Rathus, S. A., & Nevid, J. S. (1992). *Adjustment and growth: The challenges of life.* (5th ed., pp. 420–597). Fort Worth, TX: Harcourt Brace Jovanovich.

Reinisch, J. M., & Beasley, R. (1990). *The Kinsey Institute new report on sex: What you must know to be sexually literate.* New York: St. Martin's Press.

Schillewaert, N., Langerak, F., & Duhamel, T. (1998). Non-probability sampling for WWW surveys: A comparison of methods. *Journal of the Market Research Society, 40*(1), 307–322.

Sell, R. L. (1997). Research and the Internet: An e-mail survey of sexual orientation. *American Journal of Public Health, 87,* 297.

Smith, M. A., & Leigh, B. (1997). Virtual subjects: Using the Internet as an alternative source of subjects and research environment. *Behavior Research Methods, Instruments, & Computers, 29*(4), 496–505.

Smith, T. M. (1991). A critique of the Kinsey Institute/Roper organization national sex knowledge survey. *Public Opinion Quarterly, 55,* 449–457. American Association for Public Opinion Research.

Tavris, C., & Sadd, S. (1976). The Redbook report on female sexuality: 100,000 married women disclose the good news about sex. New York: Delacorete Press.

CHAPTER 7

An Intercultural Examination of Facial Features Communicating Surprise

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INTRODUCTION

The Internet has features of great interest for all scientific disciplines. For psychology in particular, cyberspace is not only a useful research tool (Krantz, Ballard, & Scher, 1997; Reips, 1996a; Welch & Krantz, 1996), but also a new object to investigate (Bordia, 1996; Smith and Leigh, 1997). Because the Internet now supports multimedia, it offers an ideal ecological context in which topics related to *pictorial communication* may be scrutinized by the models and methods of experimental psychology. Pictorial communication is a research area that studies the processes of communicating information through particular iconographic codes. Several fields of research such as (visual communication, visual sociology, the psychology of art, and the psychology of perception) as well as those of virtual reality (VR) and human–computer interaction (HCI) share a common interest in this framework (Ellis, Kaiser, & Grunwald, 1993).

In this chapter we present an exploratory intercultural study, conducted via the Internet, on the iconographic communication of the emotion of surprise in various groups of participants classifiable according to distinct cultural and

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geographical areas. For this aim, we conducted an online experiment to investigate the role of upper facial features in evaluating the emotion of surprise in a set of synthetic pictograms generated by a graphical interface called the model of structural analysis (MSA) (Lombardi, 1997; Lombardi & Burigana, 1999).

THE FACIAL EXPRESSIONS OF THE EMOTION OF SURPRISE

Research on facial expressions is currently exploring new concepts, findings, and methods (Russell & Fernàndez-Dols, 1997).

An interesting debate involves the principal theorists of the relations between faces and emotions. There are different positions concerning the issue of the innateness and universality of facial expressions that express human emotions (Ekman, 1994; Izard, 1994; Russell, 1994). Darwin's treatise on emotions (1872/1965) inspired those who postulate the existence of at least six facial expressions of emotions that are recognized cross-culturally (e.g., Ekman, 1994; Izard, 1994). These are happiness, surprise, fear, disgust, anger, and sadness. Ekman and Friesen (1978) elaborated a procedure called the facial action coding system (FACS) to measure and describe each visible facial expression.

Cross-cultural studies have investigated the recognition of emotions from facial expressions (Boucher & Carlson, 1980; Ducci, Arcuri, W/Georgis, & Sineshaw, 1982; Kilbride & Yarczower, 1980; Matsumoto, 1990, 1992; McAndrew, 1986). These studies consider similarities and differences between subjects from at least two cultures. In general, there is consensus that there are universals of facial expressions of emotions. Even so, there is also consensus that there are differences between cultures and that cultural influence may be compatible with the universality thesis (Matsumoto, 1992).

Results of various studies of facial expression show that the emotion of surprise often occupies a unique position among other emotions considered "universal." For example, Frijda & Tcherkassof (1997) noted that expressions of surprise have been considered as ones of fear by a certain percentage of subjects in various studies (Ekman & Friesen, 1975). This may be because, as Ekman (1973) suggests, fearful events can also be surprising, and because the facial features of fear and surprise are similar. In a cross-cultural study, McAndrew (1986) compared Malaysian and American subjects: he found that females were significantly better than males at recognizing surprise and that Malaysian females were more accurate than American females. Matsumoto (1992) carried out a study on American–Japanese cultural differences in the recognition of universal facial expressions and found that Americans were better than Japanese at identifying anger, disgust, fear, and sadness, but that there were no differences in scores for happiness or surprise.

There are also other differences among authors in relation to the facial expression of surprise. For example, Russel (1997) identifies a "space of psychological judgment" defined by two dimensions: pleasantness and arousal. In this space, he sets the action unit of surprise very near the peak of arousal, but in a neutral position with regard to the dimension pleasantness–unpleasantness. Katsikitis (1997) used a multidimensional-scaling procedure to obtain a spatial representation of emotion categories in a two-dimensional space: horizontal, labeled as pleasant–unpleasant, and vertical, labeled as dimension of upper-face–lower-face dominance. The emotion of surprise is placed in the upper right-hand quadrant: thus surprise is labeled as pleasant and is characterized by upper-face dominance. The eyebrows and eye region predominate in the facial configuration of surprise.

If we consider only the upper facial features (eyes and eyebrows), the expression of surprise is caused by the combined action of two distinct muscular units, respectively the *medial* and *lateral* portions of the *frontalis*. Contraction of the former raises the inner part of the eyebrows, producing corrugation of the central portion of the forehead. Contraction of the latter raises the outer part of the eyebrows, corrugating the external portions of the forehead. As a consequence, the visual field "opens" and the structural configuration of the facial features appears to be "expanded." In one sense, we may interpret the expression of surprise as the need to "see better" or "know better" (Eibl-Eibesfeldt, 1984).

In their review of the "componential" approach to the study of facial expressions, Smith and Scott (1997) report that raising eyebrows and upper eyelids is associated with attention (Darwin, 1872/1965; Frijda, 1969; Smith, 1989), the perception of newness in the environment (Scherer, 1984), and low levels of control of the situation (Darwin, 1872/1965; Scherer, 1984; Smith, 1989). Smith (1989) also noted that raising eyebrows in particular is associated with a state of uncertainty.

From the structural point of view, the expression of surprise has a definite configuration. Lombardi and Burigana (1999) have shown how level of surprise is associated with a particular structural organization in artificial pictograms. The prototype used for the construction of simplified models of facial expressions was a graphical interface created by Lombardi (1997). Called MSA, it is characterized by variation of a small set of facial features (eyes, eyebrows, mouth, etc.). This parametrization is *ad hoc*, based on observation and common knowledge of the underlying structure of the face. Two separate components, structural and procedural, define the MSA. The structural component is defined by a complex structural organization called the *symbolic* *knowledge model*, which organizes all necessary information (phenomenological, geometrical, etc.) to describe the expressions and morphological aspects of the face. The procedural component consists of the computational and graphical procedures for producing the pictograms. Variations in the values of appropriate parameters produce a large set of pictograms that can be used as models of specific facial expressions. For example, we can modify mouth opening or the degree of inclination of the eyebrows, simply by assigning particular values to their associated parameters.

An example of a structural unit of the MSA is the *extension coefficient* (*EC*), by which it is possible to represent the various levels of surprise in a pictogram. The *EC* (Figure 1) indicates the degree of topological expansion of the chief components (eyes and eyebrows; see the Appendix for the analytical description of *EC*).

The literature contains several other works on the structural configuration of the face. Several computational models inspired by the FACS have been proposed (Katsikitis, Pilowsky, & Innes, 1990; Thornton & Pilowsky, 1982; Yamada, 1993). Computer graphics have been implemented by programs that simulate the anatomical behavior of facial expressions (Cohen & Massaro, 1990; Magnenat Thalmann, Primeau, & Thalmann, 1988; Massaro & Ellison, 1996; Parke, 1982; Platt & Badler, 1981; Terzopoulos & Waters, 1990; Waters, 1987; Williams, 1990).

All these studies describe human facial expressions through physical models of the face, based on anatomy of facial muscle structures, histology of facial tissues, physics of deformations, geometry of shape, and realism of graphical visualization. The task of human face modeling and animation has become more complex to accommodate psychological and behavioral dynamics (Kalra, 1996). Problems associated with the use of pictorial codes in the communication of emotions have received less attention from researchers. This

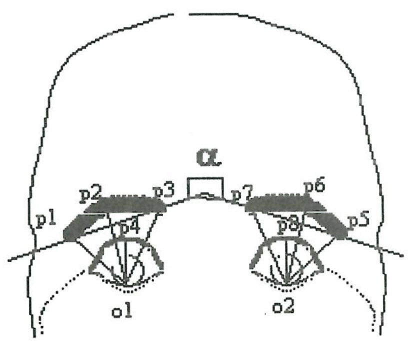

Figure 1 Pict *x* structural elements; extension coefficient (*EC*).

may be considered a serious omission, because artificial facial communication definitely offers a new dimension for human–machine interactions and interfaces (Kalra, 1996). The latest computer technologies support hypertext and multimedia, creating complex graphical interfaces. As a consequence, we think that the communication of emotions via pictorial codes, defined by a highly structured set of pictograms, represents a real and interesting object of study.

ONLINE EXPERIMENT: "HOW SURPRISED IS HE?"

We designed an online experiment to investigate the role of the upper facial features in evaluating the emotion of surprise in a small set of pictograms generated by the MSA. In this study, subjects viewed stimuli represented by MSA pictograms and rated the appropriate degree of surprise expressed. The studies of Katsikitis (1997), Ekman & Friesen (1978), and Izard (1971) highlighted the role of upper-face components in the emotion of surprise. Therefore, our research focused on the most salient features of this expression.

(a) Unlike other studies in this field (Matsumoto, 1992; Katsikitis, 1997) we chose not to use facial stimuli previously classified by raters: the peculiarity of the set of our stimuli is the structural organization of their components. It is the empirical evaluation of subjects to reveal which configurations from the set of pictograms are candidates for prototypical expressions of surprise.

(b) We decided to adopt the expression *intercultural research* to indicate a comparative study conducted via the Internet regarding evaluation of the emotion of surprise in different groups of participants classifiable according to distinct cultural and geographical areas.

The issues of universality of emotions and methodological problems in cross-cultural studies on facial expressions are raised by Russel (1993), Russell (1994), Russell & Fernàndez-Dols (1997), and Wagner (1997).

In our case, experimental subjects are Internet users who may be classified (accepting the assumption of honesty), according to their *declared* geographical provenance and their *declared* mother tongue, into distinct "virtual" cultural groups.

(c) The choice to operate on artificial pictograms, as opposed to simple photographic stimuli, affords an advantage: we have a precise analytical description of the structural elements of the face, and thus a more accurate description of the experimental stimuli.

This was very much an exploratory study. However, some general aspects were examined:

Structural aspect

- To value the reliability of the extension coefficient (*EC*) of the MSA as regards the effects of structural components of stimuli, "eye opening," "position of eyebrows," and "inclination of eyebrows".

Demographic and intercultural aspects—in the evaluation of degree of surprise in pictograms of the online experiment, to check:

- The presence of any differences between males and females, and possible accordances with or variances from results of researches conducted in the laboratory or in the field (McAndrew, 1986; Matsumoto, 1992)
- The presence of intercultural or intergeographic differences

Validity aspects

- The lack of influence of different hardware and software components and configurations used by the subjects who took part in the experiment via the Internet
- The strength of the experimental design (type of stimuli chosen) as regards possible influences from particular skills in iconographic decoding acquired by assiduous reading of comics or a passion for video games
- Comparison of the results of the same experiment conducted both over the Internet and in the laboratory under well-controlled conditions

METHOD

SUBJECTS

Self-reported subject characteristics of the online sample are listed in Table 1.

One unexpected demographic result was gender distribution: 69% of our participants were females. This fact is particularly interesting, because it clearly contradicts the results of all major demographic studies of the Internet population (Georgia Institute of Technology, 1998; hereafter, Georgia Tech).[1] Pasveer and Ellard (1998) also found results similar to ours in one of their

[1] The Georgia Tech research reports the following percentages: 33.6% female; 66.4% male.

Table 1

Self-Reported Subject Characteristics

	No.	%
Total *N*	742	
Sex		
Female	511	68.9
Male	223	30.1
Missing	8	1.1
Age		
< 18	80	10.8
18–22	244	32.9
23–30	235	31.7
31–50	154	20.8
> 50	22	3.0
Missing	7	0.9
Geographical area		
N. America (NA)	478	64.4
S. America (SA)	15	2.0
N. Europe (NE)	99	13.3
S. Europe (SE)	87	11.7
E. Europe (EE)	6	0.8
Africa (AF)	2	0.3
Asia (A)	33	4.4
M. Orient (MO)	4	0.5
Missing	18	2.4
Play video games		
Never	214	28.2
Rarely	302	40.7
Monthly	96	12.9
Weekly	71	9.6
More	41	5.5
Missing	18	2.4
Read comics		
Never	191	25.7
Rarely	332	44.7
Monthly	85	11.5
Weekly	71	9.6
More	48	6.5
Missing	15	2.0

studies conducted on the WWW. They interpreted their results as a consequence of the fact that their research aroused mainly female interest; we think the same explanation applies to our study as well.

The size of the sample and the heterogeneous provenance of the participants allowed us to subdivide them into eight geographical groups (Table 1).

Four of these groups (Northern Americans (NA), Northern Europeans (NE), Southern Europeans (SE), and Asians (A)) were sufficiently large to permit statistical comparisons.

Stimuli

The pictograms varied in degree of eye opening (3 levels: medium; medium wide; wide), position of eyebrows (3 levels: medium; medium high; high) and inclination of eyebrows (3 levels: no inclination; converging upward; converging downward) (Figure 2). The 3 levels of each variable were selected from a larger set of pictograms that had been used in a pilot study (Pagani, 1997; Pagani & Lombardi, 1999). In particular, we selected 9 pictograms from the 27 possible combinations of features, using a Latin square randomly chosen from the 12 Latin squares that could be generated given the 3 variables (with 3 levels per variable). Three different orders of presentation were devised, to avoid effects related to stimulus order and sequence.

Procedures

Within the Web site of the Department of Psychology of the University of Padua, we implemented the first Italian online lab. Participants had access to the experiment through four possible Internet links.[2]

Guests were welcomed by the first page of the experiment, which gave information regarding the experiment title, the aim of the research, and the experimenters' names. Further on was a brief description of the experiment, information about the time required to execute it, and a short list of instructions. A link called "Start the Experiment" allowed the trials to begin.

If guests decided to click the link and participate, they were granted access to the main page of the online experiment. Here, they found a series of nine pictograms and, for each one, were asked to rate the degree of *surprise* that seemed to be expressed using a 7-point scale (from 0 = *total absence of surprise* to 6 = *maximum surprise*). After this task, subjects answered a list of questions: demographic (e.g., sex, language, age, country, etc.), technical (type

[2](1) "Online Lab" link on our Psychology Department home page (Pagani & Lombardi, 1997); (2) a link in the online research page of the American Psychological Society (Krantz, 1996); (3) a link in the page devoted to sites relevant to data collection on the Internet of The Web Experimental Psychology Lab, University of Tuebingen (Reips, 1996b); (4) a link in the page concerning methodologies for experimentation on the Internet of the Department of Psychology, University of Plymouth (Kenyon, 1996).

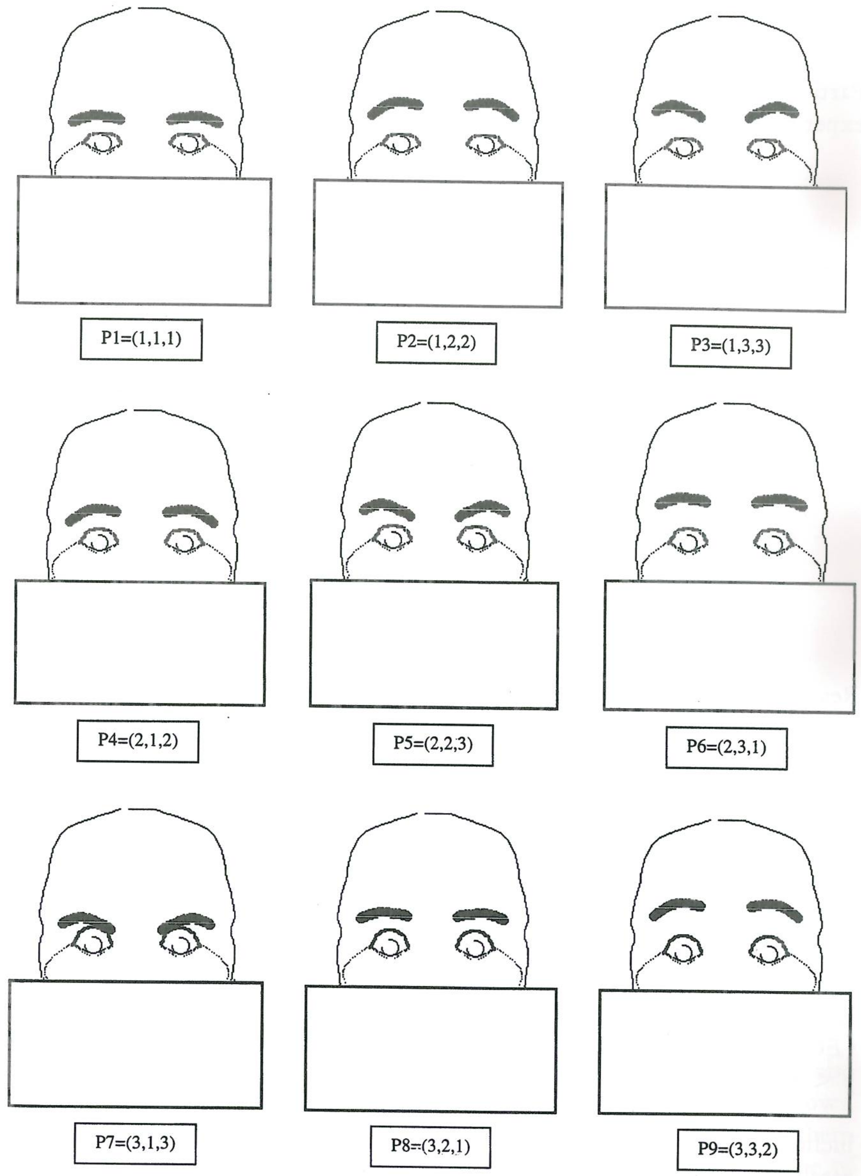

Figure 2 Experimental stimuli: labels (x_1, x_2, x_3), where x_1 ∈ EYE_OP. = {1 = medium, 2 = medium-wide, 3 = wide}; x_2 ∈ EYEBR_POS. = {1 = medium, 2 = medium-high, 3 = high}; x_3 ∈ EYEBR_INCL. = {1 = no_inclination, 2 = converging_upwards, 3 = converging_downwards}.

of computer, monitor, and browser used), and behavioral (degree of reading of comics and degree of video-game playing). There was also a text area for any comments or suggestions. A "Submit" button sent their data to our server. Participation was voluntary, and only those subjects who completed an entire experiment were included in data analyses.

Main Analyses and Planned Comparisons (Structural, Demographic, and Intercultural Aspects)

We carried out three four-way ANOVAs ((*a*), (*b*), and (*c*)) on the three possible pairs of structural factors studied:

(a) 3 (Position of Eyebrows) × 3 (Eye opening) × 2 (Gender) × 4 (Geographical Area)
(b) 3 (Position of Eyebrows) × 3 (Inclination of Eyebrows) × 2 (Gender) × 4 (Geographical Area)
(c) 3 (Inclination of Eyebrows) × 3 (Eye Opening) × 2 (Gender) × 4 (Geographical Area)

Results of ANOVAs with repeated measures on position of eyebrows, eye opening, and inclination of eyebrows are given in Table 2.

Data analysis provided some interesting information regarding the effects of the structural components of the pictograms on the evaluation of the degree of surprise, as shown in the joint analysis of Figures 3–5 and Table 2. In particular, qualitatively, we can observe the relation between the "configurations" of the within-subject factor interactions (Eye Opening (C) × Position of Eyebrows (D); Eye Opening (C) × Inclination of Eyebrows (E); Position of Eyebrows (D) × Inclination of Eyebrows (E)) and the *EC* equation (see the Appendix). Moreover, the predictive power of the extension coefficient (*EC*) is assessed through the high correlation between the *simulated* stimuli means (*EC*-data) and the *empirical* stimuli means over the total sample ($r = 0.984$; $p < .001$) (Figure 6).

Other significant interactions (Sex (A) × Eye Opening (C); Sex (A) × inclination of eyebrows (E)) allowed examination of *gender* differences, separately, for combinations of levels of eye opening (inclination of eyebrows, respectively) by appropriate interaction contrasts (Table 3, Figures 7 and 8). As regards the female group (vs. the male group), results show a relatively more accentuated trend in attributing higher degrees of surprise with increase in eye opening ($\epsilon_{\text{male}} - \epsilon_{\text{female}} = -.354$).

Table 2

Results of Four-Factor Analyses of Variance [(a), (b), and (c)]

Effect	*df*	*F*	*p*[a]
Sex (A)	(1, 623)	1.33	(n.s.) .249
Geographical area (B)	(3, 623)	1.33	(n.s.) .265
Eye opening (C)	(2, 1246)	205.58	< .001
Position of eyebrows (D)	(2, 1246)	204.09	< .001
Inclination of eyebrows (E)	(2, 1246)	87.14	< .001
A × B	(3, 623)	0.67	(n.s.) .569
A × C	(2, 1246)	6.07	< .005
A × D	(2, 1246)	0.91	(n.s.) .404
A × E	(2, 1246)	13.37	< .001
B × C	(6, 1246)	4.30	< .001
B × D	(6, 1246)	2.40	.026
B × E	(6, 1246)	1.87	.083
C × D	(4, 2492)	59.91	< .001
C × E	(4, 2492)	128.46	< .001
D × E	(4, 2492)	116.15	< .001
A × B × C	(6, 1246)	2.02	.060
A × B × D	(6, 1246)	0.57	(n.s.) .753
A × B × E	(6, 1246)	3.04	< .010
A × C × D	(4, 2492)	9.06	< .001
A × C × E	(4, 2492)	0.63	(n.s.) .645
A × D × E	(4, 2492)	3.46	< .010
B × C × D	(12, 2492)	1.92	.028
B × C × E	(12, 2492)	2.26	< .010
B × D × E	(12, 2492)	3.30	< .001
A × B × C × D	(12, 2492)	2.19	.010
A × B × C × E	(12, 2492)	0.52	(n.s.) .902
A × B × D × E	(12, 2492)	1.32	(n.s.) .198

[a] n.s. = not significant.

Instead, the male group (vs. the female group) evaluates as a higher degree of surprise the change from pictograms with no eyebrow inclination to those with eyebrows converging downward ($\epsilon_{\text{male}} - \epsilon_{\text{female}} = .5$).

Differences between ratings for distinct geographical groups were also tested separately for eye opening (position and inclination of eyebrows, respectively) (Table 4, Figures 9 and 10). Results show the trend of Northern Americans (NA) versus Asians (A) to evaluates a relatively higher degree of surprise in *relation to* an increase in eye opening ($\epsilon_{\text{NA}} - \epsilon_{\text{A}} = .969$). An analogous trend emerges between Southern Europeans (SE) and Asians (A) ($\epsilon_{\text{SE}} - \epsilon_{\text{A}} = .621$). In relation to Factor D (position of eyebrows), we observe the inverse trend between Group NA and Group A with respect to eye

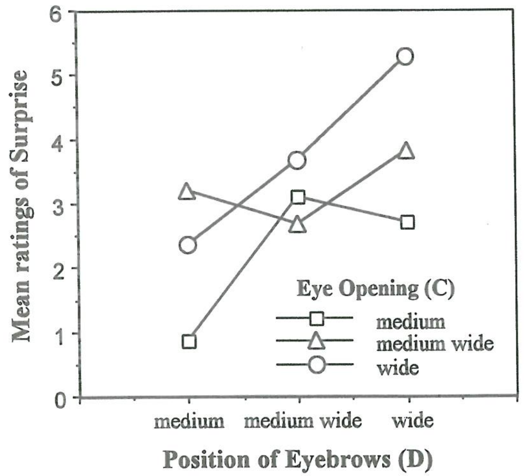

Figure 3 Mean ratings of surprise plotted as a function of the positions of the eyebrows (Factor D), with a separate type of marker and curve for each eye opening (Factor C).

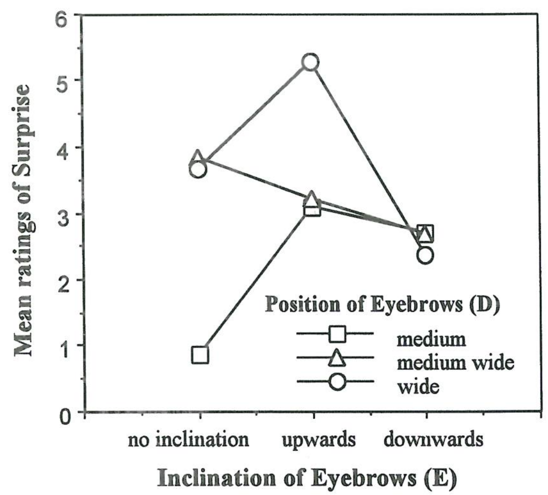

Figure 4 Mean ratings of surprise plotted as a function of the inclinations of the eyebrows (Factor E), with a separate type of marker and curve for each position of the eyebrows (Factor D).

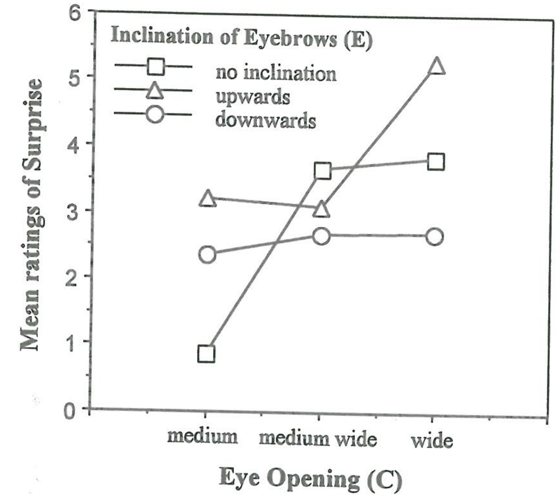

Figure 5 Mean ratings of surprise plotted as a function of eye opening (Factor C), with a separate type of marker and curve for each inclination of the eyebrows (Factor E).

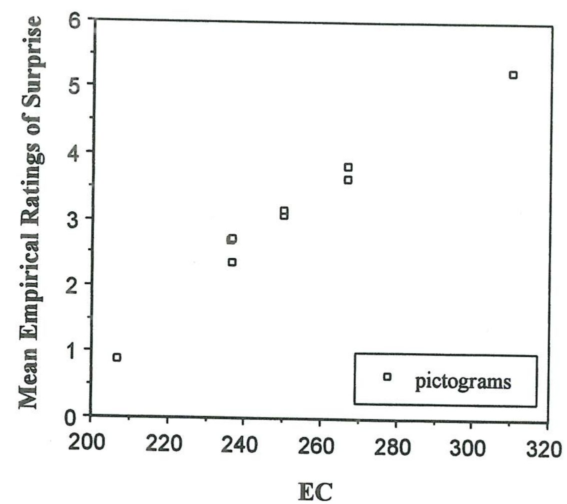

Figure 6 The empirical values associated with the pictograms plotted as a function of the EC values produced with the $\oplus = +$ linear operator, $b = 10.0$; μd_eyebr_sx and μd_eyebr_sx in $[70.0, 100.0]$; eye opening $d \in [30.0, 50.0]$ (see the Appendix).

Table 3

Contrasts

Contrast[a]	$\varepsilon_1 - \varepsilon_2$	Std. err.	t-Value	Sig. t[b]
I (C)	−.354	.1242	−2.857	.004
II (C)	.066	.095	.693	n.s. .488
I (E)	.500	.142	3.519	.001
II (E)	−.177	.142	−1.247	n.s. .212

[a] Contrast I (type polynomial) is defined by comparing difference ε_1 between the marginal means on the third and first levels of the within-subjects factor for the male group with the corresponding difference ε_2 for the female group. Contrast II (type polynomial) is defined by comparing difference ε_1 between the sum of the marginal means of the first and third levels and two times the value of the marginal means of the second level of the within-subjects factor for the male group with the corresponding difference ε_2 for the female group. C = eye opening; E = inclination of eyebrows.
[b] n.s. = not significant.

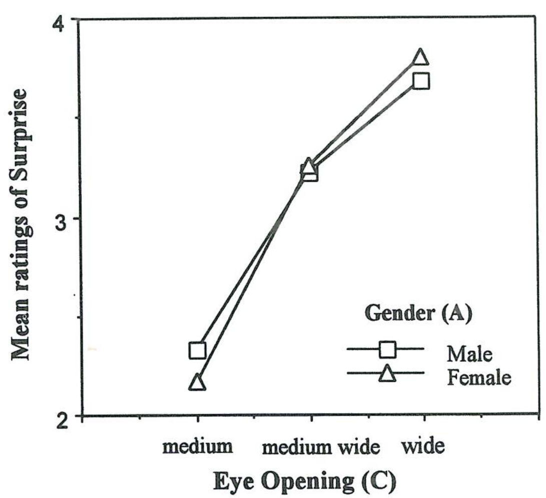

Figure 7 Mean ratings of surprise plotted as a function of eye opening (Factor C), with a separate type of marker and curve for male group and female group (Factor A).

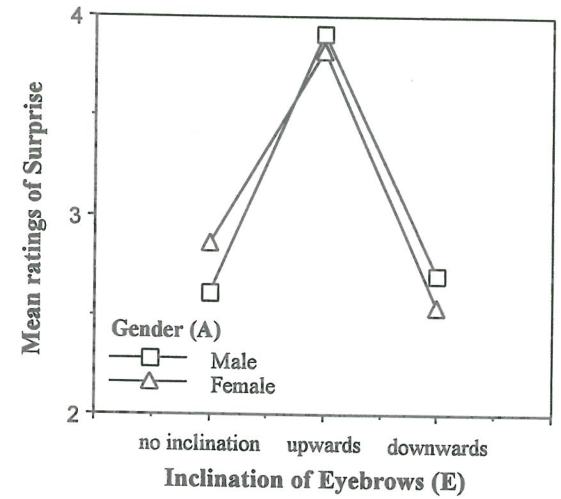

Figure 8 Mean ratings of surprise plotted as a function of the inclinations of the eyebrows (Factor E), with a separate type of marker and curve for male group and female group (Factor A).

opening evaluation ($\epsilon_{NA} - \epsilon_A = -.699$). The trend of group SE versus group NE to evaluate a *relatively* higher degree of surprise in *relation to* an increase in eyebrow raising ($\epsilon_{NE} - \epsilon_{SE} = -.631$) is interesting. In relation to Factor E (inclination of eyebrows), Group NA with respect to Group A evaluates as a higher degree of surprise the change from pictograms with no eyebrow inclination to those with eyebrows converging upward ($\epsilon_{NA} - \epsilon_A = -.929$).

However, we also found a strong relation between the modalities of evaluation of surprise in the four geographical groups as clearly shown by the cross-cultural measures of correlations ($r_{NA-NE} = .994$, $r_{NA-SE} = .973$, $r_{NE-SE} = .958$, $r_{SE-A} = .902$, $r_{NA-A} = .812 = r_{NE-A}$).[3] In conclusion, Table 5 reports the rank order of the stimuli between the geographical groups.

Main Analysis of Hardware and Software Effects (Validity Aspect a)

Three six-way ANOVAs were designed, with the same within-subject factor component and with type of *hardware* and *software* as new between-factors.

[3] Correlations are significant at the 0.1 level.

Table 4

Contrasts

Contrast[a]	Comparisons G_1–G_2[b]	$\varepsilon_1 - \varepsilon_2$	Std. err.	*t*-Value	Sig. *t*[c]
I (C)	NA–A	.969	.271	3.575	.001
	NE–SE	.217	.219	0.991	n.s. .321
	SE–A	.621	.306	2.024	.043
II (C)	NA–A	.043	.209	0.205	n.s. .837
	NE–SE	−.252	.169	−1.490	n.s. .136
	SE–A	.276	.237	1.164	n.s. .244
I (D)	NA–A	−.699	.319	−2.188	.029
	NE–SE	−.631	.258	−2.444	.014
	SE–A	−.381	.361	−1.054	n.s. .292
II (D)	NA–A	−.277	.224	−1.237	n.s. .216
	NE–SE	.013	.181	0.076	n.s. .938
	SE–A	−.248	.254	−0.977	n.s. .328
I (E)	NA–A	.129	.314	0.412	n.s. .679
	NE–SE	.367	.253	1.445	n.s. .148
	SE–A	−.093	.355	−0.263	n.s. .791
II (E)	NA–A	−.929	.309	−3.004	.002
	NE–SE	−.378	.250	−1.512	n.s. .131
	SE–A	−.474	.350	−1.354	n.s. .175

[a] Contrast I (type polynomial) is defined by comparing difference ε_1 between the marginal means on the third and first levels of the within-subjects factor for Geographical group G_1 with the corresponding difference ε_2 for Geographical group G_2. Contrast II (type polynomial) is defined by comparing difference ε_1 between the sum of the marginal means of the first and third level and two times the value of the marginal means of the second level of the within-subjects factor for Geographical group G_1 with the corresponding difference ε_2 for Geographical group G_2. C = eye opening; D = position of eyebrows; E = inclination of eyebrows.

[b] Geographical groups **G** = (NA, NE, SE, A); Between-factor matrix of contrasts **M** = $[(1,1,1,1),(1,0,0,-1),(0,1,-1,0),(0,0,1,-1)]$.

[c] n.s. = not significant.

No important significant effect emerged for different types of software and hardware configurations used by participants. In fact, the local settings of the experiment, which varied in relation to the types of monitor, PC, and browser used (Table 6), did not produce any substantial difference in evaluation except for some particular cases (see Table 7).

Main Analyses of Video Games and Comics Effects (Validity Aspect B)

Three four-way ANOVAs were considered, with *reading of comics* and *passion for video games* as between-factors. We did not find any significant effect

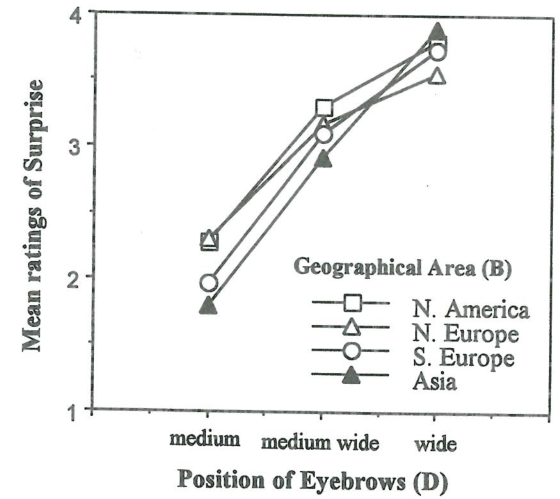

Figure 9 Mean ratings of surprise plotted as a function of the eye position of eyebrows (Factor D) with a separate type of marker and curve for each geographical group (Factor B).

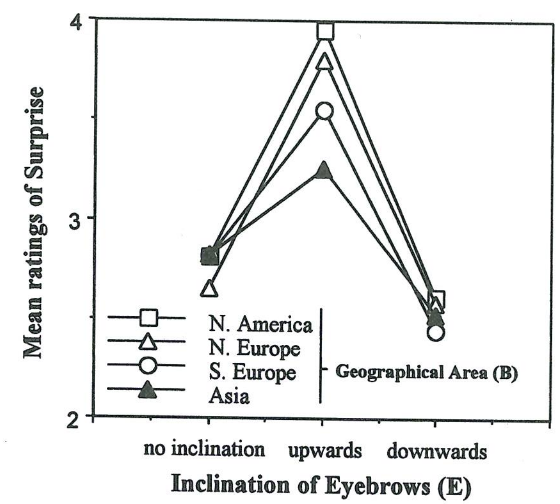

Figure 10 Mean ratings of surprise plotted as a function of the inclinations of the eyebrows (Factor E), with a separate type of marker and curve for each geographical group (Factor B).

Table 5

Rank Order of the Stimuli P*i* (Mean Values in Parentheses) for Different Geographical Groups

Rank	N. America	N. Europe	S. Europe	Asia
1	P1 (0.83)	P1 (0.93)	P1 (0.88)	P1 (1.35)
2	P7 (2.32)	P7 (2.10)	P7 (2.43)	P3 (1.88)
3	P5 (2.72)	P5 (2.79)	P2 (2.44)	P4 (2.52)
4	P3 (2.76)	P3 (2.82)	P3 (2.49)	P2 (2.53)
5	P4 (3.23)	P4 (3.08)	P5 (2.56)	P5 (2.82)
6	P2 (3.24)	P2 (3.10)	P4 (3.17)	P7 (3.36)
7	P8 (3.66)	P8 (3.40)	P6 (3.76)	P6 (3.62)
8	P6 (3.92)	P6 (3.56)	P8 (3.80)	P8 (3.81)
9	P9 (5.37)	P9 (5.11)	P9 (5.06)	P9 (4.76)

Note. Differences between groups exceeding 0.5 of a category is significant by a *t*-test, with $p < .05$.

Table 6

Hardware and Software Variables

	No.	%
Total *N*	742	
Browser		
I.E.	241	32.5
Netscape	409	55.1
Others	26	3.5
Missing	66	8.9
Computer		
PC	634	85.4
MAC	69	9.3
Missing	39	5.3
Monitor dimension		
Don't know	203	27.4
14 in.	157	21.2
15 in.	188	25.3
17 in.	151	20.4
More	27	3.6
Missing	16	2.2
Monitor resolution		
Don't know	392	52.8
600 × 400	44	5.9
800 × 600	176	23.7
1024 × 800	108	14.6
Missing	22	3.0

Table 7

Main Results of Six-Factor Analyses of Variance

Effect[a]	*df*	*F*	*p*[b]
Browser (F)	(2, 509)	0.119	(n.s.) .888
Computer (G)	(1, 509)	0.003	(n.s.) .960
Monitor dimension (H)	(4, 509)	2.39	.050
Monitor resolution (I)	(3, 509)	0.667	(n.s.) .573
C × D × I	(12, 2036)	2.01	.020
C × D × F × G	(8, 2036)	2.03	.039

[a] C = eye opening, D = position of eyebrows.
[b] n.s. = not significant.

related to the learning of previous visual and semantic codes in pictogram evaluation. No differences emerged between groups who had contrasting levels of interest in video games and comics.

Comparisons between the Results of WWW Sample and Laboratory Sample (Validity Aspect c)

A traditional laboratory is usually a room with essential and functional furnishings: the environment in which the experimental setting is immersed appears as an aseptic, strongly controlled context, planned by the experimenter.

The context associated with an online lab has two distinct environmental components, one characterized by specific planning of the online lab in terms of aspects related to human–computer interaction, and the other by the real, or physical, context in which the participant is situated (e.g., office, house). Although the former component does allow us some kind of control, the latter cannot be controlled. It is therefore necessary to use special statistical or empirical procedures that allow us to bypass this problem and establish the validity of the Internet procedures used.

Krantz et al. (1997) proposed a comparative method to evaluate results obtained via the two modalities (classical vs. online). The procedure consists of conducting the same experiment both in the laboratory and over the WWW. According to Krantz et al., if the same psychological variables are driving the results of both data sets, their trends should turn out to be very similar, leading to a high correlation between the results of the two studies.

Like Krantz et al. (1997), we replicated our online experiment in a laboratory version. Participants were 53 undergraduate and graduate psychology students at the University of Padua, and the stimuli were the same pictograms used in the WWW experiment. Participants were read the Italian version of the same instructions of the online experiment, and a randomized sequence of stimuli was then presented to them on a PC monitor (resolution, 800 × 600; size, 15 in.). The task was identical to that of the online experiment.

The laboratory data were analyzed by three two-way ANOVAs on the three possible pairs of within-structural factors. As can be seen from Table 8 and Figure 11, both studies yielded similar data trends.

Moreover, comparing data from a subsample of online, Southern Europeans with laboratory data (of Italians, also in Southern Europe), we found a high correlation between means of the two experimental designs ($r = .948$, $p < .001$). Regressing these data, we found:

$$\text{online mean} = 0.958(\text{laboratory mean}) + 0.02,$$

which shows a slope of 0.958 (with standard error of .122) and an intercept value of 0.02 (with standard error of .397), which shows the similarity of lab to comparable online data.[4]

[4] The slope (0.958) was significantly different from 1 ($t = 7.856$, $p < .001$); the intercept (0.02) was not significantly different from 0 ($t = 0.124$, $p = .905$).

Table 8

Results of Two-Factor Analyses of Variance—Laboratory Sample

Effect	*df*	*F*	*p*
Eye opening (C)	(2, 104)	77.03	< .001
Position of eyebrows (D)	(2, 104)	31.43	< .001
Inclination of eyebrows (E)	(2, 104)	40.0	< .001
C × D	(4, 208)	28.05	< .001
C × E	(4, 208)	22.39	< .001
D × E	(4, 208)	48.51	< .001

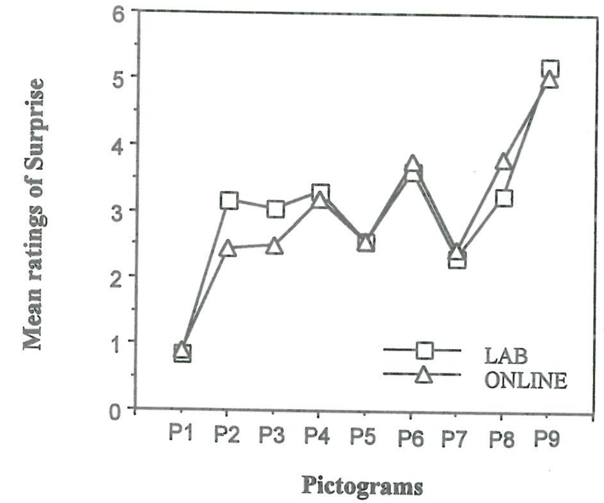

Figure 11 Mean ratings of surprise plotted as a function of the pictograms with a separate type of marker and curve for the laboratory group and the online group (Southern European group (SE)).

DISCUSSION

Demographic and Intercultural Aspects

We found a small (but statistically significant) difference between males and females in the evaluation of surprise.

Previous studies showed the presence of some differences in the recognition of emotions between males and females (Hall, 1978, 1984). McAndrew (1986) found that the emotions on which females were consistently more accurate than males were fear and surprise, which are traditionally the two most often confused. Brody and Hall (1993) summarize research and theory concerning gender differences in emotional experience, emotional expression, and nonverbal communication behaviors relating to emotion. The evidence indicates that females are superior to males both at recognizing feelings in others and at verbally and facially expressing a wide variety of feelings themselves. Brody and Hall also summarize evidence for socialization and developmental processes, including the development of verbal language and gender roles that may underlie gender differences in these domains.

Moreover, the fact that our study was accessed by a greater number of females than males is perhaps not coincidental: if the topic of emotions mostly attracts female interest, it should not surprise us more females chose to participate in a task of judging emotions.

Some significant differences between geographical groups also emerged from our study (see Table 4). They may be discussed from several points of view.

Cultural variations in the judgment of the intensity of emotion are relevant because facial expressions may be modulated by culture-specific display norms, such as intensification, deintensification, masking, and neutralization (Ekman, 1994).

It would be interesting to speculate how the results obtained might be related to plausible geographical, historical, and social–cultural differences. However, considering the small number of stimuli used in our study, we think it would be premature to make too much of these interesting relations.

It is also important to note that some cross-cultural studies on the recognition of facial expressions raised the issue of race depicted in the photos (Kilbride & Yarczower, 1980; Matsumoto, 1990). For example, Matsumoto (1992) stated that expressions must be portrayed by faces of people whose culture matches that of the judges, to separate judgments of emotions from judgments concerning race. However, Massaro & Ellison (1996) tested Japanese and U.S. students on computer-generated faces from these two countries and found that "the perceptual processing of facial affect follows well-established principles of pattern recognition, independent of the ethnicity and culture of the perceiver and of the perceived face." Moreover, Katsikitis (1997) found that the mode of stimulus presentation (i.e., photographs or line drawings) produces similar judgments of emotion. In consideration of these findings, we believe that the results of cross-cultural differences that emerged in our experiment may also be facilitated by the rating procedure, which probably allowed finer measures.

Validity Aspects

(a) From the methodological point of view, it is important that the different types of software and hardware configurations used by participants did not produce substantial influences in pictogram evaluation. This result is very interesting, because it shows how a proper, robust experimental design allows the potential noise induced by different settings to be tolerated or minimized.

(b) The fact that no differences emerged between groups with distinct levels of interest in video games and comics shows a homogeneity that we believe is related to the high structural organization of the stimuli. We also think that our pictograms permit a more general level of decoding, which is independent of specific experiences in iconographic decoding.

(c) Our Internet data were comparable to those of the laboratory experiment: both correlational and regression analyses showed that our Internet data are valid. According to Krantz et al. (1997), this kind of comparison is needed to determine what types of research will yield similar results on the WWW and to establish the validity of the Internet as an experimental medium.

In conclusion, we verified that, with the Internet, very large, geographically diverse samples could be obtained (Reips, 1996a): people from 45 different countries completed our online experiment. A large sample permits division into subgroups of sufficient size for statistical analysis.

One limitation of our method of recruitment is the large disparity in number of participants that volunteered from different countries. An alternative way of recruiting subjects would have been a "call for participation" (Hewson, Laurent, & Vogel, 1996) by targeted invitation to specific newsgroups and listservers from specific countries. However, with the immediate adoption of such a strategy we would not have been able to acquire any idea of a "hypothetical baseline" of the number of completely voluntary participants and from how many and which countries they were able to connect. We are currently giving serious consideration to this alternative strategy, which may allow us a more specific focus on cultural differences in the evaluation of facial expressions.

In sum, we have studied cross-cultural differences and similarities in the judgment of emotions from pictorial stimuli. Our experience in this project leads us to the conclusion that the Internet is the most cost-effective and practical method for such cross-cultural research.

APPENDIX

Schematically, given the pictogram Pict x (Figure 1), the extension coefficient (EC) is defined by

$$EC = [\mu d\_eyebr\_sx \oplus d(O1, P4)] \oplus [\mu d\_eyebr\_dx \oplus d(O2, P8)] \oplus \omega, \quad (1)$$

where $\mu d\_eyebr\_sx = \mu(d(O1, P1), d(O1, P2), d(O1, P3))$ is the mean of the distances between origin O1 and points P1, P2, and P3; $\mu d\_eyebr\_dx = \mu(d(O2, P5), d(O2, P6), d(O2, P7))$ is the mean of the distances between origin O2 and points P5, P6, and P7; $d(O1, P4)$ and $d(O2, P8)$ indicate respectively the degree of expansion of the left and right eyes; and ω identifies a parameter that is dependent on angular measurement α,

$$\omega = \begin{cases} +b & \text{if } \alpha \gtrsim 180^\circ \\ 0 & \text{if } \alpha \cong 180^\circ , \\ -b & \text{if } \alpha \lesssim 180^\circ \end{cases} \qquad (2)$$

where b is a whole number. Lastly, $\oplus$ represents a generic function operator, if $\oplus = +$, EC specifies a simple linear equation.

REFERENCES

Bordia, P. (1996). Studying verbal interaction on the Internet: The case of rumor transmission research. *Behavior Research Methods, Instruments, & Computers, 28,* 149–151.

Boucher, J. D., & Carlson, G. E. (1980). Recognition of facial expression in three cultures. *Journal of Cross-Cultural Psychology, 11,* 263–280.

Brody, L. R., & Hall, J. A. (1993). *Gender and emotion.* In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions.* New York: Guilford Press.

Cohen, M. M., & Massaro, D. W. (1990). Synthesis of visible speech. *Behavior Research Methods, Instruments, & Computers, 28,* 260–263.

Darwin, C. (1965). *The expression of emotions in man and animals.* London: John Murray. (Original work published 1872)

Ducci, L., Arcuri, L., W/Georgis, T., & Sineshaw, T. (1982). Emotion recognition in Ethiopia. *Journal of Cross-Cultural Psychology, 13,* 340–351.

Eibl-Eibesfeldt, I. (1984). *Die Biologie des menschlichen Verhaltens. Grundriss der Humanethologie.* Munich: Piper.

Ekman, P. (1973). *Darwin and facial expression: A century of research in review.* New York: Academic Press.

Ekman, P. (1994). Strong evidence for universals in facial expressions: A reply to Russell's mistaken critique. *Psychological Bulletin, 115,* 268–287.

Ekman, P., & Friesen, W. V. (1975). *Unmasking the face: A guide to recognizing emotions from facial clues.* Englewood Cliffs, NJ: Prentice-Hall.

Ekman, P., & Friesen, W. V. (1978). *Facial action coding system.* Palo Alto: Consulting Psychologists Press.

Ellis, S. R., Kaiser, M. K., & Grunwald, A. J. (1993). *Pictorial communication in virtual and real environments* (2nd ed.). Bristol: Taylor & Francis.

Frijda, N. H. (1969). *Recognition of emotion.* In L. Berkowitz (Ed.), *Advances in experimental social psychology.* New York: Academic Press.

Frijda, N. H., & Tcherkassof, A. (1997). *Facial expressions as modes of action readiness.* In J. A. Russell & J. M. Fernàndez Dols (Eds.), *The psychology of expression.* New York: Cambridge University Press.

Georgia Institute of Technology: Georgia Tech's Graphics, Visualization, and Usability Center. (1998). *GVU's WWW Users Surveys* [Online]. Available URL: http://www.cc.gatech.edu/gv/user_survey/

Hall, J. A. (1978). Gender effects in decoding non verbal cues. *Psychological Bulletin, 85,* 845–857.

Hall, J. A. (1984). *Nonverbal sex differences: Communication accuracy and expressive style.* Baltimore: Johns Hopkins University Press.

Hewson, C., Laurent, D., & Vogel, C. M. (1996). Proper methodologies for psychological and sociological studies conducted via the Internet. *Behavior Research Methods, Instruments, & Computers, 28,* 186–191.

Izard, C. E. (1971). *The face of emotion.* New York: Appleton Century Crofts.

Izard, C. E. (1994). Innate and universal facial expressions: Evidence from developmental and cross-cultural research. *Psychological Bulletin, 115,* 288–299.

Kalra, P. (1996). Human facial animation. In N. Magnenat Thalmann & D. Thalmann (Eds.), *Interactive computer animation.* London: Prentice Hall.

Katsikitis, M. (1997). The classification of facial expressions of emotion: A multidimensional-scaling approach. *Perception, 26,* 613–626.

Katsikitis, M., Pilowsky, I., & Innes, J. M. (1990). The quantification of smiling using a microcomputer-based approach. *Journal of Nonverbal Behavior, 14,* 3–18.

Kenyon, P. (1996). *What other experiments are there on the Internet?* [Online]. Available URL: http://salmon.psy.plym.ac.uk/mscprm/forms2.htm#Supplementary

Kilbride, J. E., & Yarczower, M. (1980). Recognition and imitation of facial expressions: A cross cultural comparison between Zambia and the United States. *Journal of Cross-Cultural Psychology, 11,* 281–296.

Krantz, J. H. (1996). *Psychological Research on the Net* [Online]. Available URL: http://psych.hanover.edu/APS/exponnet.html

Krantz, J. H., Ballard, J., & Scher J. (1997). Comparing the results of laboratory and World-Wide Web samples on the determinants of female attractiveness. *Behavior Research Methods, Instruments, & Computers, 29,* 264–269.

Lombardi, L. (1997, September). *Rappresentazione delle espressioni del volto: Proposta di un modello insiemistico orientato ad oggetti.* Paper presented at the 1997 Congresso Nazionale della Sezione di Psicologia Sperimentale, Capri.

Lombardi, L., & Burigana, L. (1999). MSA (Model of Structural Analysis): An example of formal analysis on the emotion of surprise. In M. Zanforlin & M. Tommasi (Eds.), *Research in perception: Proceedings of the Meeting in Memory of Fabio Metelli.* Padua: Logos Press.

Magnenat Thalmann, N., Primeau, E., & Thalmann, D. (1988). Abstract muscle action procedures for human face animation. *The Visual Computer, 5,* 290–297.

Massaro, D. L., & Ellison, J. W. (1996). Perceptual recognition of facial affect: Cross-cultural comparisons. *Memory & Cognition, 24,* 812–822.

Matsumoto, D. (1990). Cultural similarities and differences in display rules. *Motivation and Emotion, 14,* 195–214.

Matsumoto, D. (1992). American–Japanese cultural differences in the recognition of universal facial expressions. *Journal of Cross-Cultural Psychology, 23,* 72–84.

McAndrew, F. (1986). A cross-cultural study of recognition thresholds for facial expression of emotion. *Journal of Cross-Cultural Psychology, 17,* 211–224.

Pagani, D. (1997). *Potenzialità applicative nell'uso di Internet per la ricerca in psicologia: Proposta di un laboratorio online.* Unpublished thesis. Università di Padova.

Pagani, D., & Lombardi, L. (1997). *Online psychology lab* [Online]. Available URL: http://www.psy.unipd.it/personal/laboratorio/surprise/htmltesi/first3.html

Pagani, D., & Lombardi, L. (1999). An experiment conducted on the Internet: The evaluation of the emotion of surprise. In M. Zanforlin & L. Tommasi (Eds.), *Research in perception: Proceedings of the Meeting in Memory of Fabio Metelli.* Padua: Logos Press.

Parke, F. I. (1982). Parametrized models for facial animation. *IEEE Computer Graphics and Applications, 9,* 61–68.

Pasveer, K. A., & Ellard, J. H. (1998). The making of personality inventory: Help from the WWW. *Behavior Research Methods, Instruments, & Computers, 30,* 309–313.

Platt, S. M., & Badler, N. I. (1981). Animating facial expressions. *Computer Graphics, 15,* 245–251.

Reips, U. (1996a, October). *Experimenting in the World-Wide Web.* Paper presented at the 1996 Society for Computers in Psychology Conference, Chicago.

Reips, U. (1996b). *Other sites relevant to data collection on the internet* [Online]. Available URL: http://www.psych.unizh.ch/genpsy/UIF/Lab/WebLabLinksE.html

Russel, J. A. (1993). Forced-choice response format in the study of facial expression. *Motivation and Emotion, 17,* 41–51.

Russel, J. A. (1997). *Reading emotions from and into faces: Resurrecting a dimensional–contextual perspective.* In J. A. Russell & J. M. Fernàndez Dols (Eds.), *The psychology of expression.* New York: Cambridge University Press.

Russell, J. (1994). Is there universal recognition of emotion from facial expression? A review of the cross-cultural studies. *Psychological Bulletin, 115,* 102–141.

Russell, J., & Fernandèz-Dols, J. M. (1997). *The psychology of facial expression.* Cambridge: Cambridge University Press.

Scherer, K. R. (1984). *On the nature and function of emotion: A component process approach.* In K. R. Scherer & P. Ekman (Eds.), *Approaches to emotion.* Hillsdale, NJ: Erlbaum.

Smith, C. A. (1989). Dimensions of appraisal and physiological response in emotion. *Journal of Personality and Social Psychology, 57,* 329–353.

Smith, C. A., & Scott, H. (1997). *A componential approach to the meaning of facial expressions.* In J. A. Russell, J. M. Fernàndez Dols (Eds.), *The psychology of expression.* New York: Cambridge University Press.

Smith, M. A., & Leigh, B. (1997). Virtual subjects: Using the Internet as an alternative source of subjects and research environment. *Behavior Research Methods, Instruments, & Computers, 29,* 496–505.

Terzopoulos, D., & Waters, K. (1990). Physically-based facial modeling, analysis and animation. *Journal of Visualization and Computer Animation, 1,* 73–80.