Mona Lisa's Smile—Perception or Deception?

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What gives Mona Lisa's smile such a mysterious quality? Livingstone (2000) has suggested that the portrait changes its expression depending on where on the portrait the observer looks. The mouth, which is the essential feature of Mona Lisa's remarkable expression (Kontsevich & Tyler, 2004), appears to form an enigmatic smile. Due to *sfumato* technique (Gombrich, 2005), this impression of a smile is more prominent in the gradual luminance changes that observers perceive mainly in the periphery of their vision—that is, in low spatial-frequency ranges. It is less prominent in the fine details that observers perceive only at the center of their gaze, in high spatial-frequency ranges.[1] Consequently, the subtle smile one perceives while looking at Mona Lisa's eyes (when her mouth appears blurred) vanishes when one attempts to verify this impression by looking at the mouth with maximum visual acuity. Hence, the proposed basis for the elusive quality of Mona Lisa's smile is that "you can't catch her smile by looking at her mouth. She smiles *until* you look at her mouth" (Livingstone, 2000, p. 1299).

In this study, we simulated the phenomenon for the first time experimentally via a saccade-contingent display-change technique that allowed us to subliminally alter the expression of faces depending on the beholder's gaze position.

Method

The study investigated the effect of an elusive smile, like that of the Mona Lisa, on the appreciation of faces. We designed a *Mona Lisa* condition in which faces alternated between a smiling mouth and a neutral mouth; the smiling mouth was displayed only as long as participants gazed toward a region around the eyes. As soon as the mouth was examined directly, it displayed a neutral expression (Fig. 1a). The display changes occurred during participants' saccadic eye movements, when visual perception was suppressed, so the participants remained unaware of the experimental manipulation, and their ratings were unaffected by rational considerations. To realize these saccade-contingent display changes, we guided the participants' gaze using a fixation cross (horizontally centered) that was superimposed on the stimulus faces either between the eyes or on the mouth, covering a visual angle of 5.5° (which is comparable to the extent of the facial region of the original artwork at a distance of 120 cm). The fixation cross was first positioned at the eyes and then at the mouth; this sequence occurred twice during each 2,400-ms trial, resulting in three large vertical saccades, during which the display changes occurred. During each trial, participants performed two long fixations at the eyes and two at the mouth (450–600 ms each). To prevent participants from accidentally observing a display change, we instantly terminated a trial when a participant failed to fixate the crosses properly.

In addition to the Mona Lisa condition, two control conditions were implemented using *smiling* and *neutral* faces. To guarantee a comparable exploration of the faces across all three conditions, we guided the participant's gaze in the control conditions in the same fashion as in the Mona Lisa condition, although only during the Mona Lisa condition did display changes actually occur.

One hundred morphed female faces, each in a smiling and a neutral version (selected on the basis of pretest ratings of facial expression), served as a stimulus pool for the smiling and neutral conditions, respectively. To realize the elusive smile in the Mona Lisa condition, we transferred the mouths of smiling faces to the corresponding neutral faces; the resulting neutral faces with smiling mouths were then presented alternately with the neutral faces with neutral mouths. Each participant was presented with 25 stimuli from each of the three conditions (smiling, neutral, and Mona Lisa) in a randomized order; the sampling of these 75 experimental stimuli from the pool of 300 stimuli was counterbalanced across participants.

The stimuli were presented on a 200-Hz CRT monitor with a resolution of 640 × 320 pixels. Distance from the

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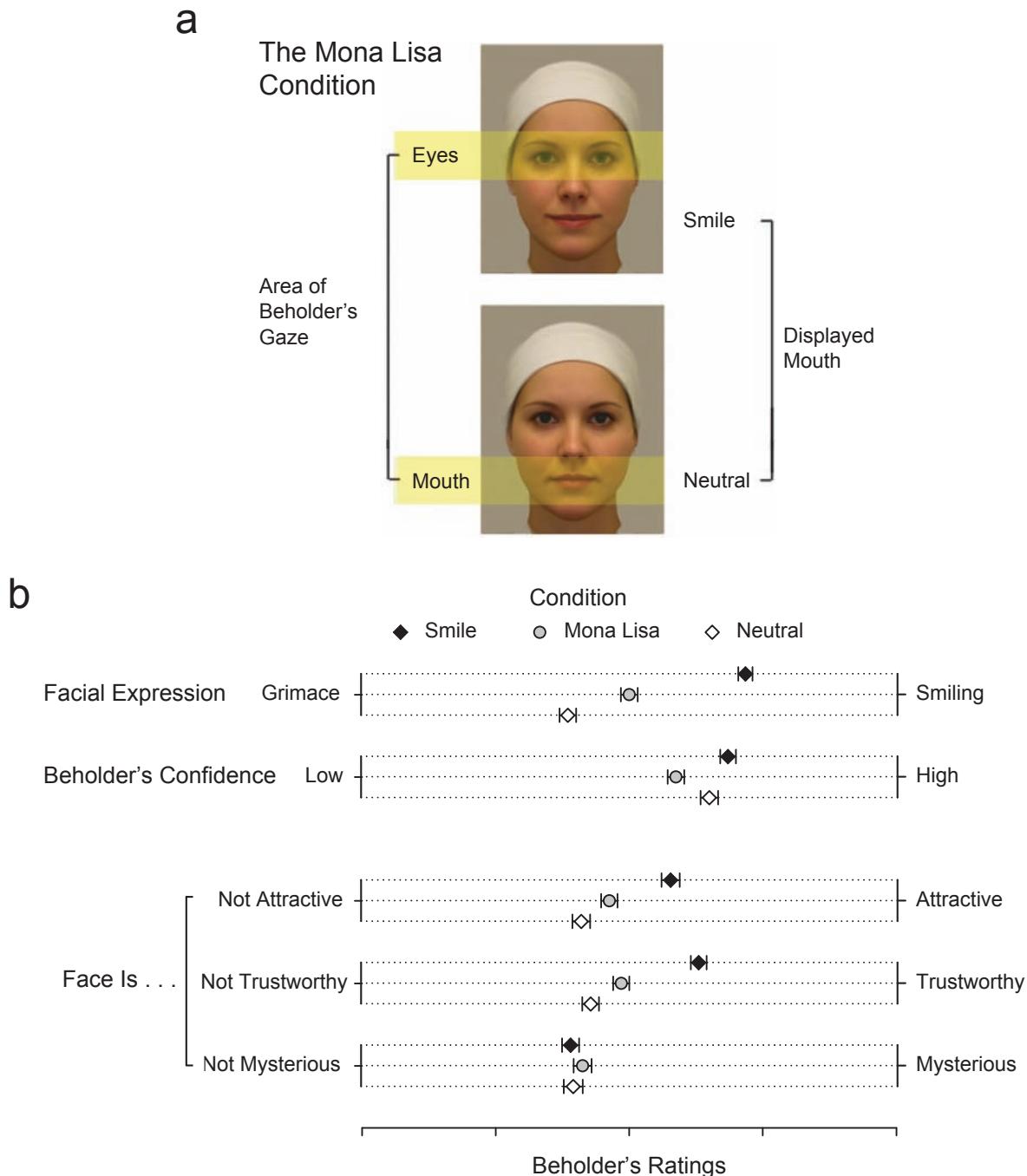E-mail: florian.hutzler@sbg.ac.at

Fig. 1. Illustration of a stimulus in the Mona Lisa condition (a) and participants' mean ratings (with standard errors) of faces in the Mona Lisa condition and the two control conditions (smiling and neutral; b). Gaze was directed to alternate between eyes and mouth. In the Mona Lisa condition, each face displayed a smiling mouth while the beholder gazed at the eyes and a neutral mouth while the beholder gazed at the mouth; the display changed during the saccade so that the change was subliminal. Participants rated each face's expression, attractiveness, trustworthiness, and mysteriousness, as well as their confidence in their judgment of the face's expression.

monitor was 37 cm, and gaze position of the left eye was monitored with a sampling rate of 250 Hz by a SensoMotoric Instruments (SMI, Berlin, Germany) high-speed tracking column. At the end of each trial, participants used 5-point Likert scales to rate the face's expression, attractiveness,

trustworthiness, and mysteriousness, as well as their confidence in their rating of the facial expression.

Care was taken to ascertain that the participants were not aware of the display changes: In a posttest interview, 23 of 42 participants reported that they had not seen a single display

change and insisted on this notion even when explicitly informed about the experimental manipulation. Participants who were aware of the display changes were excluded, and 7 of the remaining participants were excluded as well because they did not contribute a minimum of nine non-terminated trials per condition. The data of the remaining 16 participants (8 male, 8 female), who had a mean age of 23 years 4 months, were submitted for analysis.

Results and Discussion

The elusive smiles in the Mona Lisa condition, which vanished when looked at directly, did affect the appreciation of the faces, as indicated by Livingstone (2000). Although the smiling faces were (not surprisingly) rated most positively, the faces in the Mona Lisa condition were also evaluated as more attractive and trustworthy (and as having a more positive expression) than the neutral faces (see Fig. 1b, all ps < .005), even though in both the Mona Lisa and the neutral conditions participants saw neutral expressions when looking directly at the mouths. The elusive smiles in the Mona Lisa condition reduced participants' confidence in their expression ratings, relative to the other two conditions ($p < .05$), even though participants were not aware of the display changes. It is important to note that the faces in the Mona Lisa condition were not perceived as more mysterious than the faces in the other conditions, despite their elusive smiles (see Fig. 1b).

The present study adds weight to Ambadar, Schooler, and Cohn's (2005) finding that appreciation of a face can indeed be affected by subtle and fleeting expressions (e.g., *microexpressions*; Porter & ten Brinke, 2008) that do not require a direct gaze to be perceived.

In sum, although peripherally perceived facial expressions affect the appreciation of faces, Mona Lisa's smile seems to constitute only part of her enigma. She keeps her mystery, even when one catches her smile.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Note

1. This peculiarity of the portrait, demonstrated by Livingstone, can be investigated further by experimental manipulation of exposure duration (see Schyns & Oliva, 1994).

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