

“Masking” our emotions: Botulinum toxin, facial expression, and well-being in the age of COVID-19

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Abstract

Background: The globally devastating effects of COVID-19 breach not only the realm of public health, but of psychosocial interaction and communication as well, particularly with the advent of mask-wearing.

Methods: A review of the literature and understanding of facial anatomy and expressions as well as the effect of botulinum toxin on emotions and nonverbal communication.

Results: Today, the mask has become a semi-permanent accessory to the face, blocking our ability to express and perceive each other's facial expressions by dividing it into a visible top half and invisible bottom half. This significantly restricts our ability to accurately interpret emotions based on facial expressions and strengthens our perceptions of negative emotions produced by frowning. The addition of botulinum toxin (BTX)-induced facial muscle paralysis to target the muscles of the top (visible) half of the face, especially the corrugator and procerus muscles, may act as a therapeutic solution by its suppression of glabellar lines and our ability to frown. The treatment of the glabella complex not only has been shown to inhibit the negative emotions of the treated individual but also can reduce the negative emotions in those who come in contact with the treated individual.

Conclusions: Mask-wearing in the wake of COVID-19 brings new challenges to our ability to communicate and perceive emotion through full facial expression, our most effective and universally shared form of communication, and BTX may offer a positive solution to decrease negative emotions and promote well-being for both the mask-wearer and all who come in contact with that individual.

KEYWORDS

botulinum toxin, COVID-19, facial expression, mask wearing, well being

1 | INTRODUCTION

COVID-19 is a virus that has taken a tremendous toll on global health and socioeconomics. Mask-wearing has become a normality for our society and for good cause. However, the magnitude with which covering our faces affects our social interactions and ability to understand and interpret one another cannot be overlooked. Whether subconscious or intentional, our facial expressions are one of our

most critical forms of communication, particularly with regard to expressing and perceiving each other's emotions.^{1,2} Humans have evolved to communicate using facial expressions that are largely universally shared and understood between cultures. We have been communicating through facial expressions for thousands of years.³ Today, masks act as powerful and direct hindrances to our ability to understand and empathize with one another. Since most masks block the bottom half of the face, it has become significantly more difficult

to recognize a mask-wearer's positive emotions such as happiness or friendliness which are largely communicated by a smile. A true or genuine smile, also known as a Duchenne smile, employs both the bottom half of the face and the top half of the face. In order to form a Duchenne smile, one must smile with both mouth (by showing their teeth) and eyes (through squinting).⁴ The average standardized mask typically only allows us to view the squinting half of a smile, which diminishes its genuineness.

Botulinum toxin (BTX) injections are one of the many services deemed "nonessential" that have largely been put on hold during the wide-scale quarantine and social distancing measures taken abroad in order to minimize the spread of COVID-19.⁵ With these restrictions now being slowly lifted, patients are once again receiving this most common and valued aesthetic procedure for its desired effect of facial muscle paralysis to diminish or eliminate unwanted frown lines and "crow's feet."⁶ Today however, these effects are now complemented by a mask that hides the lower half of the face, interfering with emotional processing and our ability to interpret each other's emotions through facial expression. How BTX acts as a therapeutic alleviator to these mask-induced inhibitions of emotional perception and communication via its visually pleasing effect is the topic of this paper.

2 | COVID-19 AND THE SOCIAL CONSEQUENCES OF MASK-WEARING

At this point, COVID-19 needs no introduction, but to summarize, it is the infectious respiratory illness caused by the novel coronavirus, SARS-CoV-2, and responsible for just over 125 000 deaths and 2.5 million cases in the United States, and about half a million deaths and just over 10 million cases worldwide.^{7,8} COVID-19 is characterized by upper and lower respiratory symptoms as well as other systemic symptoms. The causes of death in fatal cases are related to respiratory failure, hypoxemia, and cardiovascular complications. The vast majority of cases result in only mild symptoms, but infection in patients over 60 years of age or those with underlying medical conditions can develop severe viral pneumonia which can progress to acute respiratory distress syndrome (ARDS) and multi-organ system failure.⁹

The novel coronavirus can be easily spread from person to person via respiratory droplets released by coughing or sneezing and remains infectious in aerosolized airborne form. The virus may also be transmitted from contaminated surfaces and, depending on the type of surface, the virus may remain contagious from less than 24 hours to several days. After exposure to the virus, onset of symptoms may occur from 2 to 14 days with a mean incubation period of 4-5 days.¹⁰ In the absence of an effective treatment, there are three possible outcomes: avoidance of infection, acquired immunity, and death. The highly contagious nature of the virus has contributed to its rapid transmission and a prevalence of infection that has reached a pandemic level. The lack of effective, clinically proven therapy for the coronavirus, which causes a respiratory illness that can lead to

respiratory failure and has a comparatively high mortality rate for a viral infection, has forced the population to rely on disease prevention measures.¹¹⁻¹³ Efforts to reduce the rate of disease transmission are essentially behavioral modifications, both self-imposed and government-mandated. These social countermeasures include such behaviors as frequent hand-washing, more vigilant disinfection of surfaces, social distancing, crowd avoidance, self-quarantine, and, most notably, mask-wearing.¹⁴⁻¹⁶

Paul Ekman performed a series of experiments around the world in the early 1970s, arguing that there exist six universally recognized facial expressions of emotion regardless of culture: surprise, fear, disgust, anger, happiness, and sadness.¹⁷ While his findings have been hotly debated in the field for decades, and numerous studies examining the topic have subsequently been performed, a common finding is that reading the eyes provides the most information about an emotional expression.¹⁸ However, the mouth is also very informative and helps to distinguish between several emotions such as fear and surprise or between sadness and disgust. Wearing a mask has been shown to make the discernment of emotions much more difficult largely in part because it hides the mouth.¹⁹

The social consequences of mask-wearing due to COVID-19 cannot be understated, particularly with regard to its interference in the way in which we communicate through facial expression. As we continue to cover our faces in public, it becomes significantly more difficult to interpret each other's facial expressions and easier to misinterpret them. Since masks typically cover the bottom half of the face, the ability to detect a smile or frown is drastically inhibited as the movement of the lips and showing of the teeth are no longer involved from the observer's point of view. This leaves only the top half of the face for an observer to use as a means of detecting the mask-wearer's emotions. While an observer may posit the squinting of the mask-wearer's eyes to indicate a smile and the bringing together of the eyebrows to indicate a frown, the observer is still left with incomplete information and, in turn, the presupposed emotion is likely not interpreted to be as convincing as a full frown or smile would be. There is also the possibility of confusing these only partially revealed facial expressions with an incorrect one. For example, the squinting of the eyes without the mouth visible may be misconstrued as skepticism rather than smiling. Masks may also enhance the perception of negative emotions or diminish the perception of positive emotions. Emotions such as surprise or disgust that utilize the mouth may be mistaken for strongly negative emotions such as anger or sadness, and a smile may seem diminished or less genuine when the teeth and lips are occluded.²⁰

Research shows that observers tend to reconstruct an average face when viewing faces that are partly masked in order to form an interpretation. When doing so, some areas of the face tend to have more influence on the observer's ability to correctly interpret the corresponding emotion than other areas do.^{21,22} A recent study highlights the importance of the eyes and mouth in allowing observers to correctly interpret an emotion. The study presented individual faces expressing basic emotions behind a mask of 48 tiles that were sequentially uncovered to observers (or subjects). The subjects in

the study were instructed to halt the progression of the sequence as soon as they recognized the emotion that was being revealed to them and to assign it the correct label. Each revealed tile which was equivalent to each of the 48 parts of the face was given a value of importance based on its ability to contribute to the observer's recognition of the facial expression being revealed. Results showed that observers relied mostly on tiles that revealed the mouth and eyes when correctly identifying the emotion being displayed. Subjects identified fear and sadness largely by focusing on the eyes, whereas disgust and happiness were more successfully identified when subjects focused on the mouth region.²⁰ If applied to today's social environment, these results would suggest that happiness and disgust are not as likely recognized in those wearing masks that hide the mouth. Fear and sadness, on the other hand, may overshadow the emotion of happiness since the eyes which produce these emotions are visible while the mouth is occluded. Occlusion of the mouth and the eyes has also been shown to decrease the accuracy and speed of recognition of emotions in both children and adults.²³ Mouth occlusion has been shown to cause a greater decrease in facial expression recognition than occlusion of the eyes which makes the interpretation of anger, fear, happiness, and sadness much more difficult to detect than expressions more solely dependent on the eyes such as disgust.²⁴

The importance of the eyes and mouth in facial emotional perception has allowed us to group emotions systematically into "upper-face" and "lower-face" expressions. Focusing on one half without the other makes us prone to confuse certain emotions for other ones. When viewing the upper half of a face such as one hidden behind an N-95 mask, we tend to confuse anger with disgust. When viewing a face displaying only the bottom half, such as one wearing a blindfold, we are prone to confusing fear with surprise.²⁰

What may even further weaken the observer's perception of the mask-wearer's facial emotion is the potential lack of incentive to form a particular emotion among the mask-wearer. Making facial expressions is largely used for the purpose of communicating with an observer, and if the mask-wearer is not able to communicate his or her facial expression to an observer as it is blocked by a barrier, then one may ask why he or she would expend the energy to form a full facial expression to begin with or even a facial expression at all. This brings the added inhibitory effect by the expressor themselves in addition to the mask barrier.

The potential lack of incentive among mask-wearers to form facial expressions while wearing a mask may not only be a detriment to the observer's ability to detect the mask-wearer's emotions but to the mask-wearer's ability to perceive the emotions of others and even their own. This idea stems from the theory of embodied emotion or the facial feedback hypothesis (FFH) which suggest that feedback from facial muscles influences emotion of the expressors themselves.²⁵ Electromyography (EMG) studies have demonstrated the correlation of activity of facial musculature with self-reported mood. Subjects that viewed unhappy imagery exhibited increased activity of frown muscles on EMG and depressed mood simultaneously.²⁶⁻²⁸

While interpretation of emotions is compromised by mask-wearing, so too is reciprocation. Facial mimicry is the activation of specific facial muscles to create congruence in response to an emotional facial expression.²⁹ For example, individuals react with a smile in response to seeing a happy face and react with a frown in response to a sad face. The emotions of the viewer also follow the expressions and that individual feels happy or sad. These reactions are often of very low intensity and have been measured to occur within the first 500 milliseconds of stimulus onset, typically outside of conscious awareness.³⁰ It appears these reactions occur automatically as a reflex, and they cannot be suppressed, even when instructed to do so.³¹ Covering half the face with a mask reduces the subconscious ability to properly interpret and mimic the expressions of those with whom we interact.

Recognition of and response to the outward emotional displays of one's peers is a critical and necessary component of social interaction as it helps individuals to modify their behavior in order to align with social communication and behavioral norms.³² When these emotional displays are inhibited by physical barriers such as masks, our ability to communicate effectively with one another is drastically limited and we are primarily left with mimicking negative (frown) emotions. With the lifting of COVID-19-inspired restrictions, the negative psychosocial effects of masks are becoming a reality. The therapeutic potential of BTX in alleviating these effects will be discussed further.

3 | BOTULINUM TOXIN AND THE ANATOMY OF EMOTION

The effects of BTX on displays of facial emotion in the setting of mask-wearing, let alone its effect on facial expression alone, cannot be demonstrated without first understanding the anatomy of facial expression, particularly the formation of frowning and smiling. The frown is principally formed by activation of the glabellar complex, a group of muscles that make up the medial brow depressors: the procerus, corrugator supercilii, and depressor supercilii.³³ The dynamic lines formed by activation of the glabellar complex are called glabellar lines (GL), frown lines, or angry elevens, and they become static and gain permanence with muscular contraction over time just as the LCLs do. The glabellar complex muscles are responsible for the outward display of negative emotions such as anger, fear, suffering, and sadness.³⁴ The treatment of the GLs prevents frowning and has been shown to positively impact the emotional perception of the patient by observers and by the patients themselves.

The smile is formed by a complex, coordinated contraction of facial muscles localized to the orbital and perioral regions. The bottom half of the smile is principally controlled by the zygomaticus major which draws up the corners of the mouth and enables the showing of teeth.³⁵ The top half of the smile is controlled by the orbicularis oculi which squints the eyes and creates lateral canthal lines (LCL), also known as crow's feet or laughter lines. The crow's feet are one of the most commonly treated targets of botulinum toxin.³⁶ The

combined contraction of the zygomaticus major and orbicularis oculi creates the true, full, or Duchenne smile—the showing of teeth with squinting of the eyes.⁴ This type of smile is generally interpreted as genuine and friendly compared with a smile that utilizes the zygomaticus major only.³⁷ When the zygomaticus major is contracted alone, without the accompanying eye squinting, it forms the false, Pan Am, or Botox smile.³⁸ The muscles that produce the smile are ultimately responsible for the physical display of positive emotions such as happiness, joy, and friendliness. Treatment of the LCLs by botulinum toxin prevents the display of a Duchenne smile which may negatively impact both the observer's emotional perception of the patient and the emotional feedback among patients themselves.³⁸

4 | BOTULINUM TOXIN IMPLICATIONS IN THE AGE OF COVID-19

As the first coronavirus cases were confirmed in the United States and talk of quarantine became seriously considered, grocery stores were not the only in-demand spots leading up to the stay-at-home orders. Across the country, many dermatologists reported large influxes of patients seeking last-minute botulinum toxin injections. One physician in New York City estimated his aesthetic patient load quadrupled in the 2 weeks prior to the quarantine.³⁹ Demand increased both from patients seeking touch-ups and from those seeking first-time treatments. As the quarantine continued, reports surfaced of clinics and spas opening and performing house calls for those willing to pay extra in spite of mandated closures, including a number of celebrities, influencers, and internet stars.⁴⁰⁻⁴² Still others have reportedly sought injections from less-qualified hands only to end up with undesired results such as drooping eyebrows or asymmetric cheekbones.³⁹ Clearly, the drive to seek a youthful and attractive appearance remains high for many despite the reduction in in-person interaction.

The gradual lifting of restrictions across the country in May and June has allowed for elective procedures to resume in many places so long as certain health guidelines are met.⁴³ Many dermatology offices have begun reopening for medical and aesthetic visits with precautions in place such as spaced appointments, extensive personal protective equipment use, temperature checks, and vigorous sanitization of equipment between appointments and at the end of the day.⁴⁴ Other physicians have forged a more creative route to resuming operations such as one dermatologist in Miami, Florida, who has been conducting drive-through botulinum toxin injections in his building's garage.⁴⁵ Time will tell whether these heightened precautions in patient interaction, or some variation of them, will become a permanent fixture of outpatient medicine.

Apart from the business of botulinum toxin, the psychological impacts of its use during this time of mask-wearing and social distancing should be considered. As discussed above, the ability to interpret the emotional state of others and reciprocate via facial mimicry is ingrained in our DNA and highly important in our day-to-day interactions with our peers.^{29,46} Social interactions are dynamic

exchanges of information. The observer subconsciously and continuously infers the meaning behind the words, tone, and body language used by the speaker throughout a conversation and also experiences affective emotional reactions to them. In turn, the observer's subsequent effective emotional state as displayed by body language, facial expressions, and verbal responses has a direct effect on the original speaker's emotions. It is a dynamic process, and direct adjustments to unfolding physical characteristics of the other person's movements are made throughout the conversation on both sides.^{47,48} The utilization of a mask hinders that subconscious connection by covering the bottom half of the face such that the eye region alone must be used to gauge and respond to emotions. The problem with this is that we are not conditioned to communicate or express our emotions in this manner. This leads to significant emotional misperceptions and negative facial feedback from our facial expressions that directly impact our moods.

The action of frowning gives off the perception of a bad mood. Moods are contagious, and this emotional contagion occurs unconsciously. A person's feelings, whether positive or negative, can actually be transferred to another during an interaction.^{49,50} Much of this transfer has been shown to occur through unconscious mimicry.²⁹ In other words, a frown displayed on a patient's face may influence an observer to unconsciously frown as well and a smile can do just the same. The contagious nature of emotions can become even more amplified when individuals are in frequent contact with one another.⁵¹ If this is the case, masks have the potential to amplify the transfer of bad moods by highlighting the glabellar region while it is contracted and forming the most dominant part of the frown. By redirecting our eyes to the glabella while hiding the mouth, masks may intercept the perception of non-negative facial expressions (ie surprise or confidence) that often require both glabella and mouth regions to be seen to fully interpret that particular expression.⁵² Negative emotions such as anger or sadness are much more pronounced and dependent via glabella only.³⁴ This is where BTX may play an incredibly effective role in diminishing negative emotional perceptions and negative facial feedback that may otherwise lead to the contagious spread of a bad mood.

Patients with BTX-induced paralysis to glabellar muscles have been shown to feel more attractive, exhibit higher self-esteem, confidence, and increased comfort and sociability with others, and report overall increased happiness.^{53,54} These effects are likely attributed to patients' improved self-perceptions as they view themselves in a mirror, but also due to embodied emotion via direct afferent feedback. In the setting of a mask, BTX may help to offset the negative emotions that frowning would otherwise add to a mask-wearer that may not feel obligated to smile, as discussed previously, and that regularly finds him or herself in public settings that today often bring out emotions of fear and caution which produce negative facial expressions as a result. If BTX can bring about positive emotions and prevent the formation or severity of negative emotions among patients, due to the contagious nature of facial expressions, BTX's positive effects should be mirrored by the people they come in contact with. In an analysis of 1000 survey responses, on average,

the public perceived patients treated with BTX to some of the most commonly treated sites including the glabella, as significantly more attractive, trustworthy, intelligent, youthful, naturally beautiful, and likeable than prior to treatment. These patients were also more likely to be invited to social events and asked out on a date following treatment with BTX.⁵⁵ This demonstrates that BTX-induced paralysis to the muscles of the glabella positively impacts the way in which observers emotionally perceive treated patients. Overall, public perception of negative emotions in BTX-treated patients may be diminished after GL treatment.⁵⁶⁻⁵⁸

With prolonged societal use of mask-wearing and the contagious nature of frowning, society may experience an increase in the expression of negative emotions among the general population and in the incidence of depression and depression-related disorders. If the cause is in fact due to mask-wearing and visual misinterpretation of facial expressions, then this is an issue that aesthetics may be able to solve, particularly with the use of BTX. A growing number of studies have demonstrated BTX's effectiveness in treating major depressive disorder and depression-like symptoms. The treatment of the GLs by BTX to inhibit frowning has been shown to significantly reduce the symptoms of depression across numerous case series and randomized controlled trials.^{34,59-62} In a large-scale meta-analysis of 134 subjects, response and remission rates were shown to be 8.3 and 4.6 times higher, respectively, among patients treated with BTX compared to those treated with placebo.⁶³ In congruence with the FFH, if a patient cannot frown, negative emotions such as anger, fear, and sadness are not strengthened by the afferent feedback pathway, and mood improves.

BTX-induced reduction in frowning improves interactions and relationships with others. For example, if someone making a sales call is frowned at by their prospect, this may indicate to the salesperson that their prospect is not appeased by their presentation. In turn, the negative feedback from the facial expression of the prospect may result in a frown by the salesperson in response and thus decrease their likelihood of making a sale.⁶⁴ BTX may therefore improve our interactions in both our personal lives and business encounters by helping patients be perceived as more positive and approachable to others. These characteristics are critical to productive and successful individuals and in developing positive and successful relationships with others whether personal, romantic, or business-oriented and beyond.^{65,66} As more research is published in support of BTX's positive effects in the workplace, companies may consider paying for employees to undergo BTX injections. The contagious nature of facial expressions makes BTX's induction of positive emotions even more potent as its effect reaches more than just the patient, but those that patients interact with.

While numerous studies have explored GL treatment on mood, only a few small studies have explored LCL treatment on mood. It has been shown that while treating the GLs alone does improve mood, treating the GLs and LCLs together may actually cancel out the expected positive effects on mood, resulting in no change from baseline.³⁸ Preventing the display of a Duchenne smile by treating the LCLs has been shown to blunt positive emotions among

patients. Additionally, the display of a non-Duchenne smile to one's peers is typically interpreted as disingenuous and may result in fewer genuine smiles being directed back at the patient.^{37,67} While wearing a mask, this effect may be even more pronounced. When the lower half of the face is completely covered, it leaves only the eyes to communicate the positive emotive gesture of smiling. In this setting, treating the LCLs then makes the display of any smile virtually impossible. While masked individuals can still form the half of a smile that utilizes the mouth, these individuals will likely experience inhibited internalization of the positive emotion attempting to be expressed when they are additionally treated with BTX to the LCLs. The mask likely inhibits this afferent feedback even further by decreasing a patient's motivation to form the bottom half of a particular facial expression when interacting with others since this half is blocked from sight anyway. Thus, with regard to emotional processing, treating the glabella may have largely positive effects while treating the lateral canthal area may have principally negative effects that are likely only heightened with mask-wearing.³⁸

5 | CONCLUSIONS AND CONSIDERATIONS FOR THE FUTURE

COVID-19 brought to the world more than just widespread disease but also a radical change in human psychosocial dynamics and communication. Just as cell phones function as a semi-permanent accessory to our hands or pockets, masks now function in the same manner on our faces. By cutting the visual surface area of our faces in half, masks make it incredibly challenging to display and perceive each other's facial expressions which are critical and necessary components of social interaction as they help individuals to modify their behavior in order to align with social communication and behavioral norms.

As the widespread societal adoption of masks continues, it bears the question of what the long-term effects on facial recognition and nonverbal communication will be. As emotional expressions are intercepted, so too may be our ability to practice facial mimicry and recognize or describe one's own emotions and the emotions of others, which is referred to as alexithymia.⁶⁸ In an alexithymic society, we would expect our emotions to be flatter, less intense, and less reactionary to the emotional facial expressions communicated to each other on a daily basis. If this is the case, COVID-19 brings with it not only a pandemic of global health but a pandemic of emotional communication as well. In a society in which communication has historically been 55% facial, it becomes crucial to find solutions to our diminished ability to communicate in a positive manor via facial expressions that are hidden under a mask barrier. Botulinum toxin injection offers a very realistic and practical solution.⁶⁹

Fortunately, the half of the face that is still exposed even with a mask happens to include the most common target of BTX, the glabella, which is responsible for the production of negative emotions by forming the frown. Although one of the key players in the

formation of a smile and the display of positive emotions, the mouth, is hidden behind a mask, we can still eliminate the display of negative emotions with BTX by targeting the glabella. Treatment of frown lines offers a significant advantage over the treatment of crow's feet in this day and age because it inhibits the display of negative emotions while treatment of LCLs inhibits the only half of a Duchenne (or full) smile that is able to be displayed since the mouth is blocked by a mask. Research has shown that BTX-induced paralysis of the glabella has increased the feeling of positive emotions among patients themselves both by improving patient mood and inhibition of depression. These effects are attributed not only to aesthetic effect, but through direct afferent feedback to the brain as well. Since the display of emotions through facial expression including frowning is contagious, BTX seems to show promise for improving the emotional perception of patients with BTX-induced glabellar paralysis by observers as well.

Society may need to continue to adapt to the advent of mask-wearing in ways that minimize the psychosocial impact it induces. Companies like ClearMask™ may offer a novel solution through the development of the first transparent mask that provides full-face visibility.⁷⁰ If widespread daily use of masks continue, the hope is that new innovations such as this one will allow us to no longer hide our faces behind a mask and to once again be able to appreciate the full aesthetic effects that BTX offers to millions of patients nation-wide.⁷¹ For now, BTX seems to offer a promising role as a powerful psychosocial therapeutic, a function that, while often overlooked, has long-accompanied its use as a classic aesthetic since its inception.

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