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News and Views

Reply to Crivelli et al.: The different faces of fear and threat. Evolutionary and cultural insights

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1. Introduction

The universality of human facial expressions in relation to emotion has been a key point of debate for behavior and evolution researchers since Darwin's (1872) treatise on 'The Expression of the Emotions in Man and Animals.' Since the late 1960s, seminal research by Paul Ekman, among others, indicated that certain facial muscle movements accompany primary affect states, and that these are found panculturally (Eibl-Eibesfeldt, 1970; Ekman and Friesen, 1971; Izard, 1994). However, some scholars have challenged those claims, providing numerous counter-examples in which facial expressions of emotion vary across cultures (Russell, 1994), such as in a recent article by Crivelli et al. (2016).

The goal of Crivelli et al. (2016) was to examine the 'Basic Emotion Theory', which states that six emotions are universally recognized (e.g., Ekman and Friesen, 1971). In their article, they discussed the universality of—what they dubbed—the 'gasping face,' an expression that has been recurrently recorded as a gesture of fear among Western societies. However, Crivelli et al. (2016) argued that in non-Western small-scale societies—such as in their study, the Trobriand Islands of Papua New Guinea—this face is interpreted as threatening and aggressive rather than as fearful (Fig. 1A). To support their claim, the authors included examples from agonistic displays and performance arts where this expression is often meant as a threat signal, such as in the Haka, or Maori war dance (Fig. 1B). On this basis, Crivelli et al. (2016) concluded that the common assumption of the gasping face as a universal signal of fear is unfounded, as it relies on data from mostly Western societies. The authors contended that emotion science should be more cautious when attributing universal emotion states to facial expressions, since these may in fact differ according to context or culture. In broad lines, we agree with the conclusions by Crivelli et al. (2016). However, in their paper we see a few shortcomings that could have been readily overcome by means of: (1) an appropriate classification of facial expression terminology; (2) a broader historical perspective that includes examples from visual art from different cultures; and (3) the consideration of the origins and functions of facial expressions of emotion.

2. Discussion

2.1. Facial expression terminology

First, the facial expressions selected by Crivelli et al. (2016) should be better clarified. They introduced the term 'gasping face' (Fig. 1C) to refer to a common fear expression, i.e., a type of expression in which the corners of the mouth are retracted—a similar, although not identical, expression to the 'bared teeth face' (Fig. 1D; de Waal and Luttrell, 1985; Thierry et al., 1989; Fridlund, 1994; Waller et al., 2016). This classic facial expression related to fear involves the raising and drawing together of the brows, the raising of the upper eyelids and tensing the lower eyelids, stretching the lips horizontally and dropping the jaw (Matsumoto, 1989). In accordance with their results, and in order to avoid the presupposition that the 'fear' facial display in the two sets of face stimuli used by the authors actually correspond to fear, Crivelli et al. (2016) instead employed the expression 'fear gasping face.' However, we believe that by using the term 'gasping,' they introduce even more ambiguity than there currently already is. According to the Oxford Dictionary (Hornby, 2000:530–531), the verb 'to gasp,' means "to take a quick deep breath with your mouth open, especially because you are surprised or in pain, e.g., she gasped at the wonderful view or, they gasped in astonishment at the news." The noun 'gasp' is described as "a quick deep breath, usually caused by a

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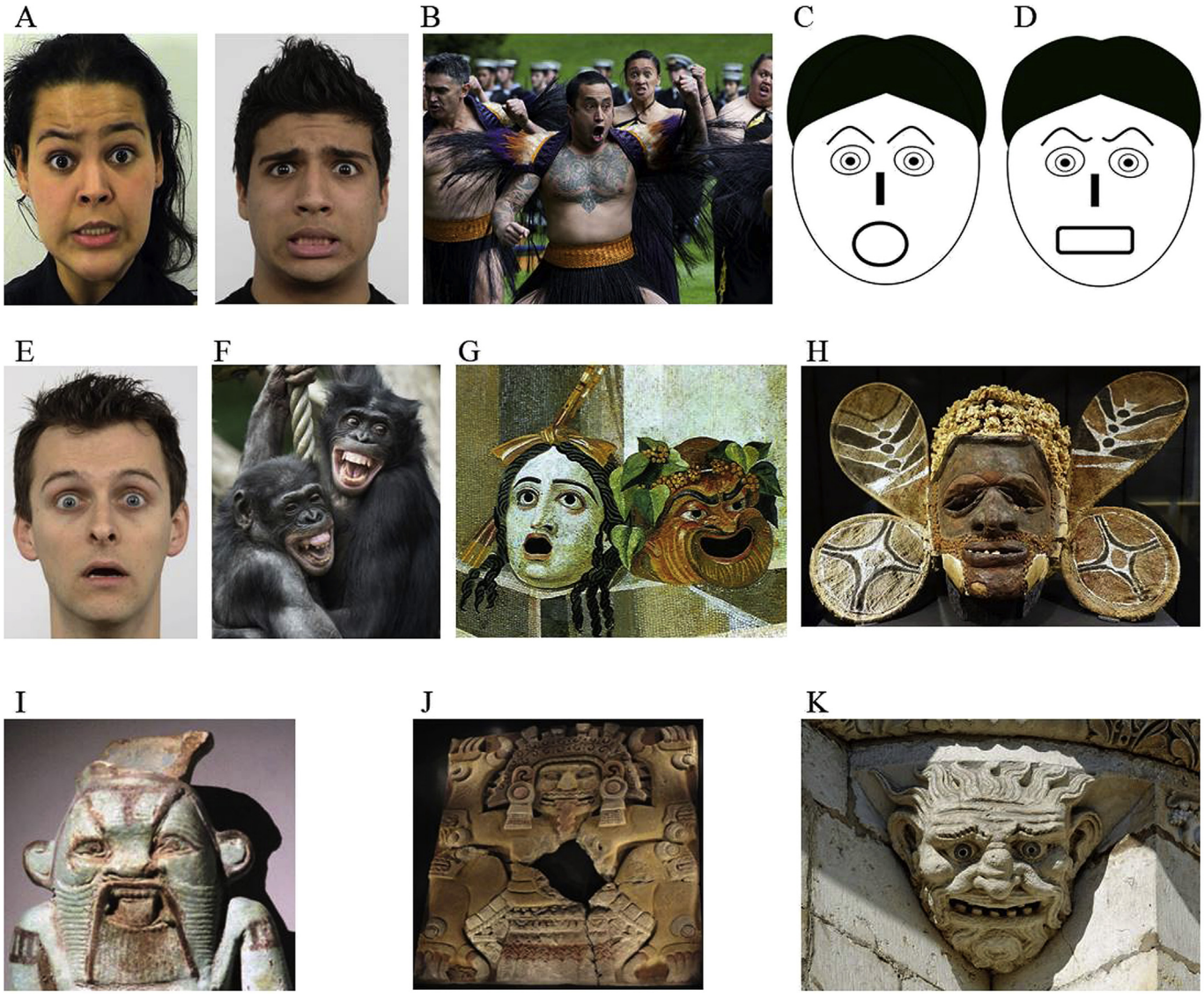

Figure 1. Facial expressions of threat in primates, humans, and visual art. A) Facial expressions used in Crivelli et al. (2016), taken from the Amsterdam Dynamic Facial Expression Set (ADFES; Van Der Schalk et al., 2011) and from the Radboud Faces Database (Langner et al., 2010). B) Maori Haka dance. Image by DoD photo by Erin A. Kirk-Cuomo; Source: Wikimedia Commons. C) Schematic gasping face. D) Schematic bared teeth face. E) Fear gasping face with the corners of the mouth relaxed and the jaw slightly dropped. F) Bared teeth face in two distressed bonobos. Photo taken by Hugh Jansman. G) 2nd century mosaic of theatrical masks of comedy and tragedy at Musei Capitolini, Rome. Source: Wikimedia Commons. H) Dance mask from New Ireland, Papua New Guinea (1916), at the Etnografiska museet in Stockholm. Source: Wikimedia Commons. I) Egyptian figure of Bes (304–330 BC) at the National Museum of Antiquities, Leiden. Photo by L.M.S. J) Tlaltecuhtli, Museo del Templo Mayor, Mexico City (Tlaltecuhtli is known from the Late Postclassic period in Central Mexico, 1200–1519 AD, but its origins are thought to go back further in time). Photograph by L.M.S. K) Gargoyle at the Church of Notre Dame de Dijon (13th century). Photo by F. de Dijon, source: Wikimedia Commons.

strong emotion: to give a gasp of horror/surprise/relief" (Hornby, 2000:530–531). Interestingly, when consulting Darwin's (1872) work, it turns out that in none of the three fearful facial expressions that are depicted in his book are the corners of the mouth retracted. Instead, they all show a 'fear gasping face' (Fig. 1C). This expression, epitomized by Edvard Munch's painting 'The Scream' or the 'Home Alone' film poster, the eyes are enlarged, the mouth is wide open, and the teeth largely concealed. Thus, in the fear gasping face, the corners of the mouth are not retracted as in the prototypical fearful face, but more relaxed. In their study, Crivelli et al. (2016) found that the inhabitants of the Trobriand Islands of Papua New Guinea recognized the prototypical expression of fear (Fig. 1A), which they call the gasping face, as anger. The prototypical expression of anger is typified by drawing together and lowering the brows, raising the upper eyelids and tensing the lower eyelids, and tensing the lips while pressing them together or raising the upper lip to bare the teeth (Matsumoto, 1989).

When carefully studying common stimulus sets of facial expressions, such as the Radboud Faces Database (Langner et al., 2010), it becomes evident that the category 'fear' consists of a mixture of both types of expression. In some, the corners of the mouth are retracted (Fig. 1A), in others, they are relaxed and more similar to a gasp (Fig. 1E; see also the expression of the Maori in Fig. 1B). Both types of expression might be real expressions of fear or threat, and these expressions, or components of them, can be found back in art across the globe and in non-human primates. We agree with Crivelli et al. (2016) that using the label 'fearful face' for all these stimuli might be incorrect. We disagree, however, with the term 'fear gasping face' as an umbrella term. Instead of lingering on terminology, we propose that we must first aim to understand the

evolutionary origins of these expressions better by making cross-species comparisons, as well as their usage in humans by studying ancient and contemporary art across the globe. In the rest of this article, we focus on the prototypical expression of fear, that is the type proposed by Ekman, where the corners of the mouth are retracted (Fig. 1A). This expression shares commonalities with the primate silent bared teeth face. The silent bared teeth face, as its name suggests, entails a grimace where the lower and upper teeth are visible (Fig. 1F). This expression is a common expression among primates (Preuschoft and van Hooff, 1995). We believe that it is important to make a clear distinction between a gasping and a bared teeth face, since they likely have different evolutionary origins and may vary in meaning. The bared teeth face possibly evolved from the ritualization of attack or prefight movements or intentions, such as biting (Andrew, 1963). In contrast, the gasping face most likely evolved as a fear display from screaming or calling behavior (Andrew, 1963; Andersson, 1980). Crivelli et al. (2016) also made a link to a specific type of call which is in Trobrianders produced in agonistic encounters, but in Papua New Guinea is used in negative as well as positive situations. However, once the contrast between the bared teeth face and the gasping face is acknowledged, it becomes evident that not only do the two photographs used by Crivelli et al. (2016:4) match the bared teeth face better, but also its interpretation by the Trobrianders as "an intent to aggress."

2.2. Examples from visual art

Our second argument, based on examples from visual art, is that the prototypical expression of fear works as a menace or threat display, not only in the small-scale communities of Papua New Guinea, but also in many societies of various scales, and from different geographies and periods (Eibl-Eibesfeldt, 1988). For instance, in the 2nd century mosaic from the Musei Capitolini in Rome (Fig. 1G), two theatrical masks are depicted. The mask on the left represents 'tragedy' and shows a facial expression similar to the gasping face. The one on the right represents 'comedy' and shows a smile, an expression that originated from the bared teeth face (van Hooff, 1972; Parr and Waller, 2006; Mehu and Dunbar, 2008). The bared teeth face is a common motif in apotropaic art, which is meant to ward off harm and deter evil (Sutterlin, 1989). Such art involves human, animal, or fantastical faces featuring expressions that evoke threat displays, grimacing, or mocking expressions. These faces generally show staring or bulging eyes, flared nostrils, an open mouth, flaunted tongue, face distortions and, very often, bared fangs or teeth (Emigh, 2011). Below, we present some examples from visual art, from Papua and across the globe, to illustrate the generality of the 'prototypical fear face,' the one similar to the bared teeth face, as a menace or threat display.

The art of the Trobriand Islands has been the object of many anthropological studies ever since Malinowski's (1922) celebrated monograph on the life of its inhabitants. From such studies it is known that the representation of teeth, for example in canoes, paddles, and shields, is often intended as a protective and auspicious motif, since they have "the ability to capture and grip prey" (Campbell, 1984:129), and in Kula exchange expeditions they are metaphorically meant to 'bite,' or secure Kula shells (Campbell, 1984). In a similar way, teeth motifs hold a deimatic connotation in the visual arts of neighboring Melanesian and Polynesian societies. Among the Yangoru Boiken of Papua's Sepik River region, eyes and teeth representations in art are meant to denote powerful and menacing beings and to provoke awe and fear in the viewer (Roscoe, 1995). The spectacular ceremonial masks of the Papuan Gulf and Sepik groups often depict grimacing (bared teeth) characters that instil feelings of terror in the audience (Kaeppler, 1963). Finally, in the art of the Marquesan Islands, the triangular teeth motif adds a defensive dimension to male tattoos (Gell, 1998). As discussed, Crivelli et al. (2016) presented their test subjects with a face showing a clenched mouth and exposed teeth, resembling a grimace. The apparent meaning of teeth as an apotropaic motif in Melanesian art may to some extent account for its interpretation as an expression of threat among the Trobrianders. The shape of the eyelids and brows in Crivelli et al.'s (2016) photograph may correspond better with a prototypical fear face rather than an angry face. However, the exact expression of the eye region does not seem to affect very much the interpretations of fear or anger expressions, which are more dependent on the mouth (Matsumoto, 1989).[1]

Examples of apotropaic characters gesturing in bared teeth face fashion are abundant across the globe and can be traced back to early antiquity. One of the oldest is the Egyptian god Bes (whose origins may be traced back to Phoenicia in the 2nd millennium BC), who is a protective deity that is generally shown with a grotesque grinning mouth (Wilson, 1975; Fig. 1I). Another ancient character is the Gorgon Medusa from Greek mythology (2nd millennium BC), whose menacing face with a grimace, teeth bared and protruding tongue held defensive powers (Howe, 1954). Even the goddess Athena wore a Gorgon face on her shield and armor for protection, and was therefore replicated in the arms, armor and architecture of classical Greco-Roman culture. In pre-Columbian Mexico, the dreaded protective earth monster goddess Tlaltecuhtli was portrayed with an open mouth displaying her teeth, often of flint blades (Fig. 1J): on the one hand, she menaced humanity and demanded sacrifice as appeasement; on the other, she offered protection to warriors and women in labor (Miller and Taube, 1993). Finally, the facades of many early Medieval churches and houses in Europe frequently showed grotesque grimacing faces and figures (e.g., gargoyles, green man; Fig. 1K), which simultaneously protected those on the inside and threatened harmful trespassers on the outside (Sutterlin, 1989).

This brief selection of examples from visual art of various times and geographies aims to show that the facial expression that Crivelli et al. (2016) identified as menacing, the prototypical expression of fear that approaches the bared teeth face, indeed has a widespread function as a threat signal, even among some Western societies. Accordingly, this reading is much more generalized than anticipated by Crivelli et al. (2016).

2.3. An evolutionary perspective

Even though the bared teeth face might have evolved from the ritualization of attack or prefight movements or intentions in non-human primates (Andrew, 1963), the current function of this expression varies in contexts and species. For instance, the expression has been associated with fear and with appeasing and submissive behavior (de Waal and Luttrell, 1985; Preuschoft and van Hooff, 1995). In most macaque and baboon species, the bared teeth face is a highly unidirectional pattern and expressed more frequently by a subordinate to a dominant (Rowell, 1966; de Waal and Luttrell, 1985). De Waal (1986) sees it as a tool to communicate the asymmetry of power between two individuals. However, in mandrills, the bared teeth face seems to be a signal often exchanged between antagonist individuals. Otovic et al. (2014) observed that this expression is most commonly exchanged between mandrills

[1] Ekman (1979) has also noted that brow and eyelid movements may overlap in fear and anger. Raising and scrunching the brows accompanied by raising the upper eyelid and tightening the lower eyelids is common in both anger and distress. He observed that "perhaps this eyebrow action should be considered the consequence of merging two actions seen in other primates during threat," or "as an anticipatory response to fear" (Ekman, 1979:197–198).

with high rates of agonism. In addition, they observed that the bared teeth face is the most common post-conflict signal exchanged, and that the mandrills exchanging this signal after fighting have poor relationships (Otovic et al., 2014). In Tonkean macaques, the bared teeth face is seen during play and in co-occurrence with the open mouth. Here, play signals inform conspecifics that bites, strikes, and throws that occur during play are indeed playful rather than serious. In this species, there is also no correlation between direction of the bared teeth display and dominance rank (Thierry et al., 1989; Pellis et al., 2011). In the common chimpanzee, bared teeth are shown in both agonistic and affiliative displays (Parr et al., 2005), and can even signal benign intent (Waller and Dunbar, 2005).

Among humans, bared teeth also appear in a number of facial expressions. They can signal joy like in a true smile but, as in non-human primates, the bared teeth face can have an appeasing function too (Marsh et al., 2005), and is thought to underlie the evolution of the so-called social smile (van Hooff, 1972; Parr and Waller, 2006; Mehu and Dunbar, 2008). As in the smile, the fear expression often shows bared teeth and raised eyebrows (Schmidt and Cohn, 2001). In addition, bared teeth displays may be expressed in dominance and aggression displays, making it an ambiguous signal in humans (Kret, 2015). Such ambiguity has been long noted by behavioral researchers, like Tinbergen (1952), who attributed the origin of threat signals as the simultaneous activation of the attack and escape/withdraw drives. Similarly, expressions of fear may evoke mixed reactions, and can be interpreted as an appeasement or submission cue inciting affiliative behavior, instead of avoidance (Marsh et al., 2005). Representations of the bared teeth face in visual art may then have positive or negative connotations. In a novel take on the analysis of Caribbean material culture, Samson and Waller (2010), for example, reinterpreted the bared teeth motif often portrayed in Taíno artworks as benign and appeasing (i.e., smile) instead of menacing, based on the function of the bared teeth face in non-human primates. It is possible, though, that this motif may indeed portray a smile, but in mocking attitude, as is common in apotropaic representations like the ones discussed in the previous section (Eibl-Eibesfeldt, 1988).

Recognizing and efficiently responding to others' emotions has great survival value, especially for social species such as humans. Cognitive neuroscience research shows that the expression of fear quickly and reliably heightens activation in emotional brain networks (Tamietto and de Gelder, 2010; Méndez-Bértolo et al., 2016). Paradoxically, the facial expression of fear is one of the most difficult ones to recognize, possibly because its meaning may be context dependent (Elfenbein and Ambady, 2002) and possibly also because the facial expression categories in the stimulus sets used in emotion research, including, admittedly, in our own (e.g., de Valk et al., 2015; Stamkou et al., 2016; Kret and Fischer, 2017), contain in fact mixed expressions. In addition, fear and aggression/anger may be hard to disentangle as separate expressions, as they are closely related in several ways (Kret et al., 2018). They both amount to threat signals, both are negatively valenced displays, and their somatovisceral and neural effects largely overlap, that is, they trigger an alerting response or 'defense reflex,' through activation of the amygdala, temporal cortices and the ventrolateral and dorsomedial prefrontal cortex (Stemmler et al., 2001; Pichon et al., 2009; Kret et al., 2011).

Like the displays of fear and anger themselves, the elements of apotropaic art may be ambiguously interpreted positively as protective, or negatively as malevolent in different cultures or contexts (Emigh, 2011). The specificity of sociocultural environments may also influence the interpretation of facial expressions (Ekman, 1980). When testing the universality of facial expressions of emotion, Ekman (1980) recruited a Papua New Guinean group as a non-Western sample, the Fore people of the Easter Highlands. Interestingly, he found that the only face that his subjects could not identify as easily as other populations was fear, which they apparently could not discriminate from surprise faces (Ekman, 1970). In view of Crivelli et al.'s (2016) results, it might be worth studying the expression and interpretation of fear among Papuan populations. Melanesian societies are known to have engaged often in intergroup warfare and conflict prior to contact with Westerners (Knauft, 1990). Such practices may have shaped the social function of the fear expression. Visual art could, in this case, aid in understanding the cultural interpretation of expressions, and how it changed over time. As demonstrated by Samson and Waller (2010), emotion psychology can inform interpretations of art, but conversely, art can provide new ways of approaching the study of emotion across cultures.

This brings us to our third point, which is that the origin and functions of human facial expressions of emotion should also be considered. That is, even when basic facial expressions likely originated in relation to specific emotions during primate evolution, because these function as signals of intent, they have probably been selected for their effects in social contexts (Mehu and Dunbar, 2008). In this sense, facial expressions may constitute communicative adaptations conveying benefits to both displayers and observers (Darwin, 1872; Susskind et al., 2008). This means that current functions of human facial expressions may, at least in some contexts, be detached from the original emotion from which they evolved, such as in the cases of the true smile compared to the social smile; the latter functions as a signal of intention rather than emotion and is displayed to draw attention and elicit a positive response from a social partner (Schmidt and Cohn, 2001). In a similar fashion, the prototypical fear face discussed here may have originated in fearful emotions, but it now can have different meanings in different contexts across and within cultures. In line with the results presented by Crivelli et al. (2016), in Melanesia this expression seems to serve as a signal of protective or aversive intent, as suggested by its recurrence in apotropaic artworks, and in ritualized agonistic displays like the Haka dance, although also there, the expression is sometimes mixed with gasping as is visible in Fig. 1B.

In order to further our understanding of the function of facial expressions, future research should study expressions during emotional situations in real life, and also look beyond recognition, and study the action tendencies that these expressions evoke in observers across cultures and species (i.e., approach, helping, avoidance; de Valk et al., 2015; Kret et al., 2016, 2018). For example, Pichon et al. (2009) have noted that fear and anger elicit similar neural responses, but different behaviors, with anger inducing a higher activity of the premotor cortex related to protective and defensive behavior. Since both anger-based and fear-based expressions can be interpreted as threat signals, but both elicit different responses, studies like Crivelli et al.'s (2016) should include questions about the behaviors that the expression motivates, and not only about what the subject believes to be the emotion underlying the expression. Furthermore, scholars should be wary of attempts to match facial expressions to single emotions, as there does not seem to be an absolute one-to-one correspondence between the two (Fridlund, 1994).

3. Conclusions

With this commentary, we aim to encourage researchers to be more cautious when discussing the universality or specificity of facial expressions, and when choosing their stimulus materials as well as the emotion labels, so that ambiguity may be reduced. Here we have argued not only that the term 'gasping face,' which Crivelli et al. (2016) have introduced is suboptimal, as it causes confusion,

but also that their results are very interesting, albeit they may be supported by a much larger body of evidence from Papuan and other visual art and from the primatology literature. In conclusion, we suggest that blending emotion science with an ethological approach to material culture can provide new insights into how emotions are expressed and interpreted across cultures, and help to test hypotheses of universality.

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