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CASE STUDY

Emotional experience and perception in the absence of facial feedback

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Abstract

The *facial feedback hypothesis* suggests that facial expressions are either necessary or sufficient to produce emotional experience. Researchers have noted that the ideal test of the necessity aspect of this hypothesis would be an evaluation of emotional experience in a patient suffering from a bilateral facial paralysis; however, this condition is rare and no such report has been documented. We examined the role of facial expressions in the determination of emotion by studying a patient (F.P.) suffering from a bilateral facial paralysis. Despite her inability to convey emotions through facial expressions, F.P. reported normal emotional experience. When F.P. viewed emotionally evocative slides her reactions were not dampened relative to the normative sample. F.P. retained her ability to detect, discriminate, and image emotional expressions. These findings are not consistent with theories stating that feedback from an active face is necessary to experience emotion, or to process emotional facial expressions.
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Keywords: Facial feedback, Emotion, Facial paralysis, Face perception

INTRODUCTION

The *facial feedback hypothesis* refers to the theory that the experience of emotion is derived from feedback from facial expressions. This idea has its roots in Darwin's (1872) contention that emotional processes are directly and intimately related to emotional expression such that emotions "hardly exist if the body remains passive" (p. 22). That facial expressions may determine emotion is also explicit in the emotion theory of William James (1890/1950), that "the bodily changes follow directly the perception of the exciting fact, and . . . our feelings of the same changes as they occur *is* the emotion" (p. 463). James believed that this process involved the entire body, however, and noted that to test the theory one would require an "absolutely anaesthetic" subject. Modern researchers emphasize the *face* as the major determinant of emotional experience.

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Tomkins (1962, 1963) suggested a feedback cycle in which a stimulus activates an innate, subcortical "affect program" which emits motor impulses to facial targets (and, secondarily, motor and circulatory signals to the rest of the body) which in turn produces muscle contractions and postural changes that are fed back to the brain. If this feedback reaches consciousness it is interpreted as emotion. In later work Tomkins (1980) suggested that it is the receptors in the facial skin and not the muscles themselves that are critical for sensing facial position and feeding the information back to the brain. Izard (1971, 1981) also postulated a feedback cycle in which information about the position of the facial musculature is critical. Izard argued that the perception of a stimulus activates central neural activity in the brain stem, limbic cortex, and hypothalamus. The hypothalamus then signals the muscles of the face, and finally feedback from facial muscles to the brainstem, hypothalamus, limbic system, thalamus, and possibly cortex determines the specific emotion that is felt.

The most common formulation of the facial feedback hypothesis states that facial expressions are "either necessary or sufficient to produce emotional experience" (Fridlund, 1994, p. 176). Fridlund noted that the best way to evaluate the "necessity" hypothesis would be an investigation of emotional experience in a person with full facial paralysis. To date, the only tests of this strong hypothesis are confined to anecdotal reports, such as those from patients with a *unilateral* facial paralysis (Bell's palsy) and individuals who experience sleep paralysis when they awaken before the muscle paralysis of REM sleep remits (Fridlund, 1994). Both conditions allow for some movement of the face (Kryger et al., 1989), and while they suggest that emotion may be experienced under conditions of facial paralysis, these reports cannot provide conclusive evidence. Therefore, in order to evaluate the role of facial feedback in the experience of emotion a number of researchers have pointed out that the study of a patient with bilateral facial paralysis would be ideal (Fridlund, 1994; Matsumoto & Lee, 1993; McIntosh, 1996).

A necessity hypothesis is by nature somewhat fragile, and it would take only one clear case of emotional experience in the absence of positional feedback from the facial musculature or skin to invalidate this version of the facial feedback hypothesis. That is, if the "necessity" aspect of the facial feedback hypothesis is correct, a person in whom there is an absence of efferent information indicating an emotional facial expression should not have *any* experience of emotion. In order to investigate the idea that facial feedback is essential to the experience of emotion we conducted a systematic evaluation of emotional processing and experience in a 21-year-old woman suffering from a bilateral facial palsy.

Feedback from the face has been regarded as critical to not only the experience of emotion, but also to the generation of visual images of emotional faces. Efference theories of imagery postulate that in order to build up a visual image, feedback from the motor system is essential (Cuthbert et al., 1991). Lang (1979) suggested that covert facial movements, that may be detected by EMG, are a key component in the process of emotional facial image generation. Jacobs et al. (1995) examined the relationship between the ability to image and perceive emotional faces and the ability to form voluntary emotional expressions in patients with Parkinson's disease. These patients experienced varying degrees of difficulty producing emotional facial expressions, and interestingly, there was a positive correlation between the degree of this deficit and the ability to both image and discriminate emotional faces. Thus, patients who had the most difficulty producing voluntary facial expressions also had difficulty forming images of facial expressions (but not of objects) and were impaired in the discrimination of emotional faces. If interpreted according to efference theories, this finding might imply that facial feedback plays an important role in the generation of an image of an emotional face, or even in the enhancement of a percept of a face such that it becomes rich enough to permit emotional discrimination.

Alternatively, Jacobs et al. (1995) theorized that because the area of dysfunction in Parkinson's disease is central and not peripheral, the source of the deficit might lie in a central processor that is responsible for emotional imagery, perception, and expression (either housed in the basal ganglia or dependent on neostriatal function). A clear-cut case of a peripheral deficit in emotional expression can differentiate between these two interpretations. If the deficits in face processing observed in Parkinson's disease are the result of reduced feedback from a face that is not very active, then similar or more pronounced deficits should be observed in a patient with facial paralysis from motor unit dysfunction. However, if the deficits in facial perception and imagery observed in Parkinson's patients result from damage to a central processor that has a role in the formation of facial expressions as well as in facial perception and imagery, then a patient with facial paralysis would be expected to perform normally on tests of facial imagery and facial emotional perception. Therefore, in addition to investigating emotional experience under conditions of facial paralysis, we assessed emotional perception and emotional facial imagery using the same neuropsychological tests as employed by Jacobs et al.

In summary, this case report is intended to address two efference theories regarding feedback from the face: The first is the hypothesis that feedback from facial expressions is *necessary* for emotional experience, and the second is that feedback from emotional facial expressions plays an important role in both imagery and perceptual processing of emotional faces. It should be noted that the level of evidence required to evaluate each of these theories is somewhat different. In order to challenge the necessity hypothesis we evaluated the emotional experience of a person who was unable to produce facial expressions, in an attempt to determine whether she had *any* experience of emotion. In order to evaluate the efference theory of imagery and to investigate the role of feedback in the perception of faces, we used tests of imagery and face processing to look for evidence of deficits. Such deficits would be at least as large as those seen in Parkinson's patients if feedback from emotional expressions underlies those impairments, and plays a critical role in the imagery and perception of emotional faces.

METHODS

Case History

The patient (F.P.) was a 21-year-old college student suffering from a bilateral facial palsy (paralysis of the seventh cranial nerve) as a result of a recent onset of Guillain-Barre Syndrome. Two weeks after an episode of gastroenteritis, F.P. had had a progressive onset of leg, arm and facial weakness over a period of three days. Facial palsy developed after she was admitted to the hospital, 7 days after symptom onset, and affected the right and then both sides of the face. Although lumbar puncture was normal, nerve conduction studies and electromyography were interpreted as consistent with the diagnosis. F.P. received intravenous gamma-globulin therapy and was discharged after 10 days.

At the time of testing, F.P.'s facial palsy rendered her unable to make any voluntary movements of any muscles of facial expression. The muscles in the lower half of her face were lax, and the palpebral fissures bilaterally widened. She was unable to initiate a blink or close her eyes, and attempts to do so, or to move the mouth, resulted in upward and inward diversion of the eyes (Bell phenomenon). A Bell phenomenon without eye closure also resulted on testing the corneal reflex bilaterally. Spasms, twitches or other abnormal movements of the face were not observed, nor were any abnormalities of secretory function. F.P. was evaluated 9 days after the onset of bilateral facial paralysis at which time she remained unable to contract her facial muscles and therefore there could be no feedback from muscles or skin to indicate a change in the posture of her face.

Materials and Procedures

Emotionally evocative slides

F.P.'s processing of emotional stimuli was assessed by having her evaluate 42 slides of emotionally evocative and neutral stimuli from the International Affective Picture System (IAPS; Lang et al., 1997). These standardized affective stimuli have been intensively investigated so that their arousal and valence-eliciting properties are known, and importantly, a strong relationship between subject's reports and physiologic measures of emotion has been established (Lang et al., 1993). Forty-two slides selected from the IAPS based on their valence and arousal ratings (13 pleasant, 14 unpleasant, and 15 neutral) and were presented in pseudo-random order. F.P. viewed the slides alone in a soundproof chamber. Each trial began with a "ready" signal that was followed 2 s later by a picture stimulus, presented as a slide. The picture to be rated was displayed for 6 s. At the offset of each slide F.P. quantified her emotional reaction on a 9-point scale by indicating according to a *self-assessment manikin* (SAM) the degree of arousal and valence of emotion that she experienced.

Florida affect battery

F.P.'s ability to detect and discriminate facial emotion and verbal prosody was assessed by using several subtests from the Florida Affect Battery (Bowers et al., 1991a). This instrument evaluates the processing of photographs of happy, angry, frightened, sad, and neutral faces, and has a test–retest reliability of .89 to .97 in a population of young adults. F.P. was videotaped as she completed six subtests that each comprised 20 items. Stimuli for all subtests were black-and-white photographs of female actors, however each subtest had a slightly different set of task demands. In the facial affect discrimination task (Subtest 2) F.P. was required to decide whether pairs of photographs of different actors depicted the same or different emotional expressions. For the facial affect naming task (Subtest 3) F.P. was required to verbally label the depicted emotions. In the facial affect selection task (Subtest 4) F.P. was required to select from five alternatives the emotion named by the examiner. For the facial affect matching task (Subtest 5) F.P. was required to match a target face to one of a set of five emotional faces based on the emotion depicted. In the match emotional prosody to an emotional face task (Subtest 9) F.P. was required to select an emotional face from a set of three to match affective tone of an audiotaped sentence read by a female actress. Finally, for the match emotional face to the emotional prosody task (Subtest 10) F.P. was shown a picture of an emotional face and required to choose the corresponding emotion from a set of three audiotaped sentences, each spoken in a different emotional tone.

Emotional facial imagery

In order to evaluate whether the ability to construct visual images of emotional faces is affected by an inability to move one's face, F.P. also completed a test of emotional facial imagery (Bowers et al., 1991b). For this test F.P. was required to imagine that she was looking at the face of someone displaying a particular emotion (happiness, sadness, anger, or fear) and asked to answer a series of eight yes-or-no questions about the physical characteristics of that expression (e.g., "Are the eyebrows drawn together?") for a total of 32 trials. F.P. also completed a test of object imagery developed by Eddy and Glass (1981) in which she was required to respond with single word or yes/no answers to a series of 22 object imagery questions (e.g., "What's higher off the ground, a horse's knee or the top of its tail?") This task was included as a control for overall imagery ability, and has been demonstrated to have equivalent difficulty to the emotional facial imagery task in a group of college students (Bowers et al., 1991a).

RESULTS

Subjective Report

When asked about her emotional experience, F.P. reported that she remained able to experience strong emotions despite her inability to move her face. Not only did F.P. report normal emotional experience, but she also expressed frustration with her new difficulty in communicating these feelings to others. In response to this frustration her friends made her a paper smile on a stick that she carried with her and could raise to indicate when she felt happy. Despite her inability to smile, F.P. clearly expressed her experience of humor through "laughter" by tilting her head back, displaying the Bell phenomenon, and producing a vocalization similar to laughter but without zygomatic contraction.

Emotionally Evocative Slides

Table 1 lists the IAPS slides rated by F.P. as well as the *z* score describing F.P.'s response relative to the population.

Table 1. F.P.'s performance on the international affective picture system slides

Item (IAPS #)	F.P. (*Z* valence)	F.P. (*Z* arousal)	Item (IAPS #)	F.P. (*Z* valence)	F.P. (*Z* arousal)
Desert (5900)	−0.47	−0.52	Diver (8280)	−0.21	0.43
Office (7700)	0.58	0.00	Rolling pin (7000)	−0.05	0.50
Man (2190)	−0.69	0.27	Couple (4660)	−0.16	0.35
Pit bull (1300)	−0.25	0.15	Gun in mouth (3530)	−0.68	0.79
Snake (1090)	−0.15	0.47	Mutilation (3000)	−0.26	−0.74
Sports car (8510)	−0.06	0.56	Truck (7130)	−0.80	−0.67
Rafting (8370)	0.15	0.45	Boy (2650)	0.23	0.71
Outlet (6150)	−0.83	0.59	KKK rally (9810)	0.04	−0.23
Starving child (9040)	−0.52	0.78	Body (3130)	−0.38	0.31
Light bulb (7170)	−0.22	0.33	Nudes (4680)	0.57	0.85
Burn victim (3100)	−0.36	0.98	Angry adult (2120)	−0.59	0.61
Babies (2080)	0.45	1.16	Ski jump (8030)	−0.19	−0.20
Astronaut (5470)	0.47	0.68	Book (7090)	−0.33	0.04
Adult (2220)	0.08	0.09	Building (7500)	−0.15	−0.04
Pizza roaches (7380)	−0.25	0.78	Iron (7030)	0.40	0.38
Water skier (8200)	−1.66	0.32	Male nude (4500)	−0.43	−0.44
Masked man (6370)	−0.15	1.02	Mutilation (3010)	−0.35	0.25
Basket (7010)	0.17	2.60*	Sailing (8080)	0.19	0.32
Aimed gun (6230)	0.59	0.22	Office (7550)	0.55	0.84
Mushroom (5500)	−0.23	−0.52	Plane crash (9050)	−0.68	0.19
Ice cream (7330)	0.03	0.18	Clock (7190)	−0.46	0.09

*$p < .05$.

F.P.'s emotionality ratings of the 42 IAPS slides did not differ from those of the normative sample of college-aged females, nor did 41/42 of her ratings for arousal. In fact, the one rating that reached the $p \leq .05$ level of significance for arousal was in the direction of a higher level of arousal than expected.

Florida Affect Battery

FP's perception of facial and prosodic affect was nearly flawless according to the Florida Affect Battery, and met or exceeded the normative scores for similar aged individuals on this test. She had no difficulty naming, discriminating, or matching facial affect, and her comprehension of emotional prosody was similarly intact. F.P.'s scores for the FAB subtests are presented in Table 2, along with the range of normal scores established by calculating a 95% confidence interval around the means of the normative sample.

Emotional Facial Imagery

F.P.'s ability to image emotional faces remained excellent despite her inability to move her own face, and was similar to her ability to image objects. Table 2 includes F.P.'s scores (percent correct) along with the range of normal scores calculated by establishing a 95% confidence interval around the means of 12 controls matched for age and sex.

DISCUSSION

These indications of normal emotional experience in a patient suffering from a bilateral facial palsy are not consistent with the hypothesis that feedback from emotional facial expressions is *necessary* for emotional experience. Feedback from emotional facial expressions may also not be *sufficient* to produce emotions, as is suggested by studies of patients with pseudobulbar palsy who express emotions they are not feeling (Poeck 1969; Sackheim et al., 1982). However, it is possible that the lesions present in pseudobulbar

Table 2. Florida Affect Battery, Emotional Facial Imagery, and Object Imagery Tests

Test	F.P.	Normal range (95% C.I.)
Florida Affect Battery		
Subtest 2	100	90.4–94.4
Subtest 3	95	93.1–96.3
Subtest 4	100	98.4–98.6
Subtest 5	100	95.1–98.3
Subtest 9	100	97.1–99.3
Subtest 10	100	98.9–99.8
Emotional Facial Imagery Test	96.9	81.23–93.72
Object Imagery Test	100	85.97–91.57

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palsy also interrupt sensory feedback to the brain. A number of paradigms that induce normals to contract the muscles used to form emotional facial expressions (e.g., by having them hold objects in their teeth or lips, or pronounce certain vowel sounds) also provide evidence that facial expressions are not sufficient to produce emotions, although there is some suggestion that facial expressions may influence the degree of emotion that is experienced (Strack et al., 1988). Indeed, Laird and his collaborators have argued that while everyone's emotional experience is influenced by situational cues, individuals differ widely in the extent to which they rely on self-produced cues (e.g. feedback from their facial expressions, posture, arousal, etc.; Laird & Bresler, 1992). F.P.'s normal ratings of emotionally evocative stimuli and normal emotional experience suggest that feedback from facial expressions might not play a large role in the modulation of emotional experience. Such an interpretation must be treated cautiously, however, because despite the relationship between IAPS stimuli and physiological measures (Lang et al., 1993), it is possible that there may be large contribution of emotional semantic knowledge to the task. A demonstration of emotion-specific physiologic activity would be required to exclude that possibility. Furthermore, it may be that feedback of the facial nerve stimulation that occurs entirely within the CNS plays a role in the experience of emotion via a central feedback loop involving the hypothalamus or brainstem (Heilman, 1994). Thus, it is possible that the motor commands for facial expression do not have to be carried to the face but instead it is feedback from the activation of facial motor programs, within the brain, that is important for the experience of emotion.

Similarly, F.P.'s excellent ability to image, detect and discriminate emotional facial expressions demonstrates that efferent information from the facial musculature does not play a critical role in the generation of images of emotional faces nor in the construction of percepts that permit emotional discrimination.[1] It is important to note that this finding does not exclude the possibility that there is a nonessential role played by facial feedback in the processing of such images; it may be that more sensitive tests for emotions that are difficult to identify would have revealed subtle deficits. It also remains possible that motor or premotor areas involved in initiating facial expression play an important role in the generation or of images of emotional faces or the processing of such faces. Cortical–cortical connections between these areas and sensory association areas may allow for imagery independent of peripheral nervous system activation.

Converging evidence from a number of different paradigms suggests that emotional processing is accomplished though a network of modules that influence one another through extensive and reciprocal connectivity (Heilman, 1994). It remains to be determined whether humans innately posses a complex repertoire of facial expressions that need never be produced externally to influence emotional experience. It may be that the loss of facial feedback would disrupt normal development of emotional experience and imagery, even if facial feedback is not necessary for maintenance of these functions in the normal adult. Follow-up studies of children with congenital facial paralysis, and longitudinal assessment of emotional processing in patients with permanent facial paralysis, would help determine whether facial feedback plays a role in the development or maintenance of emotional experience and imagery.

[1]These results also suggest, therefore, that the deficits in emotional facial imagery and perception in Parkinson's disease that were reported by Jacobs et al. are most likely due to damage to a central processor or system involved in generating emotional faces rather than to a reduced efference from the "masked faces" of Parkinson's disease.

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