Tearing: Breakthrough in Human Emotional Signaling

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Abstract: Tearing is not a benign secretory correlate of sadness or other emotional state, but a potent visual cue that adds meaning to human facial expression, the *tear effect*. Although tearing (lacrimation) provides ocular lubrication and is a response to irritation in many animals, emotional tearing may be unique to humans and does not develop until several months after birth. This study provides the first experimental demonstration that tears are a visual signal of sadness by contrasting the perceived sadness of human facial images with tears against copies of those images that had the tears digitally removed. Tear removal produced faces rated as less sad. Anecdotal findings suggest further that tear-removal often produced faces of uncertain emotional valence, perhaps awe, concern, or puzzlement, not just less sad. Tearing signaled sadness and resolved ambiguity. The evolution and development of emotional tearing in humans provide a novel, potent and neglected channel of affective communication.

Keywords: tear effect, lacrimation, crying, emotion, sadness, facial expression

Introduction

Tears, a secretion of the lacrimal glands, lubricate the eye, are a response to irritation (e.g., abrasion, onion), improve optical performance by smoothing the otherwise rough corneal surface, and provide the antibiotic lysozyme (Frey, 1985; Sullivan, et al., 2002). Tears are widespread among vertebrates (Frey, 1985), but emotional tears may be unique to humans (Frey, 1985; Walter, 2006). Although there are anecdotal reports of emotional tearing in nonhumans (Masson and McCarthy, 1995), such reports are controversial and it is difficult to establish the cause of tears that may be produced (Frey,

1985). Tearing (lacrimation) by humans is associated with sadness and other emotional states and acts, including crying, grief, despair, frustration, helplessness, powerlessness, pain, happiness, anger, and empathy, as well as yawning, laughing, and sneezing (Frey, 1985; Lutz, 1999; Provine, 2000; Vingerhoets and Cornelius, 2001). The scientific literature about tearing during crying deals with physiology, gender, development, personality, social context, culture, psychopathology, health, and catharsis (Frey, 1985; Vingerhoets and Cornelius, 2001). Remarkably, neither the specialized literature about human crying nor the much broader literature about human emotion and facial expression provides an experimental evaluation of the tacit assumption that tears are a visual signal of sadness or other emotion. This study provides the first test of the role of tears as a visual signal by contrasting the perceived sadness of facial images with tears against copies of those images that had tears digitally removed.

Materials and Methods

Eighty undergraduate students at the University of Maryland Baltimore County (54 female, 26 male; mean age = 22.0 years (*SD* = 4.30, range = 18-49) volunteered to participate in a study of sadness perception. UMBC is an ethnically diverse campus (52% white, 22% Asian, 17% African-American, 4% Hispanic, 4% international, 1% native American) with students from 93 countries.

Fifty color images of faces with obvious tears in their eyes or running down their cheeks, were found by searching for "tears," "crying," and their cognates on online image archives such as *Flickr*. Selected tears (T) images, mostly in frontal and three-quarters perspective, were equally divided between males and females and roughly divided between estimated age (25 preadolescent children, 25 adults) and race (one-third Caucasian, black, and Asian). The 50 "tears" (T) images were edited with Adobe Photoshop to remove the tears, creating 50 matching "tears removed" (TR) images. Fifty tear-free "distracter" (D) facial images with mixed, midrange emotional expressions, were obtained by archive searches ("sports," "careers," etc.), again dividing images into groups based on sex, age and race, and duplicated, yielding 100 D images, and a total of 200 images of all types (T, TR, D). The presentation order of the first 100 images was: D1, T1, D2, TR2, D3, etc. The second 100 images reversed the order of the T and TR (but not D) images in the first 100 stimuli: D1, TR1, D2, T2, D3, etc. Thus, the order of presentation of T and TR image pairs was counterbalanced, with half of T images presented before their TR counterpart, and half of the T images presented after their TR counterpart. The images, cropped and sized to provide similar image scale, were presented in slideshow format, each appearing for 5 s, or until a rating was made, after which the next image would appear. A sample of facial images is not provided because of copyright restrictions and the inability to obtain informed consent of the people portrayed.

Before beginning the study, subjects were given 10 training trials using distracter-type stimuli to confirm that they understood the procedure. Instructions to subjects in both training and experimental trials were presented in on-screen text and read aloud by the experimenter:

> During each 5-second trial you will be shown an image of a person's face on this computer screen. Your task is to estimate the sadness of the person in the image using the 7-point rating scale of sadness from 1 "Not Sad At All" to 7 "Extremely

Sad" that appears beneath the person's image. Using the mouse, you will record your response by moving the cursor to the number corresponding to how sad the person in the image appears and click the mouse button.

The study was approved by the Institutional Review Board of the University of Maryland, Baltimore County.

Results

Facial images with tears were rated as significantly sadder in appearance ($M = 5.29$, $SD = .64$) than the same images with tears removed ($M = 4.05$, $SD = .63$), as determined by a repeated-measures ANOVA, $F(1,77) = 27.53$, $p < .01$, $\eta^2 = .26$. The ANOVA used gender as a between-groups factor with age as a covariate. The repeated measures variable had two levels: the average rating of images with tears; and the average rating of the images with tears removed. There were no interaction effects for age or gender with sadness ratings. Also, age was not a significant between-groups factor.

Participants seemed unaware of the experimental design and tear-removal tactic, probably because of the large number ($n = 200$) of D, T and TR images. After the study, a few participants volunteered that some of the images were duplicates, not realizing that half of the images were exact duplicates (D) and the remaining half nearly so (T, TR). No participant commented that some of the "duplicates" had tears and some had tears removed.

Discussion

The finding that tear removal produced a face perceived as less sad was anticipated but provided the first experimental confirmation of folk wisdom that tears are a visual signal of sadness. More surprising was the incidental, anecdotal finding that tear removal often produced faces of ambiguous emotional valence, perhaps awe, concern, contemplation or puzzlement, not simply of less sadness. In other words, faces without tears may not appear very sad. The effect of tear removal can be approximated by using your finger to block-out tears in a photograph.

Emotional tears provide a potent and informative visual signal of sadness that requires facial illumination of the sender and line-of-sight contact by an observer. Tears do not work in darkness or around obstructions. Emotional tears resolve ambiguity and add meaning to the neuromuscular instrument of facial expression, what we term the *tear effect.* Tears are not a benign secretory correlate of sadness or other emotional state. Emotional tears may be exclusively human (Frey, 1985) and, unlike associated vocal crying, do not develop until a few months after birth (Darwin, 1872/1965; Hopkins, 2000). The emergence of emotional tearing during evolution and development is a significant but neglected advance in human social behavior that taps an already established secretory process involving the eye, a primary target of visual attention.

The current study examined a single dimension of tears as a visual signal—their contribution to the perception of sadness. As suggested by the wide-ranging chapters of the text *Adult Crying* (Vingerhoets and Cornelius, 2001), more work must be done to understand the full contribution of tears to the perception of sadness and other emotional states, including their blends; "it is still largely unknown why adults cry and what the

function of their crying is" (Vingerhoets, Boelhouwer, Van Tilburg, and Van Heck, 2001, p. 71). Do tears, for example, make a person appear more needy, helpless, frustrated, or powerless, as well as sadder? Do tears amplify a perceived emotional expression, add a unique message, or contribute a subtle nuance interpreted as sincerity or wistfulness? Do tears express a blend of emotions, such as anger and powerlessness? Does a happy face with tears appear more or less joyous, or something in between, perhaps described as "bittersweet?" Are tears more prominent or emotionally potent on dark than light skin? Does the race, sex or age of a tearful face influence ratings of sadness or other emotions? (The current study detected no difference between the sadness ratings of adult men and women, or of adult raters of different age.) Are there interactions between the race, sex and age of sender and recipient of tearful signals, such that, for example, children seem sadder than adults, women seem sadder than men, or same-race individuals seem sadder than individuals of different-race?

A high priority area of future research involves the replication of traditional studies of the perception of facial expressions using tears as a variable. Virtually everything remains to be done. Two approaches would involve variants of the present procedure: examining the effect of tear-removal from facial images, if tears are present; and, adding tears to tear-free facial images, a more technologically difficult procedure. As in the present research on tear removal, the addition of tears to the images of people displaying happy, angry, disgusted, or other faces may yield unanticipated results.

A promising future clinical study involves the examination of emotional experiences of people who are unable to secrete tears because of pathology or agenesis of the lacrimal glands (Sullivan, et al., 2002). This condition of "dry eye" probably has an associated but unappreciated deficit of emotional signaling of the sort experienced by a young female graduate student who shared her story with the senior author. She described the frustration of being forced to explain, at the most difficult of times, and sometimes with quivering voice, her feelings that were once automatically communicated with tears. Her story nicely summarizes the contribution of tearing to the sometimes limited neuromuscular instrument and repertoire of the facial expression of emotion.

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