Sociality of Solitary Smiling: Potentiation by an Implicit Audience

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Ss viewed a pleasant videotape either: (a) alone, (b) alone but with the belief that a friend nearby was otherwise engaged, (c) alone but with the belief that a friend was viewing the same videotape in another room, or (d) when a friend was present. S's smiling, as estimated by facial electromyography, varied monotonically with the sociality of viewing but not with reported emotion. The findings confirm audience effects for human smiles, demonstrate that the effects do not depend upon the presence of the interactant, and indicate that the smiles are better predicted by social context than by emotion. Both naive and expert independent raters given descriptions of the study made predictions that conformed to previous emotion-based accounts of faces but departed from the findings. The results suggest that some solitary faces may be implicitly social, a view consistent with both contemporary ethology, and role and impression-management theories of behavior.

People make faces when they are alone. This curious fact may have been crucial in shaping the most popular contemporary theories of facial expression. These generally hold that whereas some faces reflect social convention, others are quasi-reflexive released displays of felt emotion (Buck, 1984; Darwin, 1872; Ekman, 1972, 1973, 1977, 1984; Ekman & Friesen, 1969, 1975, 1982; Frijda, 1986; Izard & Malatesta, 1987; Lorenz, 1970, 1973; Plutchik, 1981; Tinbergen, 1952; Tomkins, 1962, 1963; Vaughan & Lanzetta, 1980). Solitary faces are usually considered the "purest" expressions of emotion, because in solitude one should be minimally constrained by social demands (Buck, 1984; Ekman, 1984; Ekman, Davidson, & Friesen, 1990).

There is, however, another interpretation of solitary faces that would propose a role for implicit sociality. When we are alone, we often imagine social interactants. We see our partner's smiling face in our "mind's eye," and we find ourselves affiliatively returning the smile. We remember disciplining a child, and we find ourselves making a scowl. If many of the faces we make in solitude actually reflect imaginary interaction, then these private faces might be as conventional as our public ones.[1]

That sociality could mediate both public and private faces would be compatible with more traditional role and impression-management theories of behavior, which hold that expressions are a means "to control images that are projected in real or imagined social interactions" (Schlenker, 1980, p. 6; see also Baldwin & Holmes, 1987; Greenwald & Breckler, 1985; Schlenker, 1985; Schlenker & Weigold, 1989; Snyder, 1979). Thus, smiling and scowling are faces conventionally made in affiliation and discipline; they should be seen whether the interaction takes place in the world or "in our heads." Social mediation would also dovetail with contemporary ethology, which now emphasizes types of social interaction more than reflex-like emotions in accounting for both nonhuman displays and human facial expressions (Cheney, Seyfarth, & Smuts, 1986; Hinde, 1985a, 1985b; Krebs & Dawkins, 1984; Marler & Mitani,

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[1] Fridlund (in press) outlined five examples of ways in which we may be imaginally or implicitly social although actually alone: (a) when we treat ourselves as social interactants (e.g., talking to ourselves, hitting ourselves, or patting ourselves on the back), (b) acting as though others are present when they are not (e.g., speaking to someone who has in fact left the room), (c) imagining that others are present when they are not (e.g., recalling a pleasant moment with a lost love), (d) forecasting interactions with others who are not immediately present (e.g., smiling just before entering the office in the morning), (e) anthropomorphizing nonhuman animals, or animate or inanimate objects, as interactants (e.g., talking to pets, dolls, stuffed animals, houseplants, or errant golf balls).

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1988; Provine & Fischer, 1989; Smith, 1977; see also Fridlund, in press, for review of studies).

Positing that implicit interaction mediates solitary faces first requires evidence that in vivo interaction mediates public faces. We know intuitively that the faces we make depend greatly on those around us. Several experimental demonstrations of such *direct audience effects* show that sociality, especially eye contact, mediates the faces people make when they are (a) scoring strikes in bowling, watching hockey games, and discussing the weather (Kraut & Johnston, 1979), (b) being interviewed during film viewing (Friesen, 1972), (c) tasting and smelling (Brightman, Segal, Werther, & Steiner, 1977; Gilbert, Fridlund, & Sabini, 1987; Kraut, 1982), (d) in pain (Kleck et al., 1976), (e) watching another in pain (Bavelas, Black, Lemery, & Mullett, 1986), (f) being exposed to humorous material (Bainum, Lounsbury, & Pollio, 1984; Chapman, 1973, 1975; Chapman & Wright, 1976; Freedman & Perlick, 1979), and (g) have reached as little as 10–18 months of age (Jones & Raag, 1989).

Although direct audience effects on faces are well documented, I know of no published research on *implicit audience effects* on faces—that is, instances in which we find ourselves making faces when our interactants are elsewhere or are simply the products of our imagination (but see Fridlund et al., 1990, for an indirect test using affective imagery). Experimentally determining these implicit audience effects would itself be important for understanding the role of sociality in solitary faces.[2]

I thus sought to explore both explicit and implicit audience effects on faces. I wished to study smiles specifically, because they are measured so economically—by means of the actions of one muscle, the *zygomatic major*, which runs from the lip corner to the top and front of the ear (Fridlund & Cacioppo, 1986).

In four conditions differing in sociality, subjects viewed a pleasant videotape specifically intended to elicit smiles. Some viewed the videotape with a friend; others viewed entirely alone. The remaining subjects viewed alone, but the situation was implicitly social: They believed that a friend in another room was either viewing the same videotape or performing an irrelevant task. These conditions could allow determining whether facial behavior was affected by viewing with a friend (a direct audience effect), as well as by simply believing that a friend was nearby (an implicit audience effect). By contrasting the two implicit-sociality conditions (i.e., those in which subjects believed that friends were either coviewing or otherwise engaged), it could be ascertained whether any implicit audience effects were influenced by the activities of the imagined friend.

Finally, by measuring emotional self-report, an estimate could be obtained of the extent to which any effects of direct or implicit sociality were mediated through the differential induction of felt emotion. It seemed that if emotion had a major role in solitary faces (i.e., happier people should smile more; cf. Cacioppo, Petty, Losch, & Kim, 1986; Ekman, Friesen, & Ancoli, 1980; Ekman et al., 1990), then in the three videotape conditions in which viewers sat alone, felt happiness would parallel smiling both within and across these conditions. Any group differences in smiling would result from effects on happiness due to assignment to the conditions (i.e., arriving to the experiment alone vs. being separated from the friend, etc.).

In the frankly social, actual coviewing condition, social demands might produce enhancement of total smiling, and as a consequence of such dissimulation, this smiling would show the poorest correlation with felt happiness (cf. Buck, 1984; Ekman, 1972, 1977, 1984; Friesen, 1972); alternatively, concern or apprehensiveness among some subjects about being emotional in the presence of another might result in reduced smiling. This was assessed by asking for self-reports of dysphoria as well as happiness and by measuring not only subjects' smiling but also their brow knitting (contractions of the *corrugator supercilii* muscle, which typically indicate concentration or disturbance).

If implicit sociality mediated even the smiling issued in solitude, then given the existing evidence that direct audience effects on smiles are potentiating (studies cited earlier), smiling should thus increase with the sociality of viewing, implicit or explicit. Specifically, smiling should show increments over the four experimental conditions: (a) viewing with no implicit friend, (b) viewing alone but with the belief that a friend was otherwise occupied, (c) viewing alone but with the belief that a friend was simultaneously viewing elsewhere, and (d) viewing with the friend physically present.

Subjects' facial behavior was measured with surface facial electromyographic (EMG) signals, using recording sites directly over the facial muscles responsible for smiling. The facial EMG method samples the electrical discharges created by contracting muscle tissue. Consequently, it provides a sensitive and precise measure of muscular contraction and enables reliable quantification of facial actions (see Fridlund & Cacioppo, 1986, for methods and standards).

Finally, I sought to discover what findings would be predicted from common intuitions and by experts on the face and emotion. I thus conducted a second, *Gedanken* (thought) experiment. The videotape study was described to naive and expert raters, who then predicted the subjects' smiling and felt emotion. The actual viewer data are reported first, followed by the *Gedanken* experiment results.

Experiment 1: Test of Direct and Implicit Audience Effects

Method

Subjects

Sixty-four undergraduate volunteers, 32 men and 32 women, provided their informed consent to participate for course credit in a study advertised as measuring "unconscious physiological activity while

[2] One study (Chapman, 1974) examined *frontalis* (forehead) region EMG signals in subjects exposed to a direct audience, a concealed audience, and alone. In all conditions, subjects were hooked to electrodes while they read a dramatic passage in fully prone position. I share concerns expressed by previous authors (see Moore & Baron, 1983) that (a) this unconventional manipulation may have embarrassed subjects and (b) the EMG signals may have measured ocular muscle tension associated with differential compliance with instructions to keep the eyes open (or, indeed, anxiety; see Fridlund, Cottam, & Fowler, 1982; Fridlund, Hatfield, Cottam, & Fowler, 1986). Implicit audiences have been used frequently in the social impact literature (e.g., Latané, 1981), but these studies have assessed variables such as group task performance, not facial behavior.

watching videotapes." Forty-eight of the 64 volunteers were asked to bring same-sex friends to the experimental session; 16 were asked to arrive alone.

Experimental Conditions

Participants were divided evenly among four experimental conditions that involved presentation of a pleasant videotape and measurement of both smiling and emotional experience. The conditions, detailed next, varied the social context of videotape viewing. Eight men and 8 women participated in each condition. The 16 subjects recruited alone were assigned to the solitary participation condition, and the 48 who arrived with same-sex friends were assigned to one of the three remaining conditions. Subjects were recruited alone in the first condition to minimize the sociality of videotape viewing.

Condition 1: solitary participation. The participant arrived for the experiment and viewed the videotape alone.

Condition 2: implicit irrelevant task. Participants were informed that the television room had monitoring equipment for only one viewer and that whoever did not view the tape would be asked to assist in a second study "down the hall" involving completion of "psychological tests of coping styles." A coin toss determined who remained to view the videotape. In actuality, whoever drew the coping styles test was merely escorted from the laboratory, debriefed immediately, and allowed to return to the soundproofed laboratory control room to watch the progress of the experiment. The deception was left intact for the actual viewer until the end of the experiment.

Condition 3: implicit coviewing. Participants were informed that both would view the videotape but because the viewing room had monitoring equipment for only one viewer, the other would watch down the hall in an identical viewing room. Both participants were informed that they would watch the same videotape, just on different television screens. A coin toss determined whether subject or friend stayed to view the videotape. The same procedure used in the previous condition was followed for those chosen to view the videotape "down the hall," and as before, the deception remained intact for the actual viewer until the end of the experiment.

Condition 4: explicit coviewing. Participants were seated next to each other facing a video monitor and viewed the videotape together. They were instructed to refrain from talking and to look at the television monitor but not at each other. Only one of the coviewers was selected for facial EMG monitoring; selection was performed by means of a coin toss.

All 64 participants (either individuals or pairs) were recruited and assigned to conditions on a rotating basis. Subjects were tested over a 4-month period, during all times of the day and days of the week; thus the rotation of group assignment provided de facto counterbalancing of these factors. For purposes of clarity, the participant selected for EMG monitoring is henceforth denoted the subject, and the participant who was either escorted from the lab (Conditions 2 and 3) or coviewed the videotape (Condition 4) is denoted the friend.

Recording Procedure

Depending on the experimental condition, the subjects (and in Condition 4, the friends as well) were seated in a soundproofed room 2.5 m from a 13-in. color television monitor. Surface EMG electrodes were then affixed on the subject's face over three major mimetic muscles (Fridlund & Izard, 1983; Schwartz, Fair, Salt, Mandel, & Klerman, 1976). In the explicit coviewing condition, in which participants sat beside each other, EMG monitoring was performed only on one (again, the subject), with selection determined by a coin toss.

To detect smiling, differential integrated EMG recordings were obtained from left and right cheek sites directly over the *zygomatic major* muscles, which retract the lips corners to form the smile (Ekman & Friesen, 1978; Fridlund, Ekman, & Oster, 1987; Izard, 1979). The facial EMG technique does not sample muscular behavior strictly confined to the single muscle underlying the electrodes (e.g., the *zygomatic major*). The detection region is diffuse and susceptible to the actions of adjacent muscles (Fridlund & Fowler, 1978). However, the cheek site is very sensitive to *zygomatic major* contractions (Tassinary, Cacioppo, & Geen, 1989), and this experiment used a specific stimulus unlikely to induce appreciable facial behavior other than smiling (cf. Ekman et al., 1980). These factors lend credence to the inference that the bilateral *zygomatic major* site EMG activity in this study probably did substantially reflect subjects' smiling (also see footnote 5).

EMG activity was also obtained from a site overlying the left *corrugator supercilii,* which furrows the brow when one concentrates, signals disturbance, and so on (Darwin, 1872; Ekman, 1979; Fridlund, in press). Activity from the *corrugator supercilii* site was used to assess whether subjects' viewing condition made them differentially attentive or dysphoric. Because its contractions are unrelated, or sometimes reciprocal to smiles, activity from this site could also control for the possibility that *zygomatic major* site EMG signals might reflect the viewer's muscular activity generally and not smiles specifically. Posed faces obtained using pilot subjects indicated negligible electrical cross talk between cheek and brow EMG sites that would otherwise obviate the use of the *corrugator supercilii* site as a control.

Three steps were taken to minimize both participants' self-consciousness about the electrodes and their tendency to make faces consistent with their expectations about the experiment. First, dummy electrodes were affixed atop the head and to the dorsum of the hand. Viewers were informed that face and head electrodes detected "brain wave activity, especially from the frontal part of the brain," whereas the hand electrode detected "heart rate and sweat gland responses." Second, the rationale provided during recruitment was repeated—that is, viewers were instructed that these responses were purely physiological, unconscious, not amenable to voluntary control, and thus it "really didn't matter" what they consciously thought or how they behaved during the experiment.

A third technique assessed experimental demand by certifying the intactness of the cover story. At the conclusion of the experiment, viewers completed "guess sheets" that challenged them to state the experimental hypotheses. No subject in either implicit condition guessed that his or her friend's participation was illusory, and nearly all subjects appeared surprised when informed of the deception and greeted by their friends at the end of the experiment. No one guessed that the sociality of viewing was being investigated. Five of the 64 subjects (2 who viewed with friends, and 1 in each of the remaining three viewing conditions) mentioned "smiling," "laughing," or "movements" among their guesses about the purpose of the experiment. Their data were unremarkable and thus were retained for analysis.

Videotape Stimulus

After connection of the recording electrodes, viewers were asked to relax for 60 s to provide a prestimulus baseline. They then watched a videotape that ran 13 min, 15 s in length and contained five segments intended to elicit smiles across a range of undergraduate subjects. The segments and their respective lengths were as follows: (a) cute babies playing with rattles (1 min, 50 s), (b) a dog playing in the yard with a flower (45 s), (c) cute babies playing peek-a-boo (3 min, 20 s), (d) sea otters playing in an aquarium (35 s), and (e) the Steve Martin "Common Knowledge" skit (a spoof of the game show "Jeopardy") from "Saturday Night Live" (6 min, 45 s).

Emotion Ratings

Immediately before the videotape, viewers completed a modified version of the Differential Emotions Scale (DES; Izard, 1972), a measure of self-reported emotion used in previous affective imagery studies (e.g., Schwartz et al., 1976; Fridlund, Schwartz, & Fowler, 1984). The scale requested self-report of emotional state along 10 hedonic dimensions. At the conclusion of the videotape, viewers reported their experience during the videotape by again completing the modified DES.[3]

The two scales were labeled Ratings Sheet 1 and Ratings Sheet 2. Each form asked subjects to indicate with an X on unanchored 0–100 scales the extent to which they felt each of the following 12 states: hunger, thirst, anger, fatigue, fear, surprise, happiness, disgust, contempt, interest, curiosity, and sadness. Lines were 100 mm long, were calibrated in millimeters from 0 to 100, and were numbered at each centimeter. The ratings sheets were headed by the instructions, "Please make an X on each line to show how strongly you" (a) "feel each of the following RIGHT NOW" (Ratings Sheet 1) and (b) "felt each of the following DURING THE VIDEOTAPE" (Ratings Sheet 2). The two forms were otherwise identical.

Results

EMG Data

To analyze viewers' cheek- and brow-site EMG activity, arithmetic means were computed for each site; these are reliable measures of overall muscle contraction (cf. Cacioppo, Tassinary, & Fridlund, 1990). In accordance with standard statistical practice (Hildebrand, 1986) and consistent with previous studies (e.g., Fridlund, Cottam, & Fowler, 1982; Fridlund et al., 1984; Fridlund, Hatfield, Cottam, & Fowler, 1986), means were log transformed [$\log_{10}$ (EMG + 1)] to minimize skewness and heteroscedasticity. Skewness was determined by direct moment computation; heteroscedasticity was determined by correlating means with variances across the four viewing conditions.

Because of their correlated actions, and because the theoretical import of left–right imbalances in facial EMG signals is unclear (Fridlund, 1988), left and right cheek sites were considered paired dependent measures under multivariate analysis of variance (MANOVA); the resulting Wilks's lambda statistics were referred to the F distribution. The brow site (overlying the left *corrugator supercilii*) was analyzed using separate, univariate analysis of variance (ANOVA). In accordance with the experimental hypotheses and based on previous studies of audience effects on smiles, tests of cheek-site EMG activity among viewing conditions were one-tailed except as noted. Tests of self-report were two-tailed.

I first validated the videotape's efficacy in eliciting cheek-site EMG activity over baseline levels. As Figure 1A indicates, EMG activity in the cheek (*zygomatic major* region) sites showed marked increments over baseline, $F(2, 60) = 55.66$, $p < 10^{-6}$, with increments occurring in all conditions, all $Fs(2, 14) > 6.59$, $p < .005$. The videotape thus worked as intended. The increments were not due to carryover from unequal prevideotape baselines; baseline levels of left and right cheek-site EMG activity did not differ among viewing conditions, $F(6, 118) = .626$, $p > .70$, or between the participate alone and the three remaining conditions, $F(2, 59) = .817$, $p < .45$. This equivalence also allays concerns that the responses of those participating alone versus with friends were influenced by subject selection or assignment to viewing condition. There were no sex differences in cheek-site EMG levels either across conditions, $F(2, 55) = 1.63$, $p < .21$, or as a function of condition, $F(6, 110) = 1.59$, $p < .17$. All EMG data were therefore collapsed across men and women.

Figure 1A shows the EMG activity for the four viewing conditions in the left and right cheek sites and the brow (*corrugator supercilii* region) control site. Among subjects who participated alone or who believed that their friends were completing tests, the cheek-site EMG levels suggested weak but visible smiling (see Fridlund et al., 1984). Among subjects who coviewed with a friend or who believed that their friend was coviewing elsewhere, these EMG levels are consistent with moderate to strong smiling. The low brow-site EMG amplitudes suggest brow knitting at or below the threshold of visibility.

Discovering any direct or implicit audience effects required testing whether the social context of viewing influenced cheek-site EMG activity. Audience effects were confirmed. Not only did cheek-site EMG levels vary with viewing condition (Figure 1A), $F(6, 118) = 2.22$, $p < .046$, two-tailed, but a test for linear trend over the four viewing conditions was also significant (polynomial weights $-3, -1, 1, 3$), $F(2, 59) = 5.72$, $p < .003$, quadratic and cubic components, *ns*. Among just those subjects who viewed the tape alone (i.e., those in the participate alone and the two implicit conditions), a test for linear trend was significant (polynomial weights $-1, 0, 1$), $F(2, 44) = 4.25$, $p < .02$, quadratic component, *ns*. Because the four viewing conditions may not represent equal increments in sociality, the linear trends are more properly considered tests of monotonicity. Thus, cheek-

[3] There are potential objections to the use of one global rating to assess happiness during the videotape. One objection is that global ratings may be insensitive to subjects' reactions to different portions of the videotape. I chose global ratings rather than periodic or episodic samples throughout the videotape because it seemed that sequential ratings would place subjects in a judgmental, vigilant set that would curtail further subjects' spontaneity.

An additional objection is that subjects may have showed higher cheek-site electromyography levels because they found the videotape amusing, even though it made them feel no happier. Such hermeneutical variations on happiness were omitted in this study because I presumed that subjects who found the tape funny would alter their happiness ratings accordingly when this dimension was the closest by forced choice. The presumption was confirmed in piloting for a related experiment. Amusement and contentment categories were added to rating sheets for 12 pilot subjects shown the same videotape. The subjects who reported being more amused also rated themselves happier ($r = .87$, $p = .0018$) as well as more content ($r = .79$, $p = .002$). Thus subjects' happiness ratings quite likely captured their amusement.

Despite these standard objections, previous studies of faces made during imagery or videotape viewing have usually found that global happiness ratings correlated with smiling. Regrettably, nearly all such studies used social stimuli (imaginary or viewed on film or videotape) as elicitors of emotion, and it may be questioned whether any correlations would be sustained if differences in sociality were controlled. Corroborating this speculation was a widely cited study of solitary subjects exposed to three videotape segments: a monkey playing, an ocean scene, and the dog-playing-with-flower segment used in this study (Ancoli, 1979). The three segments produced equivalent happiness ratings. However, subjects smiled substantially to the social stimuli (monkey and dog play behavior) but negligibly to the canonically asocial ocean stimulus. The smiling and happiness data for the ocean stimulus were omitted from the final report (Ekman, Friesen, & Ancoli, 1980).

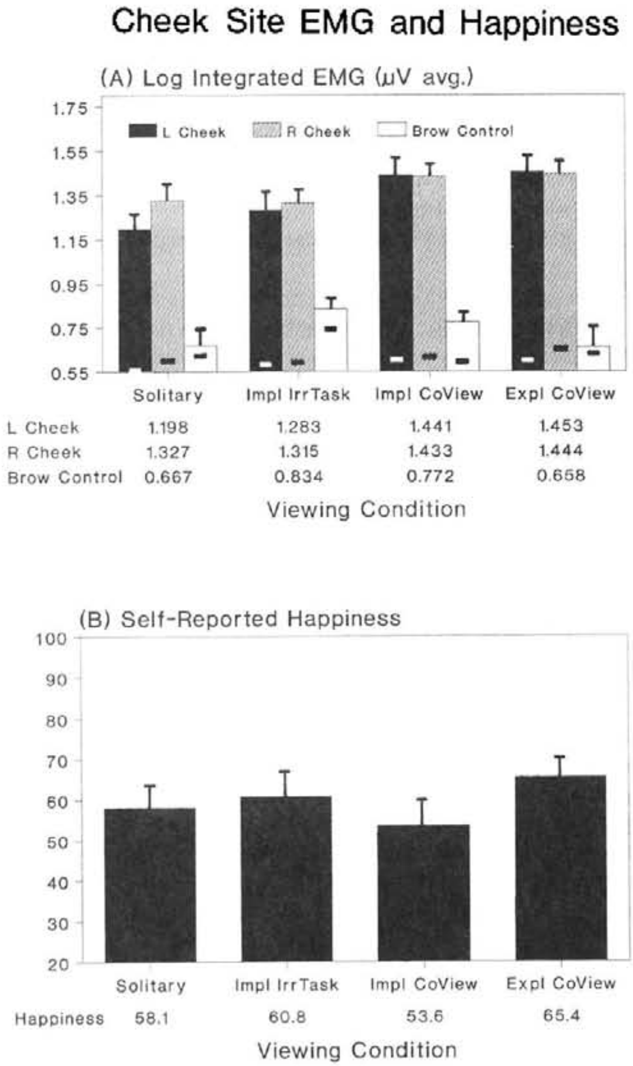

Figure 1. (A) Cheek-site electromyography (EMG) activity [$\log_{10}(X + 1.0)$] over the left (L) and right (R) *zygomatic major* muscles responsible for smiling (left and middle bars, respectively), with left *corrugator supercilii* (brow) control site (right bar), as a function of videotape viewing condition. Contrasting inset bars for cheek sites denote previdеotape levels; brow-site levels during viewing did not change appreciably from previdеotape levels. (B) Reports of happiness as a function of videotape viewing condition. Solitary = solitary participation; Impl Irr Task = implicit irrelevant task; Impl CoView = implicit coviewing; Expl CoView = explicit coviewing. Error bars depict standard errors of the mean.

site EMG activity varied monotonically with the sociality of viewing.

These EMG-level differences signify cheek-site activity specifically and not just general changes in facial muscular tension, as shown by the poor relationship between EMG activity in the left brow control site with viewing condition (see Figure 1A), $F(3, 60) = 1.93$, $p < .15$, two-tailed. Nor did brow-site EMG levels show a monotonic trend over viewing conditions like that exhibited by the cheek sites (polynomial weights $-3, -1, 1, 3$), $F(1, 60) = .10$, $p < .39$, one-tailed. Multivariate analysis of covariance (MANCOVA) was then used to remove the control-site amplitudes from the test of cheek-site EMG over viewing conditions. The differences resulting from this statistical control were negligible (MANCOVA on cheek-site EMG levels over conditions, $F(6, 118) = 2.22$, $p < .047$, two-tailed. The control-site tests also suggest that cheek-site EMG differences were not due to viewers' differential concentration on, or negative reactions to, the videotape. They further suggest that subjects with friends physically present did not inhibit smiling because they were embarrassed or otherwise disturbed by the measurement apparatus.

Given the overall effect for sociality of viewing on cheek-site EMG activity, multivariate contrasts allowed comparisons among individual conditions. Direct audience effects were confirmed: Subjects who viewed with friends physically present exhibited higher cheek-site levels than those who participated alone, $F(2, 59) = 4.65$, $p < .007$. The physical presence of the friend was not necessary to potentiate cheek-site activity. EMG levels in subjects with friends physically present did not differ from that seen when subjects simply believed that friends were simultaneously viewing elsewhere, $F(6, 118) = 0.012$, $p < .50$. Implicit audience effects were also confirmed: Subjects who believed that their friends were coviewers exhibited much higher cheek-site EMG levels than those who participated alone, $F(2, 59) = 4.32$, $p < .01$. This comparison was especially interesting given that subjects were physically alone in both conditions.

I next wanted to ascertain whether the activity purportedly engaged in by friends in the implicit conditions (either taking tests or coviewing) affected subjects' EMG activity. Subjects who believed that their friend was viewing elsewhere tended to show more cheek-site activity than those who believed their friend was completing tests, $F(2, 59) = 1.53$, $p < .13$. Finally, subjects who believed that their friend was completing tests tended to show higher cheek-site EMG levels than subjects who participated alone, $F(2, 59) = 1.50$, $p < .13$. Although they are consistent with predictions that are based on a role for implicit sociality, I am nonetheless cautious about these marginal effects.

Emotion Ratings

After finding that subjects' cheek-site EMG activity varied monotonically with the sociality of viewing, it was important to ascertain the relative contribution of subjects' reported emotional state during the videotape. Their cheek-site EMG activity was thus analyzed as a function of their happiness ratings. Because the ratings showed distributions that approximated normality, no transformation was required.[4]

[4] Analyses of self-report data by sex showed initial differences on overall ratings, $F(11, 46) = 2.65$, $p = .009$, that did not interact with viewing condition, $F(36, 133) = 1.20$, $p = .23$. This effect was chiefly due to women's greater initial curiosity, $F(1, 56) = 4.75$, $p = .034$, but lower surprise, $F(1, 56) = 6.43$, $p = .014$. I cannot explain this odd result. Following videotape presentation, the sex differences in happiness ratings disappeared, $F(1, 56) = 1.56$, $p = .22$, as did those on the remaining 11 dimensions, $F(12, 45) = 1.69$, $p = .11$. This latter marginal effect was due largely to men's greater hunger by the end of the experiment (the difference in hunger did not interact with condition). Self-report data were thus collapsed across men and women.

I first assessed whether subjects' happiness ratings differed with viewing condition. These ratings are depicted in Figure 1B. To the extent that happiness determined cheek-site EMG levels, happiness differences should parallel the EMG differences, at least among subjects who viewed alone (i.e., the participate alone and the two implicit conditions). This was not found. When subjects' happiness ratings for videotape viewing were analyzed, using a univariate ANOVA, there were no differences among viewing conditions, $F(3, 56) = 0.65$, $p > .58$. Self-report differences before videotape viewing could potentially have carried over and obscured differences during viewing, but previdеotape happiness ratings did not differ among viewing conditions, $F(3, 56) = 1.33$, $p < .28$, or on the 11 remaining self-report dimensions, $F(33, 136) = 1.14$, $p < .31$. Nor did previdеotape ratings of subjects who participated alone (Condition 1) differ from those who arrived with a friend (Conditions 2–4), either on happiness, $F(1, 60) = .01$, $p > .93$, or on the remaining 11 dimensions, $F(11, 50) = 1.33$, $p < .24$. Like the previdеotape EMG levels, the equivalence in previdеotape ratings counters concerns that responses of those who participated alone versus with friends reflected artifacts of initial subject selection. Taken together, these self-report findings suggest that viewing condition did not affect cheek-site EMG levels through the differential experience of happiness during the videotape.

Having ruled out differences in felt happiness during viewing, it was still possible that some other emotion or combination of emotions could have produced a pattern congruent with that found for the cheek-site EMG levels. For example, subjects might have been differentially inhibited, angry, and so on across the viewing conditions and their EMG levels might have been attenuated. Given that brow-site activity (which would signal any disturbance) did not differ across viewing conditions and did not parallel the differences in cheek-site EMG levels, this was unlikely. I nonetheless used a global MANOVA to analyze the remaining 11 self-report measures collectively. No clear differences emerged, $F(33, 136) = 1.33$, $p < .14$. The marginal effect for viewing condition was due largely to differences in reported hunger and fatigue. The pattern of means, however, did not explain the differences in cheek-site activity, nor did ratings of fear, anger, sadness, disgust, and contempt. These findings discount explanations relating the cheek-site EMG differences to inhibition or discomfiture in one or more viewing conditions (all Fs < 1.45, $p < .25$).

It was also conceivable that although overall reported happiness did not differ across viewing conditions, individual subjects (or at least those who viewed alone) who exhibited the highest cheek-site EMG levels might still report being the happiest. This hypothesis was tested first by regressing left/right cheek-site EMG amplitudes on happiness ratings of the 64 subjects pooled across all viewing conditions. Relationships between subjects' EMG levels and their own happiness ratings were negligible, $F(2, 61) = 1.52$, $p < .24$. The levels and variances of both EMG activity and reported happiness did not suggest that low correlations resulted from restriction of range.

Regressions of cheek-site EMG activity on postvideotape ratings within each condition were all nonsignificant but were most predictive when subjects sat with a friend; regression Fs were for actual coviewers, $F(2, 13) = 2.99$, $p < .10$; for subjects who participated alone, $F(2, 13) = .21$, $p > .80$, for those whose friend "completed tests," $F(2, 13) = .32$, $p > .72$, and for those whose friend "watched elsewhere," $F(2, 13) = .04$, $p > .95$. These results countered the interpretation that differences among cheek-site EMG amplitudes of subjects who participated alone should most reflect differences in happiness, whereas those of actual coviewers should be most dissimulative and least related to happiness. The regression of left and right cheek sites on initial ratings was nonsignificant and thus did not bias the preceding regression by means of carryover effects, regression $F(2, 61) = .35$, $p > .70$.

The global postvideotape ratings were potentially susceptible to primacy or recency effects for portions of the videotape presentation; either could weaken the regressions of the subjects' cheek-site EMG amplitudes on their self-report. Neither effect was observed when discrete portions of the videotape (babies, animals, and the comedy sketch) were regressed on postvideotape happiness ratings. All of these regressions were nonsignificant.

Finally, I wished to examine the relative importance of viewing condition versus self-reported happiness in accounting for variations in subjects' cheek-site EMG amplitudes. Separate regressions were conducted of viewing condition and happiness ratings on left and right cheek-site EMG levels across the 64 subjects. These analyses showed that viewing condition accounted significantly for subjects' EMG levels, regression $F(2, 61) = 5.81$, $p < .006$, but as reported, rated happiness did not—again, regression $F(2, 61) = 1.52$, $p < .24$. I then analyzed only subjects who viewed alone (i.e., the explicit coviewing subjects were excluded) and should have been least impacted by sociality. The findings were similar. Viewing condition accounted significantly for cheek-site EMG levels, regression $F(2, 45) = 4.34$, $p < .02$, but rated happiness did not, regression $F(2, 45) = .27$, $p > .75$.

Experiment 2: Demand Characteristics Control

Although the finding of direct audience effects might reasonably have been expected, it was a novel result that believing that a friend was a coviewer elsewhere would produce potentiation in *zygomatic major* region EMG activity equal to the friend's physical presence. The finding that the potentiation of EMG activity by both explicit and implicit audiences was unaccompanied by increases in reported happiness was equally surprising. These findings did not accord with common intuitions about the face and emotion or most scientific accounts of smiles. I sought to establish this empirically by recruiting groups of raters and asking them to indicate how subjects would respond to the experimental manipulations.

This *Gedanken* experiment was an adaptation of the demand characteristics control group, or pseudoexperiment, technique typically used in mental-imagery-scanning studies to establish how experimental demand might bias subjects (cf. Kosslyn, Pinker, Smith, & Schwartz, 1979; after Milgram, 1974; Orne, 1962). Its present purpose was to determine the outcome most people would expect from the first experiment.

Method

I recruited 24 advanced undergraduates from a class in personality psychology. All students had taken previous classes in introductory psychology that included discussions of emotion and facial expressions but had received no formal training in either. Their predictions could thus be taken as reflecting common intuitions about emotions and faces.

I also obtained predictions from a small sample ($n = 5$) of advanced graduate students and doctoral candidates studying the face and emotion at a major northeastern university (several have now entered the field). Because these students had received formal training, their predictions could be taken as theoretically informed.

All raters were provided a 1½-page description of the experiment that summarized the content of the videotape and detailed the four viewing conditions. The description was an accurate summary of the exact procedures in the study, except for the omission of the EMG monitoring and the deception used in the two implicit conditions (i.e., raters believed, as the actual subjects did, that friends actually completed tests or coviewed elsewhere).

For each of the four viewing conditions, raters were asked to predict the following: (a) How happy people in each group would say they were during the videotape after they viewed it, and (b) how much subjects in each group would smile while they watched the videotape. Raters recorded their smiling and happiness predictions by providing 0–100 numerical ratings for the happiness and smiling subjects would report and show in each condition. After completing their predictions, raters were asked to provide rationales for their responses.

Results

Summaries of predictions by both the undergraduate and graduate students are depicted in Figure 2 (panels A and B indicate smiling and happiness predictions, respectively).

Undergraduate Pseudosubjects

The undergraduates' predictions were analyzed with one-way repeated measures ANOVAs, using the multivariate approach (O'Brien & Kaiser, 1985). As Figure 2A shows, the undergraduates predicted large differences in smiling among viewing conditions, $F(3, 21) = 9.02$, $p < .001$. However, step-down F tests of the predictions showed that they were wholly discrepant from the actual EMG findings.

According to the undergraduates, subjects who viewed with a friend would smile more than subjects in all other conditions, $F(1, 23) = 27.3$, $p < .001$, and they would also smile more than subjects who believed a friend was viewing elsewhere, $F(1, 23) = 17.8$, $p < .001$. These latter subjects would, in turn, smile more than those who believed their friend was completing tests, $F(1, 23) = 10.6$, $p < .005$, and those who participated alone, $F(1, 23) = 7.84$, $p < .011$. Subjects who believed that their friend was completing tests would show smiling equal to that of subjects who participated alone, $F(1, 23) = .29$, $p > .60$.

Figure 2B shows the undergraduates' predictions about subjects' emotional reports. These raters predicted large differences among viewing conditions in reported happiness, $F(3, 21) = 13.6$, $p < .001$. Unlike the experimental subjects, the hypothetical subjects conformed to the commonplace presumption that smiles must express felt happiness.

First, the undergraduates' predictions were consistent with the belief that over viewing conditions, smiling would parallel rated happiness. Subjects viewing with a friend would rate themselves happier than subjects in all other conditions, $F(1, 23) = 40.6$, $p < .001$, and they would also report greater happiness than just those subjects who believed that a friend was viewing elsewhere, $F(1, 23) = 37.3$, $p < .001$. These latter subjects would, in turn, report being happier than those who believed that their friend was completing tests, $F(1, 23) = 18.5$, $p < .001$, and those who participated alone, $F(1, 23) = 10.3$, $p < .005$. Subjects who believed that their friend was completing tests should tend to report being happier than those who participated alone, $F(1, 23) = 3.77$, $p < .066$.

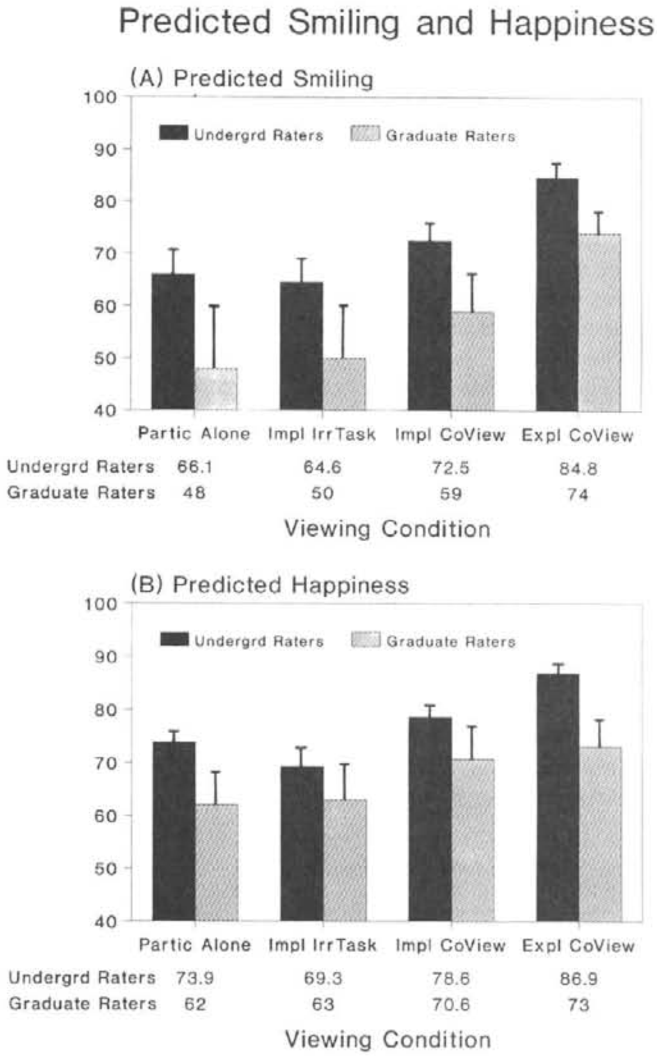

Figure 2. (A) Smiling and (B) happiness ratings of hypothetical subjects predicted by independent raters given a detailed description of experimental procedures; raters were advanced undergraduates ($n = 24$; left bars), and advanced graduate students and doctoral candidates ($n = 5$) studying the face and emotion (right bars). (Videotape viewing conditions are abbreviated as follows: Partic Alone = subjects participated and viewed alone; Impl Irr Task = subjects viewed alone, under the belief that a friend was nearby, engaged in an irrelevant task—"completing psychological tests"; Impl CoView = subjects viewed alone, under the belief that a friend was also viewing nearby; Expl CoView = subject and friend viewed the videotape together. To facilitate comparisons, ordinate scaling was adjusted for visual equivalence of participate alone levels. Error bars depict standard errors of the mean.)

Second, within each viewing condition, the undergraduates predicted that subjects' smiling would show uniformly high correlations with happiness ratings. These within-condition analyses regarded each rater's prediction as, in effect, a subject in the pseudoexperiment. The Pearson correlations for the four conditions were subjects participating alone, $r(24) = .79$, $p < .001$; subjects who believed that friends were completing tests, $r(24) = .50$, $p < .014$; subjects who believed that friends were viewing elsewhere, $r(24) = .72$, $p < .001$; and subjects viewing with a friend physically present, $r(24) = .74$, $p < .001$. Results from the actual subjects showed negligible correlations, belying the raters' implicit assumption about the relationship of smiling to happiness.

The rationales the undergraduates provided clarified the bases for their predictions. Almost without exception, these rationales emphasized how the four viewing conditions would affect emotional state, under the assumption that smiling would follow automatically. "People are happier and smile more when they are with friends" stated one. "Naturally, happier people smile more" responded another. In dissecting her differential predictions about the viewing conditions, one rater stated schematically, "Assume individuals enjoyed sharing video w/others. Assume would rather watch video than take psychological test. Assume smile = happiness. Assume happiness caused by videotape canceled out by anxiety caused by 'test'." None of the rationales provided by the undergraduates included any idea that happiness and smiling were dissociable under these experimental conditions.

Graduate Student Pseudosubjects

The graduate students' predictions coincided overall with those of the undergraduate sample. These raters predicted direct audience effects but underestimated implicit audience effects considerably. Their predicted means for smiling (using a 0–100 scale) were as follows (and see Figure 2A): subjects who participated alone, 48; subjects who believed friends were completing tests, 50; subjects who believed friends were viewing elsewhere, 59; and subjects with friends physically present, 74. Predicted happiness ratings (0–100 scale; Figure 2B) for the four viewing conditions were, respectively, 62, 63, 70.6, and 73. Thus the graduate students as well as the undergraduates believed that smiles would vary directly with happiness.

Like the undergraduates, the graduate students also predicted that within viewing conditions, subjects' smiling would be strongly associated with reported happiness. Unlike the undergraduates, however, they predicted that the strongest and weakest correlations between rated happiness and smiling would occur, respectively, among those subjects who participated alone, $r(5) = .94$, $p < .017$, and those who viewed with friends physically present, $r(5) = -.02$, $p > .96$. Predicted correlations for the remaining groups were intermediate (for hypothetical subjects who believed friends were completing tests, $r(5) = .93$, $p < .025$, for those who believed friends were viewing elsewhere, $r(5) = .61$, $p < .29$. These predictions would be expected from an interpretation that sociality substantially mediates only public faces.

The graduate students' rationales for their predictions illustrated this interpretation. One student wrote, "The differences that I would expect have to do with feeling rules and display rules." Another stated, "Subjects [with actual coviewers] should react most strongly, but the difference should be greater for their expressive behavior than the self reports [which are due to] culture-specific ideas about the videotape and the kind of reaction one should show." Still other explanations were invoked, with these students adducing constructs and mechanisms such as attribution, cultural specificity, display rules, facial feedback, feeling rules, motor mimicry, social comparison, social contagion, social facilitation, and social inhibition.

In summary, both groups of students predicted direct audience effects but substantially underestimated implicit audience effects. When audience effects were predicted, they were always accompanied by parallel differences in happiness (Figure 2). Within each condition, both groups of raters predicted that happiness would be intimately related to smiling. One exception was provided by the graduate students, who predicted that smiling would dissociate from happiness only in the actual coviewing condition. The undergraduates' rationales were often explicit in their equation of happiness with smiling; those provided by the graduate students allowed for some dissociation of smiling from happiness by viewing condition. Despite the great differences in their rationales, the two sets of raters generated largely concordant predictions. These were discrepant from the actual findings.

Discussion

Our findings demonstrate that while viewing a pleasant videotape, the presence of a friendly coviewer potentiates bilateral EMG activity in cheek sites directly overlying the *zygomatic major* muscles responsible for smiling.[5] However, the coviewer need not be physically present; equal enhancement occurs in the mere psychological presence of a coviewer. The enhanced cheek-site EMG levels observed with just the psychological presence of a coviewer was dramatic when contrasted with that of subjects who participated alone, considering that in both of these conditions, subjects viewed in solitude. Across all four videotape-viewing conditions, subjects' cheek-site EMG activity varied as a positive, monotonic function of the sociality of viewing.

These findings indicate both direct and implicit audience effects for smiles. Furthermore, the equivalence of self-report across the four viewing conditions implies that these audience effects were not measurably mediated by the differential induction of felt emotion. Our data also suggest that implicit audience effects may depend on the actions of the imagined other (we are guarded about the latter inference, given the marginal effects).

The differences in cheek-site EMG amplitudes did not appear to result from dysphoria in subjects who participated alone or from embarrassment, inhibition, or dissimulative pro-

[5] Mean EMG levels were derived for the entire viewing epoch. Thus it is unknown whether subjects smiled more frequently, more intensely, or both. Such determination would require visible facial coding by means of systems like FACS (Ekman & Friesen, 1978) or MAX (Izard, 1979) or more microanalytic study of the second-to-second EMG signals (e.g., Fridlund et al., 1986, 1984).

duction of smiles in subjects who viewed with friends. Mitigating these accounts were two lines of evidence: (a) EMG activity in the brow site (overlying the *corrugator supercilii*, which typically indicates disturbance) did not differ across viewing conditions and did not parallel the cheek-site changes, and (b) emotional self-report indicated no differential incidence of emotions such as fear, anger, sadness, contempt, or disgust.

In the second, *Gedanken* experiment, predictions by both undergraduates and graduate student experts in emotion and facial expressions indicate that these findings run counter both to intuition and common theory about faces. In accordance with the induction that smiles imply felt happiness, both groups of raters considerably underestimated implicit audience effects and predicted that smiling would parallel reported happiness. The undergraduates' predictions about smiling were based on the emotionality these raters believed would be engendered by each viewing condition. Graduate student experts made predictions similar to those of the undergraduates but provided more complex rationales that allowed that viewing condition (chiefly, explicit coviewing) could dissociate smiles from happiness.

The results ran contrary to the raters' predictions and to the view that emotion is necessarily deducible from either public or private smiling. Subjects' cheek-site EMG levels varied monotonically with perceived sociality and negligibly with felt emotion. This finding pointed to an interactional account of the inferred smiling that was based on the actual or implicit social context of viewing. The interactional account derives from role and impression-management theories that maintain that we assume roles consistent with our audiences, whether they are real or imaginary (Goffman, 1959; Greenwald & Breckler, 1985; Mead, 1934; Schlenker, 1980; Schlenker & Wiegold, 1989; for relevant views of faces, see Birdwhistell, 1970; Kendon, 1975; Mandler, 1975; and Patterson, 1983; note that this use of the word *role* implies no necessary perfidy or inauthenticity).

In this interactional account, the implicit and explicit coviewing subjects were both cast as friendly associates in a pleasant experience (watching the videotape), and this kind of situation calls for frequent reciprocation of affiliative smiles (e.g., parents viewing their child's school play). In contrast, friends doing different things in each other's presence usually just give off occasional acknowledgment smiles (e.g., two passersby in an office; see Goffman, 1967, 1971). The subjects who viewed while believing that their friends were completing psychological tests were cast in a situation with no shared activity, and thus they tended to exhibit lower cheek-site EMG levels; subjects with no friends in the proximal experimental context showed the lowest EMG levels of all.

These data are indeterminate with regard to the mechanism that accounts for these audience effects. My conjecture, anticipated by the "imaginary objects" accounts of Piderit (1886) and Gratiolet (1865/1990), is that subjects' smiling was mediated by visual imagery. Like the everyday experiences of finding ourselves smiling while imagining our partner's smiling face or scowling when imagining disciplining a child, subjects who arrived with friends but viewed the videotape alone may conceivably have conjured visually their friend and then made faces toward him or her.[6] They may also have imagined sharing their experiences with their friends after the experiment (cf. Schlenker & Weigold, 1989); in fact, perceptual studies show that people spontaneously imagine what they expect to see (Finke & Shepard, 1986).

Mediation by visual imagery, as well as being intuitively compelling, is suggested by (a) the dependency on in vivo visual contact seen by Kraut and Johnston (1979), Jones and Raag (1989), Brightman et al. (1977), and Bavelas et al. (1986), (b) the shaping of judgments of written material, and evaluations of oneself under failure, by visual imagery priming of different "salient private audiences" (Baldwin & Holmes, 1987), and (c) the observation that controlling for self-reported happiness, highly social imagery occasioned more smiling than imagery that was less social (Fridlund et al., 1990). Other mechanisms may reasonably mediate implicit audience effects. Our staging of the experimental conditions may have produced role-appropriate behavior strictly out of habit, without the necessary involvement of visual imagery (see Stanislavski, 1965).

I hasten to mention possible objections to the social role formulation: (a) that the above-baseline cheek-site EMG levels in subjects who participated alone mitigates the exhaustiveness of an implicit-audience account, (b) that the audience effects were due merely to social facilitation, and (c) that the cheek-site EMG levels of the solitary viewers reflected "display rules." To elaborate on each:

1. Subjects who participated alone clearly showed more cheek-site EMG activity during the videotape than preceding it, but the social context for these subjects would seem nonexistent. The observed EMG activity should then be primarily emotional by default. This position is certainly plausible. It is nonetheless problematic given that the cheek-site EMG levels of subjects who participated alone bore no relationship to their happiness ratings. More critically, it necessarily assumes that the solitary subjects had no implicit audience because one was not contrived experimentally. Their audience may simply have been outside the experimental context (e.g., a friend who did not accompany the subject to the experiment) or was evoked by their associations to the film (i.e., segments of the videotape invoked recall of past in vivo social interactions). It is also questionable nowadays whether *any* subjects placed alone in a psychology laboratory are certain that they are unobserved. As a consequence, the experimenter and the measurement devices may have constituted an ancillary implicit audience in all viewing conditions. Establishing the "ground truth" on the relation of any faces to felt emotion would require controlling for such unintended sociality.

2. The audience effects might ostensibly reflect social facilitation by means of Hullian drive induction (Geen & Gange, 1977; Moore & Baron, 1983). I do not believe that this mechanism plausibly explains the data for three reasons. First, increments in generalized drive produced by others should have occasioned parallel changes in both cheek-site EMG amplitudes and reported happiness and perhaps even activity from the

[6] This prediction was first stated by Cooley (1902): "People differ much in the vividness of their imaginative sociability. The more simple, concrete, dramatic, their habit of mind is, the more their thinking is carried on in terms of actual conversation with a visible and audible interlocutor" (p. 95).

brow site (assuming that these responses have the greatest habit strength). The data did not conform with this pattern. Second, a coviewer's physical presence should have effected dramatic potentiation of cheek-site EMG levels and happiness as compared with an implicit coviewer, but EMG amplitudes and reported happiness were equivalent in the two conditions. Third, a drive induction account would not predict the tendency of subjects' cheek-site EMG levels to differ with the actions of the implicit other (but, again, I am guarded about this finding given the marginal effects).

3. It might be argued that solitary subjects' cheek-site EMG levels reflected smiling that was due simply to overlearned display rules governing in vivo social behavior (display rules are putative conventions for attenuating, histrionically intensifying, or masking involuntary emotional faces in public; see Ekman, 1972). Invoking display rules to explain solitary faces is difficult to defend because it is self-contradictory: The pivotal experiment held to demonstrate them used solitary subjects as controls, under the assumption that their faces were most purely emotional (Ekman, 1972, 1973, 1984; see reanalysis of display rules study by Fridlund, in press). As the data show, correlations between cheek-site EMG levels and reported happiness were low in all conditions. They were not demonstrably higher in subjects who participated alone, when the facial behavior was ostensibly the least social. In fact, the correlation between cheek-site EMG levels and reported happiness was the highest for the subjects who viewed the videotape in the physical presence of a friend.[7]

Thus, such explanations do not seem tenable. An implicit sociality account of these audience effects is nonetheless open to criticism on two more general grounds: (a) that it is solipsistic and (b) that it is not disconfirmable. To consider each:

1. Casting solitary viewers' facial activity as social role behavior before audiences of their own making may at first seem absurdly solipsistic. It nonetheless accords with everyday experience. We mutter to ourselves and hear ourselves respond, we praise or scold ourselves and enjoy or suffer the consequences, and we rehearse what we will say to others and foresee their likely reactions. People can blush with embarrassment when alone (B. Apfelbaum, personal communication, July 1989; Goffman, 1959; Ribot, 1897), and they often respond sexually to idealized partners during highly visual seduction fantasies (Masters, Johnson, & Kolodny, 1985). These episodes are difficult to explain without invoking concepts of role and audience. In fact, viewing private behavior as role behavior accords entirely with traditional conceptions of thinking as dialogical and the self as a creation of public interaction (Cooley, 1902; Goffman, 1979; Mead, 1934; Vygotsky, 1962; see also Skinner, 1957).

2. Explaining solitary faces by appeal to implicit sociality, it might be contended, is impossible to disconfirm because implicit or imaginal interactants can never be ruled out completely. It may be that this theory, like many others, is untestable in extremis, but as the present findings suggest, it can be exposed to falsification using experimentally manipulable ranges of sociality.

Finally, in offering these findings, I must voice appropriate caution about their limitations. Subjects reported being equivalently happy across viewing conditions, and thus emotional mediation of facial behavior may have been systematic (i.e., invariant), a proposition weakened but not vitiated by the poor happiness–EMG associations within viewing conditions. These results thus do not exclude a role for emotion in the instigation of public or private faces, but they do warrant caution in deducing emotion from either. The interactional explanation of solitary faces obviously depends on confirmation with evocations other than videotapes, with emotions other than happiness, and with expressions other than smiling. Such research will map the extent of both direct and implicit human audience effects.

I began this study by questioning why people make faces when they are alone. These initial findings lead me to believe that solitary faces occur for the same reasons as public ones, if only because when we are alone we create social interactions in our imaginations. They suggest the possibility that sociality may play a major role in the mediation of solitary faces. At minimum, these findings suggest that implicit sociality must be controlled before solitary facial behavior is ascribed to emotion.

[7] Within-condition correlations, even if there were no contribution of sociality, should not approach unity given differences among subjects within each condition in facial muscle size and conformation, placement of detection electrodes, moduli used while rating emotions (cf. Stevens, 1956), and interpretation of emotion terms on the ratings scales. The quasi-random subject assignment to viewing condition controls for these factors in group analyses, and thus between-groups inspection of mean levels and differences among the within-group correlations are probably more informative.

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