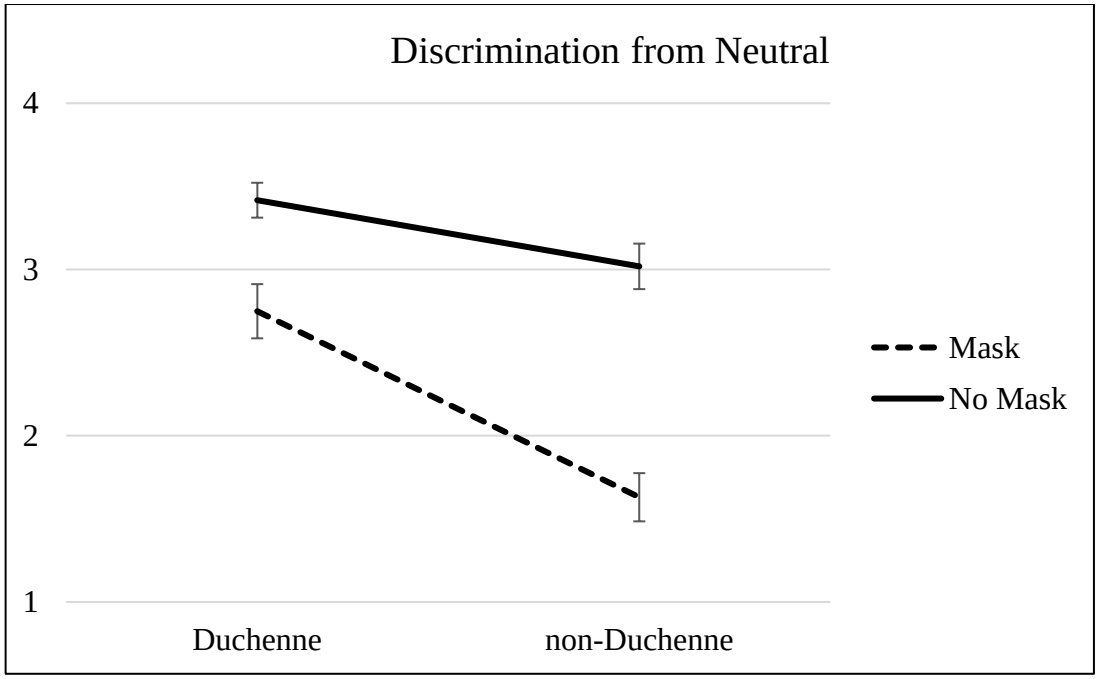

Figure 20. Study 2. Discrimination (d´) : Happy Blocks (Duchenne and non-Duchenne) with Neutral. The graphic illustrates the Discrimination (d´) from masked and unmasked Duchenne and non-Duchenne with Neutral. The differences between the means are statistically significant

Considering the discrimination among target emotions and neutral faces inside the blocks, the masked faces (M=2.49, SD=.16) retain the lowest level of sensitivity when interacted with the proportions from the unmasked faces (M=3.01, SD=.13). Therefore, the variation between them is statistically significant (F (4,124) =12.8, p<.0001, η^2p=.29), and validate the main hypothesis of Study 2, that the mask could cause a disturbance on the

judgments - meaning that, when the face is partially occluded, a decrease in the emotion accurate discrimination is expected.

Between the unmasked faces inside the blocks, was observed for sadness (*M*=2.32, *SD*=.17) and non-Duchenne (*M*=2.32, *SD*=.14) the lowest discrimination levels. These results indicate a high level of mistakes (false alarms). Contrarily, fear faces exhibited the highest discrimination level between mask and unmasked faces (*M*= 3.16, *SD* = .14). The unmasked Duchenne smile was the easier discriminated (*M*=3.41, *SD*=.10), meaning that among all the emotions, it presented the record number of hits, revealing to be easily categorized as a happy emotion.

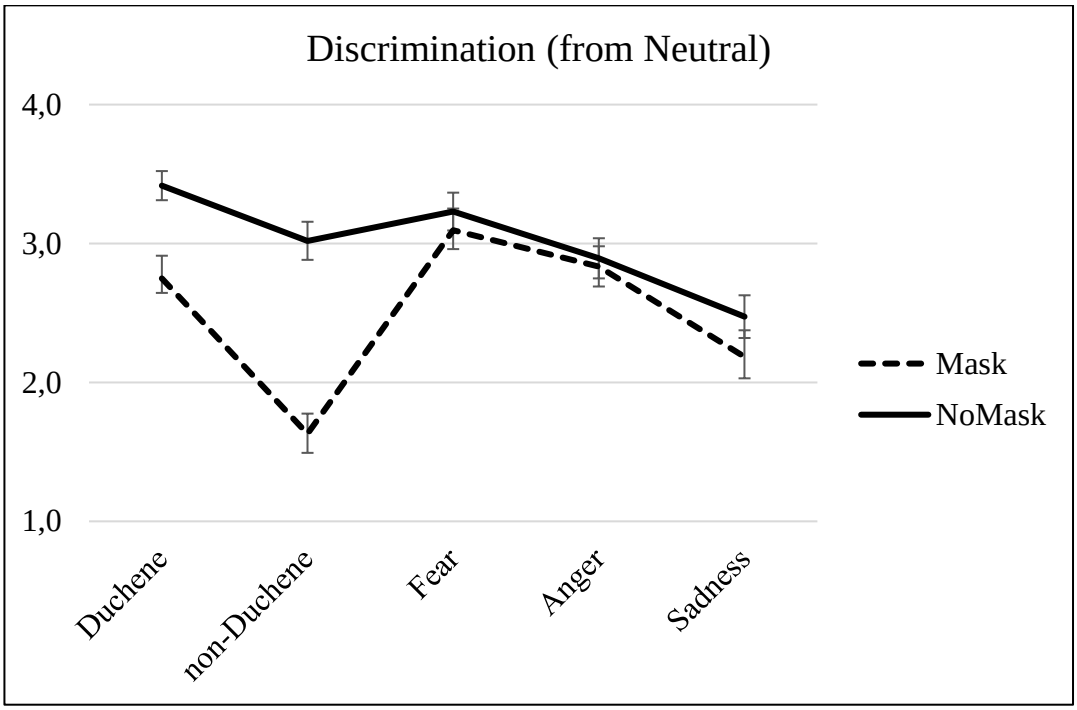

Figure 21. Study 2. Discrimination (d´): Blocks with Neutral. The graphic illustrates the Discrimination (d´) proportion from mask and unmask faces: Happy Duchenne, Happy non-Duchenne, fear, anger, and sadness compared to Neutral faces. The distributions are statistically significant.

Response Criteria (c).

It was observed a significative difference cause by the presence of the mask for the response criteria (Mask: *M*=.20, *SD*=.08; No Mask: *M*=.07, *SD*=.06) (*F* (1,31) =17.5, *p*<.0001, η^2p=.36). This difference was also notice as between the smiles (Duchenne: *M*=.04,

SD=.06; non-Duchenne: *M*=.30, *SD*=.06) (*F* (1,31) =19.0, *p*<.0001, η^2p=.38). Hence, there is a statistically significant interaction between the smiles and the presence of the mask for the response criteria (*F* (1,31) =16.0, *p*<.0001, η^2p=.34). The main contrast is the masked non-Duchenne (*M*=.53, *SD*=.07), which presented the most conservative criterium.

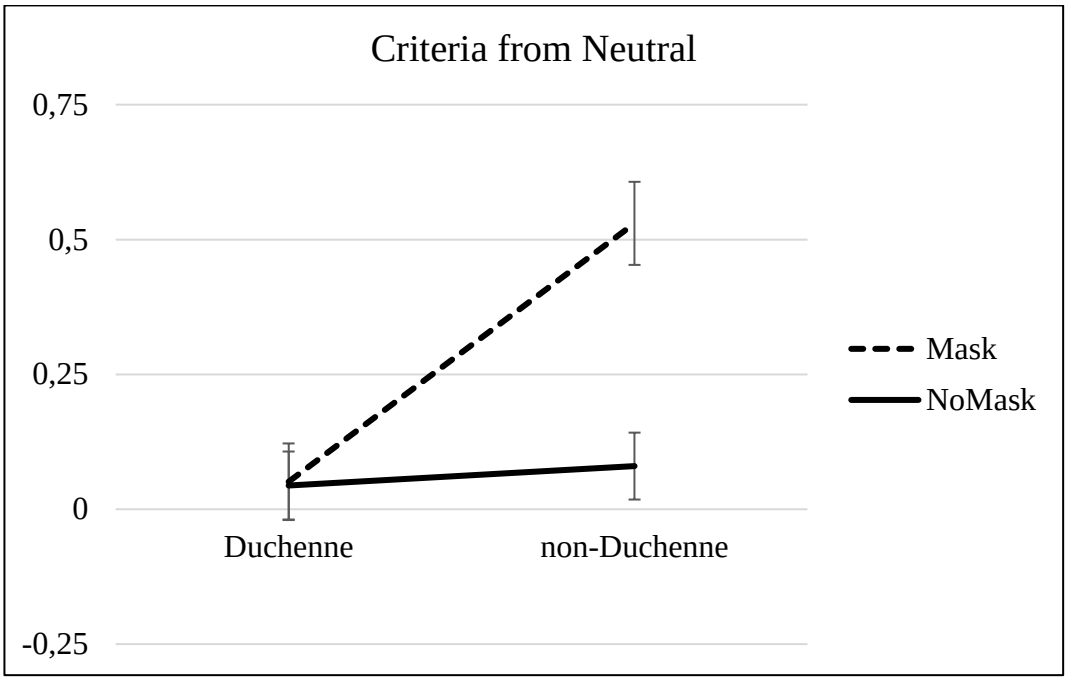

Figure 22. Study 2. Decision Criteria: Happy Blocks (Duchenne and non-Duchenne) with Neutral (c). The graphic illustrates the Decision Criteria (c) proportion from masked and unmasked Duchenne and non-Duchenne with Neutral. The differences between the means are statistically significant.

It was observed a significant variation cause by the presence of the mask for the response criteria (Mask: *M*=.20, *SD*=.08; No Mask: *M*=.07, *SD*=.06) supported statistically (*F* (4,124) =8.87, *p*=.006, η^2p=.22). This difference was also notice for the blocks (*F* (4,24) =5.97, *p*<.0001, η^2p=.16). Hence, there is a statistically significant interaction between the target emotions and the presence of the mask for the response criteria (*F* (4,124) =6.59, *p*<.0001, η^2p=.17).

The key variation was between the non-Duchenne block, with mask (*M*=.53, *SD*=.07) and without mask (*M*=.08, *SD*=.06), whereas the masked non-Duchenne considerable denoted a more conservative criterium in comparison to all the other emotions. This evidenced a lower proportion of false alarms and more omissions, implying that the subjects could not identify

the stimulus as a happy expression (the stimulus was present but there was no detection). Those inferences confirm the findings from Study 1.

Furthermore, a dissonant response pattern was observed for sadness, revealing additional mistakes while distinguishing sadness without the mask from neutral faces - hence taking a liberal criterium for unmasked faces (*M*=-.08, *SD*=.07) and a conservative mean for masked faces (*M*=.06, *SD*=.09). The Duchenne block, fear and happy, respectively, did not show a significative difference in the response criteria between masked and unmasked faces.

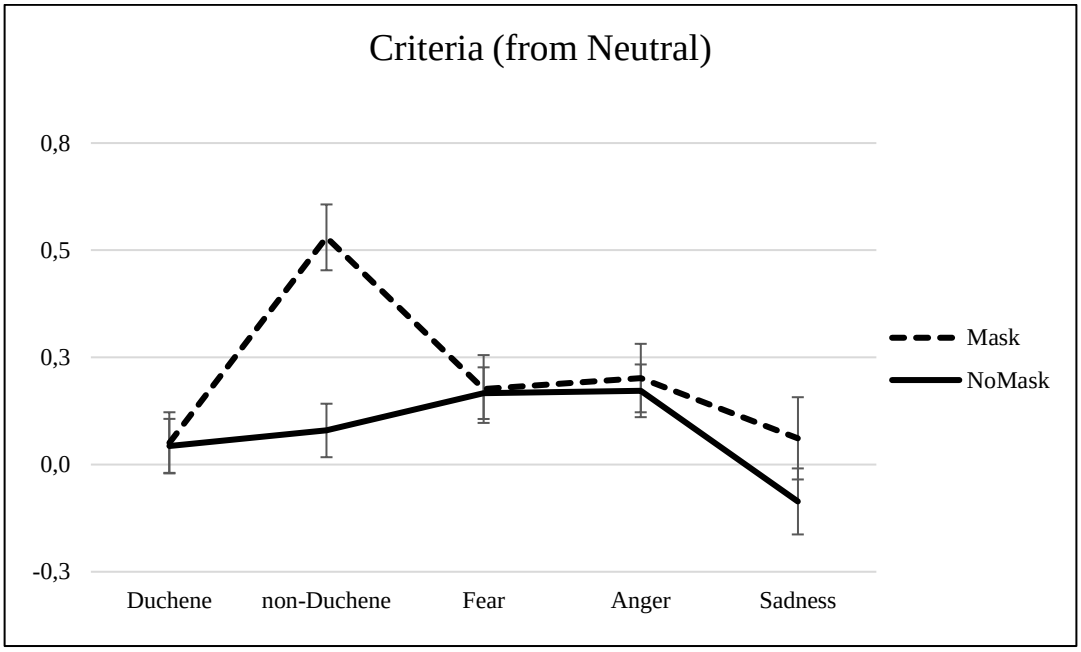

Figure 23. Study 2. Decision Criteria: Blocks with Neutral (c). The graphic illustrates the Decision Criteria (c) proportion from mask and unmask faces: Happy Duchenne, Happy non-Duchenne, fear, anger, and sadness compared to Neutral faces. The differences between the means are statistically significant.

Empathy and Complementary Measures.

The correlation between empathy, complementary measures (anxiety traits; fear and anxiety of COVID-19) and the emotion discrimination, was calculated by the Detection Theory Signal Indexes, respectively, discrimination (d-prime) and response criteria (c). Hence, it was considered this interaction with the emotions (Duchenne ; non-Duchenne;

anger; fear; sadness) and the presence of the mask (Mask; No Mask). The data analysis was estimated by the Pearson´s correlation.

Sensitivity in discrimination (d-prime).

Table 5.

Pearson's Correlation: Discrimination.

		IRI	STAI	COVID -19	
		Empathy	Anxiety	Fear	Anxiety
Mask					
	Duchenne	.28	.11	.47**	.24
	N-Duchenne	.10	.06	.28	.37*
	Fear	.53**	-.07	.09	.11
	Anger	.35*	-.02	.08	-.02
	Sadness	-.04	.01	-.15	-.27
No Mask					
	Duchenne	-.00	-.24	.09	-.16
	N-Duchenne	.23	-.02	.32	.17
	Fear	.44*	-.04	.10	-.04
	Anger	.32	-.07	.09	-.08
	Sadness	.32	.26	.05	.05

Note. The values correspond to the discrimination between mask, smiles and control measures: IRI = *Interpersonal Reactivity Index* (Mark Davis, 1983; Portuguese Adaptation - Teresa Limpo, Rui A. Alves & São Luís Castro, 2010*)*; *STAI = State-Trait Anxiety Inventory* (Portuguese adaptation - Silva & Correia, 1998); *Control-measures Covid-19* (Loureiro, Garcia-Marques & Bártolo ,2020).

*$p < .05$ ** $p < .01$ ***$p < .001$

According to the results from Study 2, there was two positive correlations between empathy and the discrimination of masked emotions. A positive and statistically significance association was observed between the empathy and discrimination of masked fear faces (*r*=-

.53; *p*=.00) and angry masked faces (*r*=.35; *p*=.04). Also, there was a statistically significance association between empathy and discrimination for unmasked fear (*r*=.44, *p*=.01) These outcomes suggest that the judgment for the masked fear and anger, is positively correlated with empathy, specially fear that revealed the same association for the unmasked faces.

For the COVID-19 measures, the discrimination of masked Duchenne was positively associated with fear of COVID-19 (*r*=.47; *p*=.00), and the non-Duchenne faces were positively associated with anxiety of COVID-19 (*r*=.37; *p*=.03).

There was no expressive association for the anxiety traits (STAI).

Response Criteria (c).

Table 6.

Pearson's Correlation:Response Criteria.

		IRI	STAI	COVID -19	
		Empathy	Anxiety	Fear	Anxiety
Mask					
	Duchenne	-.09	.32	.15	-.03
	N-Duchenne	.16	.06	.08	.30
	Fear	-.33	-.16	.22	-.10
	Anger	-.34	.06	-.10	-.18
	Sadness	-.35*	-.20	-.27	-.32
No Mask					
	Duchenne	.11	.22	.15	.40
	N-Duchenne	.01	-.07	.19	.28
	Fear	-.18	-.10	.04	.89
	Anger	-.14	-.09	.20	.05
	Sadness	-.05	.05	.01	.96

Note. The values correspond to the response criteria between mask, smiles and control measures: IRI = *Interpersonal Reactivity Index* (Mark Davis, 1983; Portuguese Adaptation - Teresa Limpo, Rui A. Alves & São Luís Castro, 2010*)*; *STAI = State-Trait Anxiety Inventory* (Portuguese adaptation - Silva & Correia, 1998); *Control-measures Covid-19* (Loureiro, Garcia-Marques & Bártolo ,2020).

It was observed one negative correlation between empathy and the response criteria. This association was notice for masked sadness (r=-.35; p=.04). The results imply no relationship between empathy and the response criteria for the other emotions and the presence of the mask.

There was no expressive association for the anxiety traits (STAI) and the COVID-19 measures (fear and anxiety) with the response criteria indicating no correlation between these variables, whereas the faces were shown with or without the mask.

Discussion

It was presumed that the discrimination, namely from Duchenne and non-Duchenne faces, high accurate levels could be caused by the interspersed appearance order in the experience - which could facilitate the discrimination. Thus, Study 2 was designed, where the Duchenne and non-Duchenne faces were separated in distinct blocks (Happy Duchenne and Happy non-Duchenne) to test if there was any significant contrast in discrimination that could arise from the order of appearance. Hence, the hypotheses from the first judgment from Study 1 were tested in this second experience. Also, it was hypothesized that the mask would reduce the discrimination from the other emotions that were added in separate blocks for this last study (anger, fear and sadness).

Analyzing The Hypotheses from Study 1, Judgment 1.

The first hypothesis, which implies that Duchenne smile exhibit the highest discrimination level, when compared to the non-Duchenne smile, was confirmed. Thus validates the Study 1 hypothesis and the finding in literature. A substantial contrast from the discrimination between the happy blocks (Duchenne and non-Duchenne) was observed.

Second, the interaction of the mask in the discrimination of the smiles has been tested. The findings from the second study corroborates with the previous one.

About the main hypothesis from Study 1, which implied that the mask would interfere in the discrimination between the two types of smiles. This point was equally confirmed in this second experiment. As in the previous study, some expressive results for the masked non-Duchenne smile were observed, revealing the weakest discrimination. Oppositely, comparing the smiles, the emotion with the higher discrimination was the unmasked Duchenne, followed by the unmasked non-Duchenne. Here we see the main difference between the studies: in

Study 2, the means between the Duchenne smile was higher between the masked and unmasked faces, meaning that the mask slightly reduces the discrimination of the masked Duchenne in this context.

Another interesting point was observed from these results: the masked non-Duchenne detained the lowest sensitivity distribution, revealing a high level of false alarms (providing the wrong answer - e.g., saying it was not a happy emotion when it actually was a happy emotion). This uncertainty can be explained by the lack of clue in the region area for the non-Duchenne smile, which holds the main clue on the mouth area). This interaction between the masked and unmasked type of smiles is statistically significant and corroborate with our previous hypothesis and the findings from Study 1.

Concluding, the main contrast in this second study was the highest discrimination for the Duchenne smile, meaning that among all the emotions, it presented higher levels of discrimination, and was easily categorized as a happy emotion. Additionally, for the response criteria, a major variation between the non-Duchenne block was detected, whereas the masked non-Duchenne considerable denoted a more conservative criterion. This evidenced a higher proportion of false alarms and more omissions, implying that the subjects mistake the stimulus as a non-happy expression. Different from Study 1, the unmasked non-Duchenne showed a conservative response, compared to the liberal response on the previous experiment. This could imply that the context of appearance slightly influenced on the detection and judgment of this expression, implying more mistakes in the first study, and more omission in the second.

Mask Interaction with Other Emotions

Here we observed whether the use of face masks affects the discrimination from other emotions: anger, fear, and sadness.

We found an expressive indication that the mask reduces the levels of discrimination for all the target emotions (Happy Duchenne, Happy non-Duchenne, Fear, Anger and Sadness). The elevated percentage of correct responses without the mask can indicate a highly potential to recognize emotions, which is waken by the presence of the face mask, leading to a decrease in discrimination accuracy when the face is partially occult.
Thereby, it confirms the main hypothesis of Study 2, that the mask would impair emotion discrimination.

Although when evaluating the means inside the blocks, fear and anger, even showing a weaken discrimination for the masked faces, had no expressive variation when discriminating these emotions, indicating that the mask was not a significate obstacle for the judgments. Adding to this, from the blocks, fear was the emotion with the lowest percentage of false alarms.

The number of mistakes were distinctively elevated for masked and unmasked sadness, and this may possibly indicate a difficulty in recognizing and identifying this specific emotion. Furthermore, the main dissonant response pattern observed for sadness, revealed a high level of false alarms while distinguishing unmasked sadness from neutral faces, indicating a tendency to mistake this emotion with a neutral expression.

Analyzing the blocks, a conservative criterion for the masked faces was observed. The key variations were masked non-Duchenne considerable denoted a more conservative criterion in comparison to all the other emotions. For the response criteria, the main contrast, as said formally, was observed for sadness, revealing between the target emotions, the highest levels of mistakes, and consequently a liberal response.

General Discussion

In the effort to contain the spread of COVID-19, protective masks were eventually introduced in the daily social interactions. Since the faces are partially covered, we hypothesized that the masks could affect the perspective on facial and emotion recognition, and consequently social interaction. Thereby, this project verified how the discrimination of emotions would be affected by protective masks. More specifically, we focus to evaluate this impact on the discrimination of the Duchenne Smile – considering this as a happy genuine expression of emotion- and the non-Duchenne smile. The other emotions included in the experiments were anger, fear, sadness, and neutral. Study 1 investigated how much the mask influenced the discrimination of happiness from other emotions and whether the happy emotion was a genuine expression. It was hypothesized that the faces covered with the protective mask would have a less accurate discrimination than the faces without the mask. Likewise, we assumed that the non-Duchenne smile with the mask would have the lower accuracy. Considering that there would be no main clue in the face to support a proper discrimination of a happy emotion. Following the happiness discrimination, we tested if the participants could classify them as a genuine expression or not. In Study 1, happy faces of Duchenne and non-Duchenne were diversified with each other, so it was thought that there

may have been a greater ease to discriminate the genuine smile, since there is a distinct contrast with the non-genuine smile. Thereby, the aim of Study 2 was to make sure that discrimination would not be affected by the order. So, in this second experiment, genuine happiness (Duchenne) and non-genuine happiness (non-Duchenne) were shown in different blocks. Additionally, blocks to discriminate other emotions were added. By that, we could also evaluate the impact of the mask in other emotions. Control measures.

Presence of Face Masks and Discrimination of Other Emotions (Anger, Fear and Sadness).

Primarily, the finding for Study 1 and 2 confirmed the premises that a decrease in emotional perception would be expected for masked faces, and these outcomes are pertinent with previous investigations (Carbon, 2020; Grundmann, Epstude, and Scheibe, 2021). This highlights an impairment in facial perceptive performance when faces are displayed covered with masks. And it highlights the importance of the holistic operation in processing faces (Freud et al., 2020; Tanaka & Farah, 1993; Garcia-Marques et al., 2015). Thereby, when occluding face features, a weaken on the accurate emotion discrimination is expected (Tanaka & Farah, 1993; Carbon, 2020; Grundmann, Epstude, and Scheibe, 2021; Fischer et al., 2012).

Analyzing the emotions, sad faces revealed an expressive contrast. This expression showed low levels of discrimination, independent of the presence of the mask, and by that being easily misinterpreted as neutral - as was also noticed by Carbon (2020). By that, this expression had the lowest sensitivity for unmasked faces, meaning that, when compared to the other emotions, had the highest level of mistakes, indicating an extreme difficulty in discriminating sadness. Additionally, sadness revealed the higher variance between masked and unmasked faces inside the blocks - specially reduced masked faces. Therefore, these results highlight an expressive impairment for sadness discrimination. These findings, corroborate with Carbon (2020) that sadness, when comparing to neutral faces, showed significant differences between the discrimination, with and without mask.

Consequently, as the emotional discrimination was reduced for masked faces, fear and angry faces showed interesting results. Although the discrimination was weakened by the mask, it did not provoke a significant disturb between the means, as was also recently found by Carbon (2020). Angry faces also expressed a high level of discrimination, with and without the mask.

This could be explained and supported by the idea that the eye region, as it was not occluded by the mask, provides most of the emotional information indicative for this emotional state, according to Wegrzyn, et al. (2017).

Last, between all the emotions, the unmasked Duchenne smile, exhibited the highest sensitivity level, meaning that this expression was easily discriminated as happiness. The happy discrimination in Carbon (2020) also revealed these highest scores from other emotions. Although, the main difference between both studies is that in the Carbon 2020 experience there is no differentiation between these levels among the type of smiles. This could perhaps be an indication of the face selection from different face bases, which include ways of capturing the emotions (e.g., spontaneous or FACS) and the intensity of the smile.

Duchenne and non-Duchenne Smile in Happiness Discrimination: Impact of Face Masks.

Study 1 and Study 2 confirm the tested hypotheses, independent of the context of appearance. First, it was confirmed that the Duchenne smile is easily recognized as a happy expression, when compared to the non-Duchenne. Second, an impact of the face mask in the discrimination was detected.

Consequently, this finding confirms previous research which presented that the Duchenne smile is perceived more positively than other smiles (that lack the cheek raiser activation, AU6), known as the Duchenne marker. Consequently, it confirms that this smile is rated more as emotionally positive than smiles without eye constriction (Frank and Ekman 1993; Thibault et al. 2009; Gunnery & Ruben,2016). This explains the high discrimination for the Duchenne smile as a happy expression, and the lower discrimination for the non-Duchenne smile in this current study. Adding to this, Williams et al (2001) noticed that participants that gave more attention (e.g., for a longer period) to AU6 when judging facial expressions, mostly classify them (happy faces) as happy, which corroborate with the current findings, but only for the Duchenne faces, meaning that the face mask did not impact the happiness discrimination for this smile.

It was also expected that the mask would diminish the emotional discrimination, especially for the non-Duchenne smile, and this result can be seen in the interaction between the masked and unmasked smiles. The presence of the mask reduces the discrimination from the non-Duchenne faces, thereby we corroborate the main hypothesis of this research, meaning that this masked smile was less considered to be a happy emotion. This disturbance

is explained by the interference from the mask, that by covering the mouth area, takes the main clue for recognizing the non-Duchenne smile - since the eye region is not considered to be activated in this non-genuine happy expression. Thereby this finding goes along with the idea that perception of emotions is mainly affected by an absence of expressive cues. In this case, specifically for the non-Duchenne, the mouth is a valuable indication to recognize a happy expression and by covering the lower part of the face results in the perception of less happiness (Fischer, Gillebaart, Rotteveel, Becker & Vliek, 2011; Wegrzyn et al., 2017).

The Duchenne smile in genuine happiness discrimination.

In the second judgment, the findings suggest no impact from the face masks when discriminating the genuineness of the smiles, nor an obstacle to judge the authenticity of the smiles. However, it was observed some substantial variance between the discrimination responses for the Duchenne faces in the happiness discrimination judgment and genuineness discrimination judgment.

The smile revealed higher levels of discrimination when participants were required to evaluate the expression as happiness. Although, when the purpose was to evaluate the genuineness of the expression, a reduce capacity to discriminate the smile as authentic was presented. This result was equally observed on the response criteria proportions, whereas the high levels of mistakes occur specially for the genuine discrimination. Additionally, it was observed an impact of the face mask in the discrimination, specially decreased for the second judgment.

Although there was not a considerable difference on the discrimination of the authenticity of the smiles and the presence of the mask, the discrimination of the Duchenne smile as a genuineness expression was found to be highly reduced when compared to the happiness discrimination. This difficulty is found in literature, whereas the capacity to correctly distinguish between genuine and posed smiles is less expected. (Frank et al., 1993; Gosselin et al., 2002, Boraston et al., 2008; Manera et al., 2011). Thereby, the intensity of the smile could be a factor to these results

Corroborating with previous findings and considering specially the impact of the face mask, the AU6 was a strong indication on happiness discrimination, however for genuineness discrimination found to be less relevant to this subject, but still, helped to subject to correctly classify the authenticity of the smiles. This corroborate with the findings from Raul et al

(2020), that even though the AU6 alone was a strong indicator for genuine smiles (as the Duchenne marker), the participants, were inept to take this hint into full consideration.

Thus, it can be concluded from the genuineness happy discrimination results, that the AU6 is perceive highly as a happy indication, rather than genuineness of the smile. Also, for this judgment and the mask, the interaction was not as strong as in the happiness discrimination. Thus, it can be assumed that the intensity of the smile (considering the high contracting of the check area) lead to recognize the Duchenne smile more as a happy expression, however this cue was weaker when classifying the smile as genuine happiness.

Empathy, Complementary Measures and Emotion Discrimination

Happiness and genuine happiness discrimination.

First in Study 1, the happy judgment detected a negative correlation between empathy and the discrimination of masked Duchenne and non-Duchenne. This finding was found only related to the masked smiles. Hence it could be thought that the participants with higher level of empathy consider the mask in the holistic process, and this may perhaps cause a disturbance that led them to discriminate less the masked smiles. This finding goes against the previous research, which found positive interactions between self-reported emotional empathy and expression recognition (Martin et al., 1996, Riggio et al., 1989, Gery et al., 2009). In this specific discrimination, there was no positive associations with empathy, only negative for the masked smiles. On contrary, the second study found no association between the smiles, empathy, and the presence of the mask. Although this was the findings for the happiness discrimination, the genuineness discrimination showed no relation with empathy measure as was expected from previous findings (Tibi-Elhanany and Shamay-Tsoory, 2011).

For the COVID-19 measures, only the second study showed significative results. The discrimination of masked Duchenne was positively associated with fear of COVID-19 and the non-Duchenne faces were positively associated with anxiety of COVID-19. Hence, the pandemic stress cause by the virus was only related to the masked smiles (Duchenne and non-Duchenne). This finding support former studies, which believe that a stressful context could influence the discrimination (Barel & Cohen, 2018; Tibi-Elhanany and Shamay-Tsoory, 2011).

Although there were some interesting results, there was not an expressive finding that could appeared in both studies. Even though there was no conflicted association, they were

not reconfirmed. Thereby, there is not a substantial association for happiness discrimination (Duchenne and non-Duchenne), the presence of the mask (Mask x No Mask) and control measures. This could be an indication of the sample, which was not substantial for the correlation. So, it is suggested that a new experiment with a higher level of participants.

Other Emotions

According to the results from Study 2, the outcomes suggest that the judgment for the masked fear and anger, is positively correlated with empathy, specially fear that revealed the same association for the unmasked faces. This finding corroborates with previous finding from Barel & Cohen (2018) that support that a stressed context improved the accurate recognition of anger.

Conclusions

Unlike what has been studied so far, this research evaluated the discrimination of happiness and the impact of the mask, through two types of smiles - Duchenne and not Duchenne - adding a new contribution to the scientific field. Consequently, it was also analyzed the interaction from the face mask in other emotions.

The results revealed a decrease in emotion perception when faces appear covered by protective masks; the discrimination accuracy was lower for masked faces, in all the emotions (Happy Duchenne, Happy non-Duchenne, Anger, Fear and Sadness). Thereby, emotion recognition is strongly reduced when the holistic process is prejudice by covering parts of the face (Freud, 2020; Carbon , 2020; Fischer et al., 2012; Grundmann, Epstude, and Scheibe, 2021).

Specifically, it was confirmed that the Duchenne smile is perceived more as a happiness expression than the non-Duchenne smile, but this contrast is expressive when adding the face masks. The cheek raiser activation (*Obiularis occuli;* AU6), known as the Duchenne marker, is an important cue to happiness discrimination, and this proved to be evident by the low discrimination of masked non-Duchenne faces. When covering the smile, considered by many authors the main cue to recognize happiness, the discrimination of this smile as a happy expression is impaired (Fischer et al.,2011; Wegrzyn et al., 2017).

Consequently, it strengthens that the smile with the AU6 activation are rated more as emotionally positive than the smiles without the eye constriction (Frank and Ekman 1993; Thibault et al. 2009; Gunnery & Ruben,2016). This explains the high discrimination for

Duchenne smile as a happy expression, and the lower discrimination for the non-Duchenne in this current study.

Although, in the genuine happiness discrimination judgment, there was no differentiation between the judgment of smiles and the presence of the mask, this distinction was found to be highly reduced when compared to the happiness discrimination. Thereby, corroborating with previous findings and considering specially the impact of the face mask, the AU6 was a strong indication on happiness discrimination. As for genuineness discrimination, this mark might have been lees valuable.

Comparing all the emotions, even if the discrimination was reduced for masked faces, fear and angry faces did not reveal a significant disturb between the means. Angry faces expressed a high level of discrimination, meaning that the face mask had very little interference in this discrimination. This could be explained and support by the idea that the eye region, as it was not occluded by the mask, provides most of the emotional information indicative for this emotional state, according to Wegrzyn, et al. (2017). This masked expressions, fear and anger, were found to be positively correlated with empathy. Specially fear, that also indicated a positive association with empathy (Barel & Cohen, 2018).

Moreover, the results highlighted an expressive impairment for sadness discrimination. This expression showed low levels of discrimination, independent of the presence of the mask, and by that being easily misinterpreted as neutral - as was also noticed by Carbon (2020). By that, especially when appeared with the face mask, sadness indicated an extreme difficulty to be recognized.

Summarizing, the presence of the mask decreases emotion discrimination, specially for sadness and non-Duchenne smile. The less affected expression by the mask were Duchenne and fear faces, followed by anger. Hence, these impacts in emotion perception could have social implications and significantly impact daily tasks and interaction.

Limitations and Future Directions:

The difference between the discrimination for the Duchenne smile in the happy discrimination and genuine discrimination could be further explore. The interaction of the face mask and the genuineness judgment was not as strong as in the happiness discrimination. Thus, it can be postulated that the intensity of the smile (considering the high contracting of the eye area) lead to recognize the Duchenne smile more as a happy expression, meaning that

this cue was weaker when classifying the smile as genuine happiness. Continually, an implementation of the electromyography to the study can revealed the differences of facial responses between the smiles and the judgments. Also, it might be possible to investigate the influence from the selected faces and their respective data bases and analyze if the methodology to elicit the smiles (e.g., instructions via FACS; spontaneous stimulus) influenced on the discrimination and mimicry responses.

Additionally, would be interesting to explore the interaction from sad faces with neutral faces, aiming to understand the confusion, specially referred to the eye area. In this line, it could be explored the discrimination responses to sad and neutral faces with the help of electromyography measures, willing to observe if there is a mimicry related to this misperception.

As for empathy and the complementary measures, mainly for the smiles, the results were mostly inconclusive, hence this project could be repeated with a higher sample.

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Appendix A

Índice de Reactividade Interpessoal Mark Davis, 1983 (adaptação portuguesa de Teresa Limpo, Rui A. Alves e São Luís Castro, 2010).

This index of 24 questions is based on a multidimensional conception of empathy. It is built on four subscales: perspective taking, empathic concern, personal discomfort and fantasy. In an empathic episode, observation of someone activates mechanisms that produce responses in the observer. Four sequential mechanisms are identified in this episode: antecedents, processes, intrapersonal and interpersonal consequences. The background denotes the characteristics of the observer or the situation. The processes imply the mechanisms by which the empathic response is produced. The intrapersonal consequences are the answers that arise in the observer by knowledge of the target; may be cognitive (e.g., interpretations), affective (e.g., empathic concern), or motivational concern. Interpersonal consequences are behavioral responses engaged to the observed person. Each factor is predisposed by the one who precedes it and influences the one that follows. "The antecedents will influence the entire empathic episode and, in particular, cognitive, affective and/or motivational processes. These progressions will produce intrapersonal responses that, in turn, determine interpersonal responses (the observer's manifest behavior in relation to the target and/or situation) " (Limpo, Alves & Castro, 2010).

1.Tenho muitas vezes sentimentos de ternura e preocupação pelas pessoas menos afortunadas do que eu. [PE]

2. De vez em quando tenho dificuldade em ver as coisas do ponto de vista dos outros. [TP] [i]

3. Às vezes, não sinto muita pena quando as outras pessoas estão a ter problemas. [PE] [i]

4. Facilmente me deixo envolver nos sentimentos das personagens de um romance. [F]

5. Em situações de emergência, sinto-me desconfortável e apreensivo/apreensiva. [DP]

6. Habitualmente mantenho a objetividade ao ver um filme ou um teatro e não me deixo envolver por completo. (F) [i]

7. Quando há desacordo, tento atender a todos os pontos de vista antes de tomar uma decisão. [TP]

8. Quando vejo que se estão a aproveitar de uma pessoa, sinto vontade de a proteger. [PE]

9. Por vezes tento compreender melhor os meus amigos imaginando a sua perspectiva de ver as coisas. [TP]

10. É raro ficar completamente envolvido/envolvida num bom livro ou filme. [F] [i]

11. Quando vejo alguém ficar ferido, tendo a permanecer calmo/calma. [DP] [i]

12. As desgraças dos outros não me costumam perturbar muito. [PE] [i]

13. Depois de ver um filme ou um teatro, sinto-me como se tivesse sido uma das personagens. [F]

14. Estar numa situação emocional tensa assusta-me. [DP]

15. Geralmente sou muito eficaz a lidar com emergências. [DP] [i]

16. Fico muitas vezes emocionado/emocionada com coisas que vejo acontecer. [PE]

17. Acredito que uma questão tem sempre dois lados e tento olhar para ambos. [TP]

18. Descrever-me-ia como uma pessoa de coração mole. [PE]

19. Quando vejo um bom filme, consigo facilmente pôr-me no lugar do protagonista. [F]

20. Tendo a perder o controlo em situações de emergência. [DP]

21. Quando estou aborrecido/aborrecida com alguém, geralmente tento pôr-me no seu lugar por um momento. [TP]

22. Quando estou a ler uma história ou um romance interessante, imagino como me sentiria se aqueles acontecimentos se tivessem passado comigo.[F]

23. Quando vejo alguém numa emergência a precisar muito de ajuda, fico completamente perdido/perdida. [DP]

24. Antes de criticar alguém, tento imaginar como me sentiria se estivesse no seu lugar. [TP]

Legenda. [i] item invertido; [TP] Tomada de Perspectiva; [PE] Preocupação Empática; [DP] Desconforto Pessoal; [F] Fantasia

Appendix B

Loureiro, Garcia-Marques & Bártolo (2020) Control Measure Covid-19.

Como avalia as medidas de proteção tomadas contra a COVID-19?

Adequadas 1 2 3 4 5 6 7 Exageradas

Qual o nível de ansiedade que sente em ambientes caracterizados como protegidos da COVID-19?

Nenhuma Ansiedade 1 2 3 4 5 6 7 Muita Ansiedade

Qual o nível de medo que tem da COVID-19?

Nenhum Medo 1 2 3 4 5 6 7 Muito Medo

Qual o nível de ansiedade que sente ao pensar na COVID-19?

Nenhuma Ansiedade 1 2 3 4 5 6 7 Muita Ansiedade

Appendix C

STAI – Ansiedade de Traço, Adaptação de Silva & Correia, 1998.

1. Sinto-me bem
2. Sinto-me nervoso e inquieto
3. Sinto-me satisfeito comigo próprio
4. Quem me dera ser tão feliz como os outros parecem sê-lo
5. Sinto-me falhado
6. Sinto-me tranquilo
7. Sou calmo, ponderado e senhor de mim mesmo
8. Sinto que as dificuldades estão a acumular-se de tal forma que as não consigo resolver
9. Preocupo-me demais com coisas que na realidade não tem importância
10. Sou feliz
11. Tenho pensamentos que me perturbam
12. Não tenho muita confiança em mim
13. Sinto-me seguro(a)
14. Tomo decisões com facilidade
15. Muitas vezes sinto que não sou capaz
16. Estou contente
17. Às vezes, passam-me pela cabeça pensamentos sem importância que me aborrecem
18. Tomo os desapontamentos tão a sério que não consigo afastá-los do pensamento
19. Sou uma pessoa estável
20. Fico tenso(a) ou desorientado(a) quando penso nas minhas preocupações e interesses mais recentes.

Appendix D

Result Tables from Study 1.

Judgment 1. Happiness Discrimination

Hits.

Table 7.

Judgment 1. ANOVA Within Subjects Effects. Hits Proportion.

	SS	*df*	*MS*	*F*	*p*	η^2_p
D-ND	1.23	1	1.23	171.2	< .001	0.86
Residual	0.19	27	0.00			
M-NM	0.69	1	0.69	86.2	< .001	0.76
Residual	0.21	27	0.00			
D-ND ✻ M-NM	0.57	1	0.57	61.8	< .001	0.69
Residual	0.25	27	0.00			

Note: D = Duchenne; ND = non-Duchenne; M = Mask; NM = No Mask.

Table 8

Judgment 1. Paired Samples T-Test. Hit Proportion: non-Duchenne and mask interaction.

		t	*df*	*p*	Mean difference	*SE* difference	Effect Size
ND	NDM	8.71	27.0	< .001	0.30	0.03	0.23

Note: ND = non-Duchenne; NDM = masked non-Duchenne .

Table 9.

Judgment 1. Paired Samples T-Test: *Hit Proportion: Duchenne and mask interaction.*

		t	*df*	*p*	Mean difference	*SE* difference	Effect Size
D	DM	2.17	27.0	0.03	0.01	0.00	0.41

Note: D = Duchenne; DM = masked Duchenne.

False Alarms.

Table 10.

Judgment 1. ANOVA Within Subjects Effects. False Alarm from Neutrals and Other Emotions

	SS	df	*MS*	F	p	η^2_p
NT-OE	0.22	1	0.22	17.99	< .001	0.40
Residual	0.33	27	0.01			
M-NM	0.00	1	0.00	1.46	0.238	0.05
Residual	0.09	27	0.00			
NT-OE ✻ M-NM	0.00	1	0.00	1.00	1.000	0.00
Residual	0.12	27	0.00			

Note: NT = Neutral; OE = Other Emotions; M = Mask; NM = No Mask.

STD Indexes.

Sensitivity in discrimination (d-prime).

Table 11.

Judgment 1. ANOVA Within Subjects Effects Discrimination from smiles and mask interaction

	SS	*df*	MS	*F*	*p*	η^2_p
D-ND	24.35	1	24.35	252.1	< .001	0.90
Residual	2.61	27	0.09			
M-NM	13.12	1	13.11	44.7	< .001	0.62
Residual	7.93	27	0.29			
D-ND ✻ M-NM	7.91	1	7.90	64.5	< .001	0.70
Residual	3.31	27	0.12			

Note: D= Duchenne; ND= Non-Duchenne; M = Mask; NM= No Mask.

Table 12.

Judgment 1. Paired Samples T-Test: *Discrimination. non-Duchenne and mask interaction.*

		t	*df*	*p*	Mean difference	*SE* difference	Effect Size
ND	NDM	8.65	27.0	< .001	1.22	0.14	1.63

Note: ND = non-Duchenne; NDM = masked non-Duchenne

Table 13.

Judgment 1. Paired Samples T-Test: *Discrimination - Duchenne and mask interaction.*

		t	*df*	*p*	Mean difference	*SE* difference	Effect Size
D	DM	1.53	27.0	0.13	0.15	0.09	-0.29

Note: D = Duchenne; DM = masked Duchenne.

Response Criteria (c)

Table 14.
Judgment 1. ANOVA Within Subjects Effects: Response Criteria from smiles and mask interaction

	SS	*df*	*MS*	*F*	*p*	η^2_p
D-ND	6.08	1	6.08	252.1	< .001	0.90
Residual	0.65	27	0.02			
M-NM	1.94	1	1.94	16.7	< .001	0.38
Residual	3.14	27	0.11			
D-NM ✻ M-NM	1.97	1	1.97	64.5	< .001	0.70
Residual	0.82	27	0.03			

Note: D= Duchenne; ND= Non-Duchenne; M = Mask; NM= No Mask.

Table 15.

Judgment 1. Paired Samples T-Test. Response Criteria: non-Duchenne and mask interaction.

		t	*df*	*p*	Mean difference	SE difference	Effect Size
ND	NDM	6.15	27.0	<.001	0.52	0.08	1.16

Note: ND = non-Duchenne; NDM = masked non-Duchenne.

Table 16.

Judgment 1. Paired Samples T-Test. Response Criteria: Duchenne and mask interaction.

		t	*df*	*p*	Mean difference	SE difference	Effect Size
D	DM	-0.04	27.0	0.96	-0.00	0.05	.00

Note: D = Duchenne; DM = masked Duchenne.

Judgment 2. Genuine Happiness Discrimination

Table 17.

Judgment 2. ANOVA Within Subjects Effects. Hit Proportion: Mask interaction.

	Sum of Squares	*df*	*Mean Square*	*F*	*p*	η^2_p
M-NM	0.00	1	0.00	1.24	0.27	0.04
Residual	0.17	27	0.00			

Note. M= Mask; NM: No Mask.

Table 18.

Judgment 2. ANOVA Within Subjects Effects. False Alarm Proportion: Mask interaction

	Sum of Squares	*df*	*Mean Square*	*F*	*p*	η^2_p
M-NM	0.09	1	0.09	2.28	0.14	0.07
Residual	1.15	27	0.04			

Note. M= Mask; NM: No Mask.

Table 19.

Judgment 2. ANOVA Within Subjects Effects. Discrimination: Mask interaction

	Sum of Squares	df	Mean Square	F	p	η^2_p
M-NM	2.04	1	2.03	2.46	0.12	0.08
Residual	22.40	27	0.83			

Note. M= Mask; NM: No Mask.

Table 20.

Judgment 2. ANOVA Within Subjects Effects. Response Criteria: Mask interaction

	Sum of Squares	*df*	*Mean Square*	*F*	*p*	η^2_p
M-NM	0.08	1	0.08	1.05	0.31	0.03
Residual	2.18	27	0.08			

Note. M= Mask; NM: No Mask.

Duchenne Smile in Happiness Discrimination and Genuine Happiness Discrimination.

STD Indexes.

Sensitivity in discrimination (d-prime).

Table 21.

Judgments´ Interaction. Discrimination for Duchenne smile and mask interaction in happiness and genuineness discrimination

	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2_p
M-NM	2.00	1	2.00	3.88	0.05	0.12
Residual	13.91	27	0.51			
D	81.22	1	81.22	34.98	< .001	0.56
Residual	62.68	27	2.32			
M-NM ✻ D	0.36	1	0.36	0.80	0.37	0.02
Residual	12.26	27	0.45			

Note. D= Dcuhenne; M= Mask; NM = No Mask.

Response Criteria (c)

Table 22.

Judgments´ Interaction. Response Criteria for Duchenne smile and mask interaction in happiness and genuineness discrimination.

	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2_p
M-NM	0.04	1	0.04	0.71	0.40	0.02
Residual	1.70	27	0.06			
D	2.42	1	2.42	8.39	0.007	0.23
Residual	7.80	27	0.28			
M-NM ✻ D	0.03	1	0.03	0.65	0.42	0.02
Residual	1.65	27	0.06			

Note. D= Duchenne; M= Mask; NM = No Mask.

Appendix E

Result Tables from Study 2.

Hits.

Table 23.

ANOVA Within Subjects Effects. Hits from Neutral Within Smiles.

	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2_p
M-NM	1.12	1	1.12	56.2	< .001	0.64
Residual	0.62	31	0.02			
D-ND	0.81	1	0.81	59.7	< .001	0.65
Residual	0.42	31	0.01			
M-NM ✻ D-ND	0.45	1	0.45	41.9	< .001	0.57
Residual	0.33	31	0.01			

Note: Hit calculation for neutral faces within the same block (Duchenne and non-Duchenne). D = Duchenne; ND = non-Duchenne; M = Mask; NM = No Mask.

Table 24.

ANOVA Within Subjects Effects. Hits from Neutral Within Emotions.

	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2_p
M-NM	0.78	1	0.78	46.5	< .001	0.60
Residual	0.52	31	0.01			
E	0.98	4	0.24	15.3	< .001	0.33
Residual	2.00	124	0.01			
M-NM ✻ E	0.90	4	0.22	22.2	< .001	0.41
Residual	1.25	124	0.01			

Note: Hit calculation for neutral faces within the same block. E = Emotions (Duchenne, non-Duchenne, anger, fear, and sadness); M = Mask; NM = No Mask.

False Alarms.

Table 25.

ANOVA Within Subjects Effects. False Alarm from Neutral Within Smiles.

	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2_p
M-NM	0.10	1	0.10	12.87	0.001	0.29
Residual	0.24	31	0.00			
D-ND	0.01	1	0.01	1.63	0.21	0.05
Residual	0.28	31	0.00			
M-NM ✻ D-ND	0.00	1	0.00	0.13	0.71	0.00
Residual	0.29	31	0.00			

Note: False Alarm calculation for neutral faces within the same block (Duchenne and non-Duchenne). D = Duchenne; ND = non-Duchenne; M = Mask; NM = No Mask.

Table 26.

ANOVA Within Subjects Effects. False Alarm from Neutral Within Emotions.

	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2_p
M-NM	0.06	1	0.06	6.61	0.01	0.17
Residual	0.32	31	0.01			
E	0.62	4	0.15	8.45	< .001	0.21
Residual	2.29	124	0.01			
M-NM ✻ E	0.04	4	0.01	1.16	0.33	0.03
Residual	1.14	124	0.00			

Note: False Alarm calculation for neutral faces within the same block. E = Emotions (Duchenne, non-Duchenne, anger, fear, and sadness); M = Mask; NM = No Mask.

STD Indexes.

*Sensitivity in discrimination (d-prime**).***

Table 27.

ANOVA Within Subjects Effects. Discrimination from Neutral Within Smiles.

	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2_p
M-NM	33.84	1	33.83	61.1	< .001	0.66
Residual	17.15	31	0.55			
D-ND	18.40	1	18.39	62.4	< .001	0.66
Residual	9.14	31	0.29			
M-NM ✻ D-ND	4.17	1	4.17	10.8	0.003	0.25
Residual	11.97	31	0.38			

Note: Discrimination calculation for neutral faces within the same block (Duchenne and non-Duchenne). D = Duchenne; ND = non-Duchenne; M = Mask; NM = No Mask.

Table 28.

ANOVA Within Subjects Effects. Discrimination from Neutral Within Blocks.

	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2_p
M-NM	20.6	1	20.63	59.0	< .001	0.65
Residual	10.8	31	0.35			
E	41.8	4	10.44	20.7	< .001	0.40
Residual	62.5	124	0.50			
M-NM - E	19.1	4	4.76	12.8	< .001	0.29
Residual	46.0	124	0.37			

Note: Discrimination calculation for neutral faces within the same block. E = Emotion (Duchenne, non-Duchenne, anger, fear, and sadness); M = Mask; NM = No mask.

Response Criteria (c)

Table 29.

Study 2. ANOVA Within Subjects Effects. Effects Criteria from Neutral Within Smiles.

	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2_p
D-ND	2.12	1	2.12	19.0	< .001	0.38
Residual	3.47	31	0.11			
M-NM	1.67	1	1.67	17.5	< .001	0.36
Residual	2.96	31	0.09			
D-ND ✻ M-NM	1.57	1	1.57	16.0	< .001	0.34
Residual	3.04	31	0.09			

Note: Criteria calculation for neutral faces within the same block (Duchenne and non-Duchenne). D = Duchenne; ND = non-Duchenne; M = Mask; NM = No Mask.

Table 30.

Study 2. ANOVA Within Subjects. Effects Criteria from Neutral Within Emotions.

	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2_p
E	3.98	4	0.99	5.97	< .001	0.16
Residual	20.65	124	0.16			
M-NM	1.33	1	1.32	8.87	0.006	0.22
Residual	4.64	31	0.14			
E✻ M-NM	2.28	4	0.57	6.59	< .001	0.17
Residual	10.72	124	0.08			

Note: Response criteria calculation for neutral faces within the same block. E = Emotion (Duchenne, non-Duchenne, anger, fear, and sadness); M = Mask; NM = No mask.

Appendix F

Reaction Time Results.

Study 1.

Judgment 1.

The contrast between the emotions (Duchenne, non-Duchenne, neutral and other emotions) was statistically significant (F (1,27) =13.74, p<.0001, η^2p=.37).

For all expressions, the reaction time was higher for recognizing expressions with the mask (M=1233, SD=95), compared to the unmasked faces (M=1002, SD=71), indicating extra time to discriminate an emotion when the faces were partially covered. This contrast, between is support statistically (F (1,27) =41.89, p=<.001, η^2p=.60) and corroborates with the hypothesis that the mask has an impact on the response discrimination - by adding the response time as an extra account and backing for the previous findings.

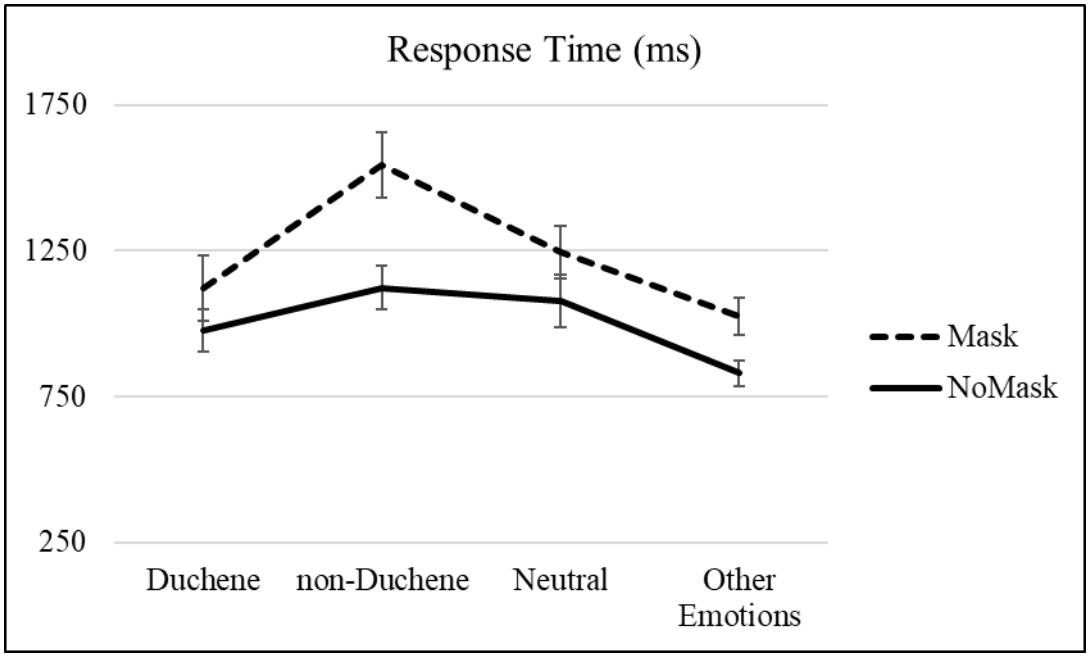

Figure 24 Study 1. Judgment 1: Response Time (ms) - This figure illustrates the Response Time in milliseconds, from mask and unmask faces: Duchenne, non-Duchenne, Neutral and Other Emotions (anger, fear, sad). The differences between the means are statistically significant

The main effect of the response time was for discerning the masked non-Duchenne smile (*M*=1544, *SD*=112). This expression took longer to be discriminated than the other expressions and might signify an extra difficulty to judge it. Statistically, the decrease in time response from the non-Duchenne faces was affected by the mask (*t*-test (*t* (27) =-5.25, *p*<.001, *d*=.99) while the Duchenne faces (*t*-test (*t* (27) =-2.17, *p*=.03, *d*=.41) showed no significative impact from the mask in the response time.

Overall, the response time was significant between the masked and unmasked expressions (Duchenne, non-Duchenne, neutral and other emotions) (F (3,18) =4,34, p=.00, η^2p=.13) and the main contrast were found for masked faces, especially the non-Duchenne smile.

Table 31.

Study 1. Judgment 1. ANOVA Within Subjects Effects: Reaction Time.

	Sum of Squares	df	Mean Square	F	p	η^2_p
D-ND-OE	5.04	3	1.68	13.74	< .001	0.33
Residual	9.90	81	122213			
M-NM	3.00	1	3.00	41.89	< .001	0.60
Residual	1.93	27	71605			
E ✻ M-NM	684572	3	228191	4.34	0.00	0.13
Residual	4.25	81	52518			

Note. D= Duchenne; ND= non-Duchenne; OE = Anger, Fear, Sadness; M= Mask; NM= No Mask.

Judgment 2.

The second judgment´´ response time was faster than the first judgment, meaning that the participants took longer to discriminate happiness from other emotions, than discriminating a genuine happy emotion from a non-genuine happy emotion. In the genuine happiness discrimination judgment, there was not a statistically difference in the response time (*F* (1,27) =.058, *p*=.450, η^2p=.021), masked (*M*=615, *SD*=78) and unmasked smiles (*M*=589, *SD*=86), suggesting there was no impact from the mask on the judgment´ response length between the smiles. Also, there was no significance between the Duchenne smile (*M*=568, *SD*=87) and the non-Duchenne smile (*M*=636, *SD*=78), (*F* (1,27) =3.78, *p*=.062, η^2p=.0123). Thereby there is no interaction between the smile, the mask and the response time (*F* (1,27) =.053, *p*=.818, η^2p=.002).

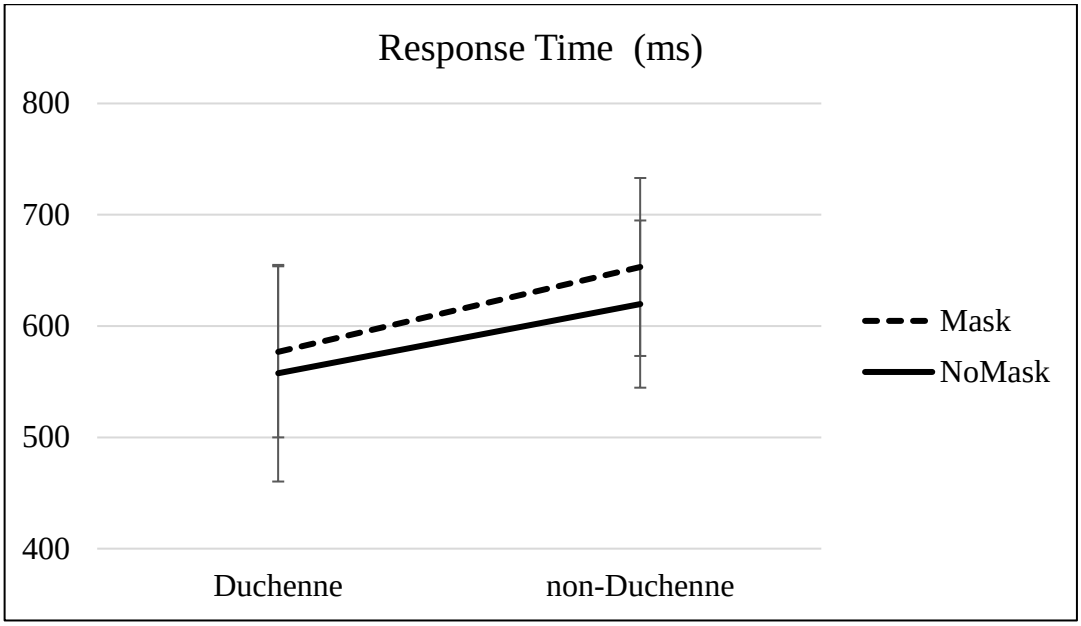

Figure 25. Study 1. Judgment 2 : Response Time (ms). The figure illustrates the Response Time in milliseconds, from Duchenne with and without the mask, and non-Duchenne with and without the mask. The differences between the means are not statistically significan

Table 32.

Study 1. Judgment 2. ANOVA Within Subjects Effects: Reaction Time.

	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2_p
D-ND	134021	1	134021	3.78	0.06	0.12
Residual	955374	27	35384			
M-NM	19332	1	19332	0.58	0.45	0.02
Residual	888234	27	32898			
D-ND ✻ M-NM	1392	1	1392	0.05	0.81	0.00
Residual	697664	27	25839			

Note. M= Mask; NM = No Mask; D= Duchenne; ND= non-Duchenne.

In the response criteria, the interaction between Duchenne with and without the mask had no significant variation. It was detected a liberal response indicating more false alarms when the subjects discriminated the genuineness of this smile. It implies a high percentage of mistakes when discriminating genuineness with and without the mask. This could imply a positive reinforcement to answer genuine when was not genuine. This impression can also be supported by the response time in the second judgment, that was responded faster than the first judgment, which means that the participants took more time to discriminate happiness from other emotions, than discriminating a genuine happy emotion from a non-genuine happy emotion.

In the genuine happiness discrimination judgment, there was not a statistically variance in the response time for Duchenne and non-Duchenne faces, suggesting there was no impact from the mask on the judgment´ response length between the smiles. This rush could justify the high level of false alarms.

Study 2.

Interaction within target emotions.

Among the blocks, the response time for masked faces were superior to unmasked faces, except fear, where it was notice that the discrimination for masked (M=697, SD=39) was faster than the unmasked ones (M=640, SD=30), and it is statistically significant (F (4,24) =15.39, p=<.001, η^2p=.33).

The variance between the blocks and neutral faces and the presence of the mask was statistically significant d between the response time (F (4,24) =2.50, p=.04, η^2p=.07). The block Happy Duchenne registered the faster response time between masked (M=583, SD=26) and unmasked faces (M=529, SD=23), when contrasted to the additional emotions. Between the smiles the highest response time difference between means was for the non-Duchenne (M=650, SD=31), and the Duchenne smile presented the fastest response time between the smiles and the other blocks (M=556, SD=24). Henceforward, the distribution from masked and unmasked Duchenne and non-Duchenne, is not a statistically significative (F (1,31) =3.16, p=.08, η^2p=.09), meaning that no expressive variance in the response time between the smiles was detected.

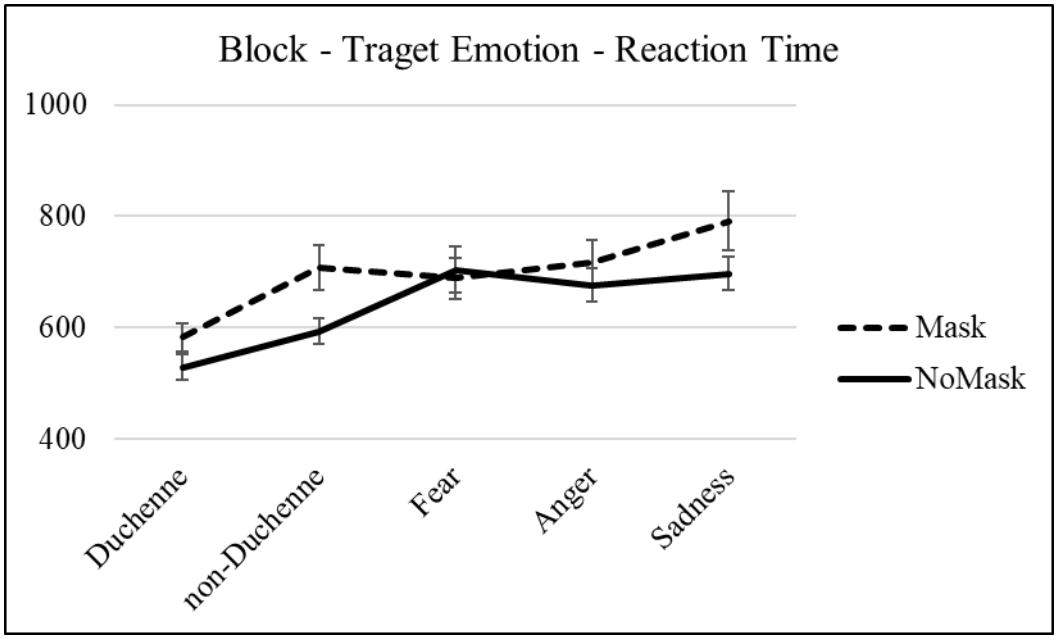

Figure 26. Study 2 Response Time: Block Target Emotion (ms) - The graphic illustrates the Response Time in milliseconds, from mask and unmask faces for the blocks: Happy (Duchenne), Happy (non-Duchenne), Anger, Fear, Sadness. The differences between the means are statistically significant.

Table 33.

ANOVA Within Subjects Effects Reaction Time from Neutral Within Blocks.

	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2_p
M-NM	265058	1	265058	15.39	< .001	0.33
Residual	533921	31	17223			
E		4	324594	11.33	< .001	0.26
Residual		124	28656			
M-NM ✻ E	163149	4	40787	2.50	0.04	0.07
Residual		124	16302			

Note: Reaction Time calculation for neutral faces within blocks. E= Duchenne, non-Duchenne, anger, fear, sadness; *D* = Duchenne; ND = non-Duchenne; M = Mask; NM = No Mask.

Interestingly, and complimenting the previous findings from the response criteria and sensitivity, sadness had the highest length of response time (*M*=744, *SD*=41), and was specially disturb by the face mask (*M*=791, *SD*=53), showing a response time superior to any other emotion, with and without the mask.

Duchenne and non-Duchenne from neutrals.

The block Happy Duchenne registered the faster response time between masked (*M*=583, *SD*=26) and unmasked faces (*M*=529, *SD*=23), when contrasted to the additional emotions. The block with the highest response time difference between means was non-Duchenne (Mask: *M*=708, *SD*=40; No Mask: *M*=593, *SD*=23). Henceforward, the distribution from masked and unmasked Duchenne and non-Duchenne, is not a statistically significative (*F* (1,31) =3.16, *p*=.08, η^2p=.09), meaning that no expressive variance in the response time between the smiles and the presence of the mask was detected.

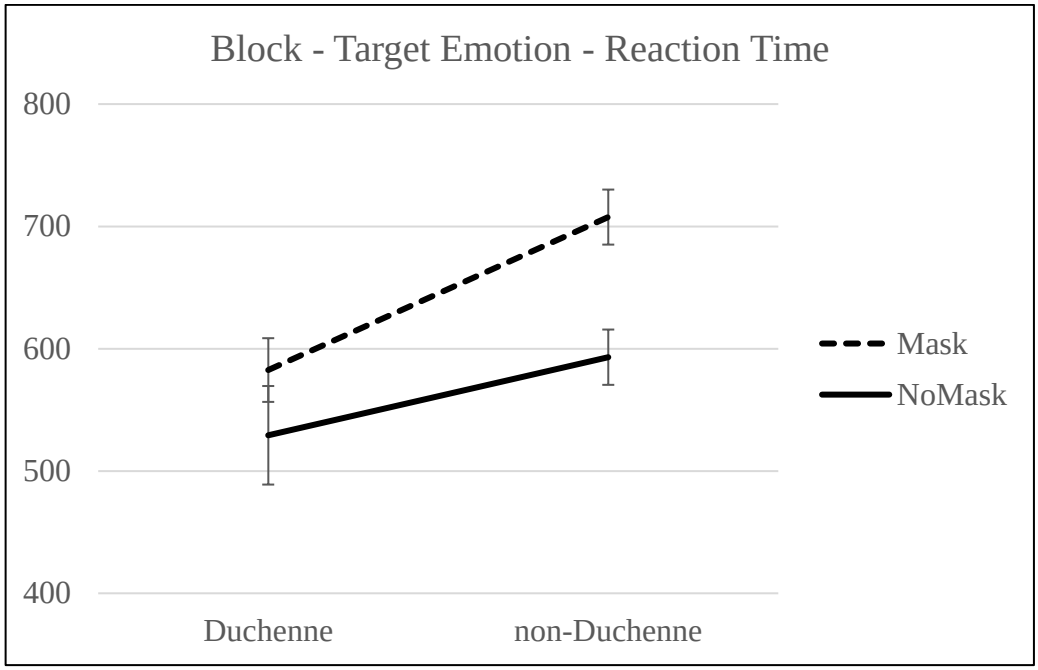

Figure 27. Study 2. Response Time: Block Happy (Duchenne) Happy (non-Duchenne) (ms). The graphic illustrates the Response Time in milliseconds, from masked and unmasked faces for the blocks: Happy (Duchenne), Happy (non-Duchenne). The differences between the means are not statistically significant.

Table 34.

ANOVA Within Subjects Reaction Time from Neutral Within Smiles.

	Sum of Squares	*df*	Mean Square	*F*	*p*	η^2_p
M-NM	225590	1	225590	17.98	< .001	0.367
Residual	388928	31	12546			
D-ND	285503	1	285503	19.14	< .001	0.382
Residual	462346	31	14914			
M-NM ✻ D-ND	29964	1	29964	3.16	0.085	0.092
Residual	294149	31	9489			

Note: Reaction Time calculation for neutral faces within the same block (Duchenne and non-Duchenne). D = Duchenne; ND = non-Duchenne; M = Mask; NM = No Mask.