

# *Three Facial Expressions Mothers Direct to Their Infants*

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Mothers modify both their voices and their faces when interacting with infants. Although considerable work has detailed the modifications in the voice, less is known about those in the face. In this paper, three specific types of infant-directed (ID) facial expressions were identified in videotapes of 10 English- and 10 Chinese-speaking mothers interacting with infants aged 4–7 months. Four measures were taken to examine the form and meaning of these ID facial expressions. In Measure one, 32 undergraduates easily differentiated the three identified facial expression types. In Measure two, the muscle movement of each type were described through Ekman and Friesen's facial action coding system (FACS). In Measure three, 35 mothers and 40 undergraduates provided different emotional descriptions and communicative messages for each type. In Measure four, rank correlations were conducted to identify the FACS units most indicative of each facial expression type. These four measures confirmed the appearance of three expression types in both Chinese and English mothers, the involvement of unique muscle movements in these expression types in comparison to adult-directed expressions which have been described, and the expression of distinct and consistent emotional messages. The meaning and importance of these expressions to mother-infant interactions are discussed, and directions for future research are identified. Copyright © 2003 John Wiley & Sons, Ltd.

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## INTRODUCTION

The communicative exchanges between mothers and their infants constitute one of the most remarkable forms of human interaction. These multimodal exchanges involve special modifications in the mother's voice, in her body

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movements, and in her facial expressions in ways that seem exquisitely tuned to the state of the infant (Stern, 1974; Sullivan and Horowitz, 1983; Papousek et al., 1985). The immediate familiarity and ubiquity of this interaction pattern has raised the hypothesis that it evinces a biologically significant caretaking bias (Papousek and Papousek, 1995; Papousek et al., 1986; Stern, 1974).

Detailed naturalistic observations and microanalytic studies have documented the subtle ways in which mothers and infants reciprocally influence one another (Trevvarthen, 1977). The exquisite mutuality of these interactions has led some researchers to posit a kind of 'primordial' interpersonal communion (Werner and Kaplan, 1963) or intersubjectivity (Trevvarthen, 1977, 1979) that enables sharing of feelings. The purpose of the current research is to take a more empirical approach to describing and characterizing one component of that rich mother-child interaction—the facial expressions mothers use when communicating with their infants.

Modifications in the human voice in speech directed to infants were first noted by Darwin (1872), and described anecdotally by a number of other authors. When he documented that this special style of speaking to infants is common in mothers across several different cultures, Ferguson (1964) suggested that there might be a unique 'baby-talk' register. With the systematic description and documentation of the special characteristics of infant-directed speech that followed (Fernald, 1984, 1985; see also Papousek et al., 1985), we now know that parents from many different language and cultural groups use a higher pitch, elongated pitch contours, and a unique pattern of burst and pause when speaking to their young infants (Ferguson, 1964; Fernald and Simon, 1984; Fernald et al., 1989; Greiser and Kuhl, 1988; Papousek and Papousek, 1991; Stern et al., 1982). We also know that infants respond preferentially to this 'infant-directed' style of speaking with increased attention (Cooper and Aslin, 1990; Fernald, 1985; Pegg et al., 1992; Werker and McLeod, 1989), and with increased interactive attempts (Werker and McLeod, 1989), even if the speech that is being delivered is from an unfamiliar language (Werker et al., 1994). There is even some evidence that the modifications in infant-directed speech facilitate infants' ability to parse (Hirsh-Pasek et al., 1987), discriminate (Karzon, 1985), and comprehend (Fernald et al., in press) language, and that the exaggerated prosodic characteristics may optimally convey communicative messages such as praise vs. prohibitions (Fernald, 1993).

Less detailed work has been done, however, on the characteristics of the facial expressions that accompany mother-infant interactions. The lack of detailed empirical work is surprising given the wealth of descriptive accounts of the elaborate facial display mothers use when communicating with their infants. As early as 1872 in his book entitled *Expression of the Emotions in Man and Animals*, Darwin noted that 'The movements of expressions in the face and body... serve as the first means of communication between the mother and her infant; she smiles approval and thus encourages her child on the right path or frowns disapproval' (Darwin, 1872, p. 385). Since Darwin's time many others, using more systematic observational techniques, have also noted the use of engaging facial expressions in mother-infant interactions (Brazelton et al., 1975; Fogel, 1977; Papousek and Papousek, 1977; Stern, 1974; Stern et al., 1977; Stern and Gibbon, 1979; Sullivan and Horowitz, 1983; Trevvarthen, 1977, 1979, 1985). What is still required, however, is experimental work systematically delineating the precise characteristics and perceived messages of specific infant-directed facial expressions.

The naturalistic studies suggest the existence of more than one ID facial expression. From home observations of mothers interacting with their 3- and 4-month old infants, Stern (1974) noted that infant-directed facial expressions, like infant-directed speech, are often more exaggerated, slower in tempo and longer in duration than adult-directed facial expressions. He described what he called the 'mock surprise' expressions as a good example of an exaggerated facial expression in which 'the eyebrows go way up, the eyes open very wide, the mouth opens and purses and usually emits a long 'Oooooo,' and the head comes up and forward sometimes to within inches of the baby's face' (p. 192). He describes also the 'fish mouth face' expression, which he believes is used as a greeting behavior by mothers (Stern *et al.*, 1977, p. 187).

These descriptive reports suggest that the facial expressions that mothers use with infants may be as different as the vocal characteristics of mother-infant interactions, and potentially, as important. The naturalistic studies report subtle ways in which maternal expressions influence infant behaviour, via emotional regulation (Murray and Trevarthen, 1985) and what Stern calls 'affect attunement' (1985) from a very young age. Split screen analyses of parents and infants interacting reveal an intricately choreographed interchange in which parents both lead and imitate their infant's actions in a way that serves to communicate affect, and maintain infant attention and emotional regulation (Murray and Trevarthen, 1985; Reddy *et al.*, 1997).

There are experimental studies that support the perceptual availability and functional importance of ID facial expressions. Research shows, for example, that newborn infants imitate the facial displays (Meltzoff and Moore, 1977) including lips open vs. pursed (Reissland, 1988) and the emotional expression (Field *et al.*, 1982) of adults. Moreover, experimental studies reveal that infants show more attention (as evident in more play to attend transitions vs. play to avert transitions) in response to interactive over still faces (Cohn and Elmore, 1988), elect to look at exaggerated over neutral facial expressions (Kuchuk *et al.*, 1986), and show more smiling to an interactive face while more grimacing to a 'still' face (Stack and Muir, 1992). Perceptual tasks reveal that within the first half year of life infants discriminate (La Barbera *et al.*, 1976; Young-Brown *et al.*, 1977) and categorize (Nelson, 1987) facial expressions, and even look preferentially to facial displays that match the affect in the voice (Walker, 1982). More importantly, infants of both 4- and 9-months of age look longer and attempt to interact more with multimodal video displays of women communicating with their infants over video displays of women communicating with an unfamiliar adult (Werker and McLeod, 1989; Werker *et al.*, 1994).

In summary, there is considerable descriptive evidence suggesting that parents do modify their faces in special ways when interacting with their infants. And, there is support from both microanalytic studies of parent-child interaction, and from experimental studies of infant perception that facial modifications are of central interest and importance to infants. There has not, however, been any experimental investigation of the consistency, regularity, and meaning of infant-directed facial expressions, or of the specific role infant-directed facial expressions might play in development. It is also not known whether infant-directed facial expressions are rare or common; whether idiosyncratic to only some mothers or whether they occur in similar form with regularity across mothers, and whether there is similarity in these expression types across cultures. For these reasons, we decided to conduct a study to systematically describe the precise form and perceived

meaning of facial expressions as displayed by mothers from two very different cultures.

### *Preparatory Work*

Before conducting a full-scale study examining the form and meaning of infant-directed facial expressions, an exploratory study was conducted using videotapes in our archives. We reasoned that if infant-directed facial expressions are as obvious and ubiquitous as the descriptive and anecdotal reports would suggest, such expressions should be evident to an intuitive viewer, and should be apparent in most video recordings of mothers interacting with their infants. The videotapes that we examined in this Exploratory Study had originally been recorded as candidates for use in a study of infant preference for infant-directed (ID) over adult-directed (AD) speech. These videotapes comprised 5 English- and 5 Chinese-speaking parents (9 mothers and 1 father) speaking to either their own infant or to a friendly, adult confederate speaking the same language as the parent. In examining these videotapes in detail, the authors were struck by the dramatic, unique, and easily identifiable facial expressions parents were using with infants but not with other adults. We tentatively identified three such patterns: one that is reminiscent of Stern's 'fish face', one of his 'mock surprise', and a third that seemed to be a special kind of infant-directed smile. Before immediately beginning a more systematic study of these three expression types, we recruited four naïve judges<sup>1</sup> to help us devise a standardized scoring scheme, and to ensure that the facial expressions we had so readily identified could also be identified by viewers who were not already biased by the existing literature.

The naïve judges were four undergraduate students in a research design course. They were blind to the authors' hypotheses, and unaware of the previous work on mother–infant interactions. Three of the judges were ethnic Chinese and one was of English descent. Two of the ethnic Chinese were first generation Canadians whose first language was a Chinese language, and the other ethnic Chinese judge was second generation with English as a first language. The Canadian of English descent was third generation Canadian. To the extent that even the identification of facial expressions as present or absent lies in the perceiver as well as the sender and that there may be cultural differences in the perception as well as display of emotions, we felt it important to make sure that the culture of the parents was represented in that of the judges.

To ensure that the naïve judges focused exclusively on the facial expression of the parents and were not influenced by the content of the speech, the sound was turned off when they viewed the tapes. In the first phase, the judges viewed the full, approximately 15 min video clip of one English- and one Chinese-speaking mother interacting with her own infant. These two mothers were selected because they used particularly exaggerated, and thus perhaps more easily identifiable, facial expressions when interacting with their own infants. The judges examined these video tapes for distinct prototypical expressions that could not be characterized as typical or common in adult-to-adult interactions, and which appeared to them to be more characteristic of adult-to-infant interactions. All of the judges identified the three facial expressions we had so readily seen. All four judges agreed on one expression that is much like Stern's 'mock surprise' (the judges described it as eyebrows raised, eyes wide open, and big open mouth), and on a special happy expression (they described it as partially squinted eyes with an exaggerated or contrived, but very warm smile).

All also identified a third prototype, (lips rounded and pursed with furrowed eyebrow and wrinkled forehead), but two of the four initially divided this expression type into two categories, one that was characterized primarily by rounded and pursed lips (much like Stern's 'fish face') and one they called 'worried' (lips still rounded and pursed, but eyebrows more furrowed, forehead wrinkled, and chin down). There were no facial expressions other than these four identified by more than one judge.

Using all four categories, the student judges coded 5 min of the remaining 8 (4 Chinese and 4 English) infant-directed videotapes, and five minutes of videotapes of the same parents when speaking to an adult. The 5-min infant- and adult-directed video segments were chosen on the basis of being the first contiguous 5-min segments that were at least 90 seconds into the tape. Each judge scored the facial expressions independently so that there would be no bias or influence from one another. An expression was scored if the baseline or neutral countenance changed to one of the four expression types, and was held for more than one second. The judges were allowed to review the tapes as many times as required until they were comfortable with their scoring.

The student judges showed high agreement on identifying instances of the facial expression that is similar to Stern's 'mock surprise' and the ID 'Happy' expression, but less agreement on the last two. They were then asked to recode with this category collapsed into the single category including all pursed lips (like Stern's 'fish face') regardless of the degree of exaggeration of the eyebrow furrowing. With this consolidation into a single category, near perfect agreement was achieved. Moreover, each of these three expression types was noted by each judge at least once in each of the parents during the 5-min ID segment (many parents showed several instances of each during this segment). Importantly, none of these facial expression types were seen in the 5-min segments of AD interactions of these same parents.

This exploratory study confirmed that the three ID facial expressions the authors had tentatively identified were also identified and easily used by naïve viewers. The ease and consistency with which the students identified and classified the same three ID facial expressions in this exploratory study that we had seen (two of which were similar to ones previously noted in the literature) convinced us to proceed to a larger study.

### *Overview*

The purpose of the larger study was to address, under more controlled conditions, the following preliminary questions: (1) Is there evidence of these three facial expressions more generally in adult-infant interactions? (2) Are these ID facial expressions unique to mothers of one cultural background? (3) When described precisely using standardized facial coding schemes, are these expressions merely exaggerated instances of already described adult-to-adult facial expression, or are they unique? (4) Are there relatively clear emotional messages conveyed by these facial expressions? To address these questions, we videotaped Chinese- and English-speaking mothers addressing either their infants or an adult confederate. We set up taping conditions that would elicit a variety of emotions (e.g., happy, worried, sad, disgust, etc.) in order to ensure that we had the full range of expressions parents might use. As described below, we then selected instances of the three special facial expression types that had been identified in the preparatory study.

We designed and applied four Measures to assess the reliability and validity of the classification scheme we used to identify the three expression types. Measures 1a and 1b were designed specifically for this purpose. We asked naïve undergraduates to sort into three piles selected instances of each expression type and compared their sorts to our initial classification. Measure 2 was designed to determine if these expression types actually constitute unique facial expressions. The same selected instances used in Measure 1 were coded using Ekman and Friesen's (1978) facial action coding system (FACS), which is based on the anatomical coding system of Hjortsjö (1969). The facial action units obtained in FACS were then compared to those of standard adult-directed (AD) facial expression types. The purpose of Measure 3 was to ascertain whether these expression types each convey unique and unambiguous communicative messages. A new group of undergraduates and mothers were asked to state, in their own words, the emotional message conveyed by these selected instances. Finally, in Measure 4 we asked naïve undergraduates to rate the representativeness of these different exemplars, and compared their ratings of best instances of each expression type to the results of FACS coding to establish prototypes of the three ID facial expressions.

### *Participants*

The study was conducted in Vancouver, Canada, a multicultural urban centre in which various ethnic groups maintain strong cultural and linguistic traditions. Ten English-speaking and 10 Chinese-speaking mothers were filmed interacting with their infants aged 4–7 months. The age range of 4–7 months was selected because of reports in the literature that face-to-face interactions are very common starting by 2–3 months of age (Trevarthen, 1977) and peak between 3–5 months, with continued high face-to-face interaction through 7 months (Lamb *et al.*, 1987). Although it is virtually impossible to obtain the same kind of intimacy in adult-to-adult interactions in the lab as it is in mother–infant interactions, in order to obtain a baseline comparison for eventual FACS coding, mothers<sup>2</sup> were also filmed interacting with an adult confederate. All the English-speaking mothers were born in Canada, and were native speakers of the English language. Eight Chinese mothers were born in Hong Kong and 2 were born in China. The mothers from Hong Kong and 1 mother from China spoke Cantonese as their first and primary language while the other mother from China spoke Mandarin as her first and primary language. Participants were recruited from the Greater Vancouver area through health units, baby clinics, the largest local maternity hospital, and advertisements in English and Chinese newspapers and other media. No mention was made of our interest in facial expressions.

After obtaining the mothers' permission to contact them to volunteer for a psychology experiment, we telephoned them when their infants reached the appropriate age and told them that we were interested in how mothers and their infants interact with one another. We described the study to the mothers, and they then signed a consent form and a release form which gave us the permission to use their videos or pictures for our study.

### *Apparatus and Procedure*

The mothers were filmed either in a small, cozy room in the Psychology building at the university or in a small all-purpose room in Strathcona Community Centre

(a community centre which has a primarily Asian constituency). These two settings ensured that all mothers could participate in an environment in which they felt comfortable with their infants.

All mothers were asked to bring their infants either to the infant laboratory at the university or to the Community Centre (whichever was more convenient). The filming took place in a small room in one of these places. The room was made to look as welcoming as possible without having too many distracting features in it. A comfortable car-seat for the infant was taped firmly to a table to prevent it from moving during the filming. A chair for the mother was placed directly across from the car-seat where the infant sat. A JVC GX-N7 Lolux video camera was placed on a tripod on the other side of the table, behind the car-seat.

Each mother was given a list of seven topics (see the appendix) and told that there were two sessions each lasting approximately 15 min. In the first session, she was to interact with her infant (without toys) as she would normally do at home except she was asked to tell her infant a little story about each of the seven topics. The topics were chosen to elicit a variety of facial expressions (e.g., worried, happy) from the mother while she related the stories to her infant. English-speaking mothers spoke English, Chinese-speaking mothers spoke Chinese. The mother was asked to try to keep the baby in the car seat as much as possible, but to feel free to remove him/her for comforting as required. The video camera was focused on the mother's face. The experimenter then activated the camera, and left the room to leave the dyad to interact alone.

When the first 15 min session was completed, a warm and friendly adult confederate entered the room and sat across from the table next to the camera. The confederate spoke the language of the mother. The chair on which the mother was sitting was repositioned so that she now sat directly across from the confederate. In this session, the mother was asked to talk to the confederate about the same topics she had told her infant about. The camera was then readjusted so that only the mother's face was in focus and the camera set in the recording mode.<sup>3</sup>

With the mother's permission, the experimenter played with the baby in an adjacent room so that the mother could interact with the adult confederate without her infant present. At the end of the second session, the baby was returned to the mother. A certificate of participation, and an 'Infant Scientist' T-shirt, were given to the infant.

### *Stimuli for all Measures*

A single exemplar of each of the three expression types was selected from each mother for use in the subsequent validation measures. We will refer to these expressions as A, B, and C. To select these final stimuli, a number of steps were taken. First, all instances of each expression type from each mother were identified and digitized (each of these expression types was evident at least 5 times in a clear form in each mother in infant-directed interactions, and in some mothers, each was evident 15–20 times). A Macintosh IIfx computer was used to digitize the video images of the facial expressions. The program used to capture the images was MIC Video-snap, while the program used to print the images was SuperPaint 3.0.

All instances of each of the three expression types in each mother were printed out. Then, all instances were identified in which the mother's face was as centrally located on the videotape as possible so that the full facial expression

could be seen. To select from among the remaining options, the first two authors, using their joint judgement, the judgement of other members of the lab<sup>4</sup>, and the insights gained from the exploratory study, then selected a single prototypical instance of each expression type from each mother. This yielded a total of 60 printed video images, 30 from each language group, with 10 of each of the three expression types for each language group. The same video images were used in all four Measures. An example of each Expression type, A, B, and C, from both a Chinese- and an English-speaking mother is shown in Figure 1.

## MEASURE ONE

The first measure was designed to verify that we had indeed found three different types of facial expressions. We wanted to ensure that observers who were naïve to our hypotheses would group together pictures we thought were of the same type and distinguish pictures we thought were of different types. Would they sort instances of the pictures into three piles corresponding to the three expression types we had identified? In this endeavor, undergraduates were asked to sort instances of the pictures into three piles.

### *Method*

In Measure 1a, 20 undergraduates were given the entire stack of 60 pictures arranged in random order. They were informed that the pictures showed mothers interacting with their infants. Their task was to examine the pictures, and sort the pictures into three piles. They were not told anything about the facial expressions we had in mind, and were given no instructions as to what kinds of cues to use in



Figure 1. An example of expressions A, B, and C in Rows 1, 2, and 3, respectively, from two English-speaking and two Chinese-speaking mothers.



sorting the images. Subjects were tested individually so that they could not influence one another's behavior.

Measure 1b was included to control for the possibility that in Measure 1a performance would be artificially improved by the inclusion of three instances of each mother. We were concerned that in Measure 1a the subjects might have suspected that only one picture from each mother belonged in each pile given that the total set contained 3 pictures of each mother and the experimenter requested 3 piles. In Measure 1b, 12 additional undergraduates were given random selections of 20 of the pictures and asked to again sort them into 3 piles. Each student received a different random selection of 20 pictures. Thus students ended up with an uneven number of each expression type (range 4–10 per type).

**Results**

Using both Measures 1a and 1b participants were able to sort reliably the video images into three distinct piles which corresponded to the three distinct facial expression types we had identified. The percentage of pictures sorted under each facial expression type is shown in Tables 1a and 1b. The overall percent correct in Measure 1a was 93.4 and in Measure 1b it was 85.8. The likelihood of the obtained percentages occurring by chance was evaluated using Cohen's Kappa. This allowed us to analyze the agreement between the subjects' sort and the sorting done by the authors.

For Measure 1a, the Kappa was 90.1% (asymptotic std. error = 0.01). For Measure 1b the Kappa was 78.8% (asymptotic std. error = 0.034). These results provide strong support for the reliability of the classification scheme we developed for ID facial expressions as three distinct types.

**MEASURE TWO**

Measure 2 was designed to ascertain whether the muscle movements involved in the three infant-directed facial expressions are similar to or uniquely different from those described in the adult literature. The video images were analyzed by a coder trained in the use of the Facial Action Coding System (Ekman and Friesen, 1978). FACS can be used to score either moving facial expressions or still images.

Table 1.

		Facial expression type		
		A	B	C
<i>(a) The percentage of pictures correctly sorted under each facial expression type in Measure 1a</i>				
Subjects' sort	A	95.25	2.5	2.25
	B	4.25	89.75	6.0
	C	0.0	4.75	95.25
<i>(b) The percentage of pictures correctly sorted under each facial expression type in Measure 1b</i>				
Subjects' sort	A	92.5	5.0	2.5
	B	5.0	77.5	17.5
	C	3.75	8.75	87.5

If it is used to code static poses, it is necessary that a picture of a neutral face for that model also be provided as a standard to compare against the static pose (Ekman, 1982). We chose to code the static images as those were the images that were used in Measures 1, 3, and 4. We used as the standard for scoring each facial expression, a neutral facial expression displayed by each mother as recorded in the adult-directed segment of the video tape.

In FACS coding it is stipulated that facial expressions should not be coded if they are accompanied by talking, for fear that the articulatory gestures involved in producing certain words will influence the facial muscles being used. However, it has been noted repeatedly that mother–infant interactions are multimodal in nature, involving modifications not only in the face, but also in gestures, body movements, and in the voice (Papousek *et al.*, 1985; Stern, 1974; Sullivan and Horowitz, 1983). In our selections there were almost no instances in which mothers displayed facial expressions without accompanying vocalizations. For this reason it was not only appropriate, but essential, to code the facial expressions even though they were nearly always accompanied by speech.

### Method

A neutral facial expression of each of the 20 mothers was captured and printed as a baseline comparison to use with the respective mother's ID expressions. The neutral expression was taken from an AD segment of the tape. A trained (and certified) FACS coder was given these 20 neutral faces plus the 60 experimental video images. The experimental images were arranged randomly. The coder was told which were the neutral faces, and that the other facial expressions were all directed at infants. He was not told that we believed there were three distinct facial expression types. His task was simply to code all the images.

### Results

The results of using FACS to code the muscle movements involved in each expression type also revealed three distinct facial expressions. Table 2 illustrates the frequency and types of facial action units involved in each expression type. As can be seen, Expression A is characterized primarily by lip pucker. Two other

Table 2. Number of mothers by language group exhibiting the principal facial action units for each facial expression type

Facial action unit	Facial expression A		Facial expression B		Facial expression C	
	Chinese mum	English mum	Chinese mum	English mum	Chinese mum	English mum
Inner brow raise (1)	—	4	9	10	—	4
Outer brow raise (2)	—	3	9	9	—	4
Cheek raise (6)	—	—	1	—	10	9
Lip corner Pull (12)	6	2	7	5	10	10
Lip pucker (18)	9	10	—	—	—	—
Lips part (25) and/or Jaw drop (26)	10	9	2	—	10	9
Mouth stretch (27)	—	—	8	10	—	1

Note: Maximum in each cell is 10. Blanks indicate zero.

Action Units (AU), lips part and jaw drop, were also present in the English-speaking mothers' and Chinese mothers' A expressions, but their frequency of occurrence was much lower. Expression B is characterized by inner and outer brow raise, lip corner pull and mouth stretch. Expression C is characterized by cheek raise, lip corner pull, and some facial action that involves the mouth opening (either lips part or jaw drop).

The presence of these various facial action units was, in almost all cases, equally common in both the Chinese- and English-speaking mothers, lending support to the notion that these expression types are present even in very different cultures. The few differences noted between English- and Chinese-speaking mothers might indicate random noise, individual differences, or perhaps, cultural differences in the precise form of each expression type. To explore this, we also rank-ordered the relevant FACS units on a scale of 1–5 for degree of display. There were very few differences between the two groups of mothers, but when they did occur, typically it was the English-speaking mothers who tended to show more exaggerated displays.

Finally, we compared the facial action units involved in these ID facial expressions to those described by Ekman and Friesen (1978) as prototypical signals of emotions in AD interactions. All three ID expressions were different. Expression A involves puckered lips and a slightly open mouth, and is unlike any standard adult facial expression described by Ekman and Friesen, or to our knowledge, by any other investigator of adult-directed facial expressions. Expression B is similar to an adult 'surprise' expression with a wide open mouth and raised eyebrows, but with the added feature of lip corner pull (AU 12)—a feature that is not present in surprise (Ekman and Friesen, 1978). This hint of a smile occurs in over half of the mothers sampled. Expression C corresponds closely to an adult 'happy' expression, except that the mouth is always at least slightly open. The high incidence of cheek raise (AU 6) and lip corner pull (AU 12) makes this expression similar to the Duchenne smile described by Ekman *et al.* (1990).

### MEASURE THREE

This measure was designed to ascertain whether the three identified infant-directed facial expressions convey clear and systematic emotional messages. We showed participants images from each expression type and then asked them to tell us, in their own words, what emotional and communicative messages they felt were being conveyed by each expression type. Half of the subjects were given pictures of Chinese mothers and half of English mothers. This manipulation was included to examine, in a between-subjects design, whether the expression types conveyed similar messages when judged in the displays of members of two distinct cultural groups.

#### *Method*

The printed video images were divided into two piles: one with all the pictures of English-speaking mothers and the other with all the pictures of Chinese-speaking mothers. Within each pile, the pictures were sorted into the three expression types. Three color-coded questionnaires—green, blue, and yellow (one color for each expression) were attached to the front of each set of 10 pictures. The

questionnaire attached to the front of each set of 10 pictures of expression A was green, blue for Expression B, and yellow for Expression C.

To ascertain whether maternal experience shapes participants' judgement, two groups of participants were recruited for this measure. The first group comprised 40 undergraduates, 23 females and 17 males. The second group consisted of 35 mothers of infants aged 4½ months to 8 months. The members of each group mirrored the ethnic diversity in Vancouver. Every participant was given an envelope containing a green, yellow, and blue questionnaire with attached pictures. In the undergraduate group, 20 participants were given an envelope with all pictures of Chinese-speaking mothers and 20 were given an envelope with all pictures of English-speaking mothers. In the group of mothers, 19 were given an envelope with all pictures of Chinese-speaking mothers and 16 were given an envelope with all pictures of English-speaking mothers. The instructions attached to the front of each set of pictures directed the participants to look through the attached set of 10 pictures, and then answer the following two open-ended questions: Question (i) How does this set of pictures make you feel? and Question (ii) What emotional message do you think is being communicated by this set of pictures? An open-ended format was chosen because we did not want to limit the scope of responses from the participants or bias the participants' answers<sup>6</sup>.

## Results

Participants' responses to Questions (i) and (ii) in the questionnaire varied from one word to two sentences. To narrow down the number of descriptive terms and to make sense of the data, only the key descriptive words, such as surprise, happy, etc., were extracted from the answers. Words that were either inappropriate and/or uninterpretable for the question asked were discarded (e.g., 'weird', 'silly' in response to Question (i), and 'feeding', 'change diapers,' in response to Question (ii)).

A semantic analysis of the remaining 317 (159+158) feelings reported by both the undergraduate and mother groups in response to Question (i) yielded 9 categories: Happy, Loved, Comforted, Praised, Surprised, Excited, Interested, Sad and Disconcerted. Only 4 items were not classifiable using these 9 categories. A total of 318 (164 + 154) responses were given to Question (ii), and these yielded 9 analogous categories: Happiness, Love and Warmth, Comfort and Caring, Praise and Admiration, Surprise, Excitement and Enjoyment, Interest and Attention, Sadness, and Bad News. Only 5 items were not classifiable using these 9 categories. Response frequencies for each category are shown in Tables 3a (UNDERGRADUATE GROUP) and 3b (MOTHER GROUP) for Question (i), and in Tables 4a (UNDERGRADUATE GROUP) and 4b (MOTHER GROUP) for Question (ii).

Words from almost every category were mentioned in response to each expression. What differentiated the expression types, however, was the proportion of words from each category given in response to each facial expression type. Here it is clear that the three different expression types communicated clear and distinct feelings and emotional messages even to our diverse groups of judges. Looking first at the basic frequency data (see Frequency columns), several patterns are apparent. Among the undergraduates, the most common response to Expression A is Comfort and Caring, followed by a mixed set of Happy, Sad, Love, Interest. The most common response to Expression B is

Table 3.

Response category	Expression type A		Expression type B		Expression type C		Total
	Freq	E	Freq	E	Freq	E	
<i>(a) Frequency (Freq) and expected frequency (E) of responses to Question (i) for each of the three facial expression type: undergraduate group</i>							
Happy	8	18.9	8	14.1	<b>48***</b>	31.0	64
Loved	6	6.5	3	4.8	<b>13</b>	10.7	22
Comforted	<b>11**</b>	4.7	<b>4</b>	3.5	1	7.7	16
Praised	1	1.5	1	1.1	<b>3</b>	2.4	5
Surprised	3	5.9	<b>12**</b>	4.4	5	9.7	20
Excited	2	2.4	1	1.8	<b>5</b>	3.9	8
Interested	<b>5</b>	2.1	<b>2</b>	1.5	0	3.4	7
Sad	<b>7*</b>	2.1	0	1.5	0	3.4	7
Disconcerted	<b>3</b>	1.8	<b>3</b>	1.3	0	2.9	6
Other	1	1.2	<b>1</b>	0.9	<b>2</b>	1.9	4
Total	47	47	35	35	77	77	159
<i>(b) Frequency (Freq) and expected frequency (E) of responses to Question (i) for each of the three facial expression type: mother group</i>							
Happy	0	16.5	14	16.8	<b>38***</b>	18.8	52
Loved	<b>4</b>	3.5	2	3.6	<b>5</b>	4.0	11
Comforted	<b>33***</b>	13.0	1	13.2	7	14.8	41
Praised	0	1.6	<b>2</b>	1.6	<b>3</b>	1.8	5
Surprised	0	1.6	<b>5***</b>	1.6	0	1.8	5
Excited	0	4.7	<b>12***</b>	4.8	3	5.4	15
Interested	6	6.3	<b>13***</b>	6.5	1	7.2	20
Sad	<b>6***</b>	1.9	0	1.9	0	2.2	6
Disconcerted	<b>1</b>	0.9	<b>2</b>	1.0	0	1.1	3
Total	50	50	51	51	57	57	158

Note. Response frequencies greater than their expected value are highlighted in bold. \* $p < 0.10$ . \*\* $p < 0.05$ ; \*\*\* $p < 0.01$ .

Surprise, followed by Happy (Question (i)) and Praise (Question (ii)). Expression C generated primarily Happy responses, followed by Love (Question (i)) and Excitement (Question (ii)). For the mothers, Comfort and Caring was also the predominant response to both Questions for Expression A, followed by Sad and Love to Question (i) and only Love to Question (ii). Expression B yielded Happy, Interest, Excited and Surprise to both Questions (i) and (ii). As with the undergraduates, Expression C again yielded primarily Happy, but as well Love, Comfort, Praise, and Excitement.

Because the response frequencies differ across response categories and across expression types, base rates were calculated. An expected frequency for each cell of Tables 3 and 4 was calculated by multiplying the marginal frequencies corresponding to each cell and dividing this figure by the total number of responses. Of the 114 cells, 50 showed a frequency greater than expected from the marginals alone; these entries are highlighted in bold.

To estimate whether an observed frequency exceeded the expected frequency to a statistically significant degree, we calculated the probability of obtaining at least the observed frequency in a particular cell based on its expected frequency. For example, for Expression C in Table 3a, the probability of occurrence of a

Table 4.

Response category	Expression type A		Expression type B		Expression type C		Total
	Freq	E	Freq	E	Freq	E	
<i>(a) Frequency (Freq) and expected frequency (E) of responses to Question (ii) for each of the three facial expression type: undergraduate group</i>							
Happiness	6	11.3	4	9.7	<b>27***</b>	16.0	37
Love & Warmth	6	6.4	0	5.5	<b>15**</b>	9.1	21
Comfort & Caring	<b>20***</b>	7.6	3	6.6	2	10.8	25
Praise & Admiration	3	5.5	7	4.7	<b>8</b>	7.8	18
Surprise	1	8.2	<b>21***</b>	7.1	5	11.7	27
Excitement & Enjoyment	3	4.9	2	4.2	<b>11</b>	6.9	16
Interest & Attention	5*	2.1	0	1.8	2	3.0	7
Sadness	<b>1</b>	0.9	2	0.8	0	1.3	3
Bad News	<b>2</b>	1.2	<b>2</b>	1.0	0	1.7	4
Other	<b>3</b>	1.5	<b>2</b>	1.3	0	2.2	5
Total	50	50	43	43	71	71	164
<i>(b) Frequency (Freq) and expected frequency (E) of responses to Question (ii) for each of the three facial expression type: mother group</i>							
Happiness	2	10.8	6	9.9	<b>26***</b>	13.2	34
Love & Warmth	<b>6</b>	5.1	3	4.7	<b>7</b>	6.2	16
Comfort & Caring	<b>38***</b>	14.6	2	13.4	6	17.9	46
Praised & Admiration	0	4.5	4	4.1	<b>10**</b>	5.5	14
Surprise	0	1.3	<b>4***</b>	1.2	0	1.6	4
Excitement & Enjoyment	0	5.4	<b>9*</b>	5.0	8	6.6	17
Interest & Attention	2	6.0	<b>14***</b>	5.6	3	7.4	19
Sadness	0	0.0	0	0.0	0	0.0	0
Bad News	1	1.3	<b>3</b>	1.2	0	1.6	4
Total	49	49	45	45	60	60	154

Note. Response frequencies greater than their expected value are highlighted in bold.  
 \* $p < 0.10$ ; \*\* $p < 0.05$ ; \*\*\* $p < 0.01$ .

response falling in the category Happy is its expected frequency (31), divided by the number of responses to Expression C (77), yielding an estimate of 0.40. Using this figure, we then calculated the probability of getting at least the observed frequency (48) using a z-test, which in this case was less than 0.01. These calculations were computed for each of 50 frequencies that exceeded that expected from the marginals alone. All cell frequencies greater than that expected by chance when alpha is set at 0.10 are starred in Tables 3 and 4 (two stars for alpha of 0.05 and three stars for 0.01).

For the undergraduates, seven entries were significant when alpha was set at 0.05 and two additional entries were significant when alpha was increased to 0.10. For the mothers, eleven entries were significant when alpha was set at 0.05 (virtually all at the 0.01 level), with one additional significant entry when alpha was increased to 0.10. The pattern of statistically significant entries was largely consistent across Questions (i) and (ii) for both undergraduates and mothers, with some interesting differences.

The pattern of responses was highly consistent with the hypothesized core meaning of each Expression. Responses to Expression A were significantly related to notions of Comfort and Caring for both groups of respondents. As well, 'Sad' was significant for Question (i) but not Question (ii) for both

undergraduates and mothers. Among the undergraduates, response frequencies to Expression B were significantly greater than chance only to feelings of Surprise, but among the mothers, Surprise, Interest, and Excitement responses all occurred with significant frequency in response to both questions. Response frequencies to Expression C were significant for Happiness in both groups, plus Love and Warmth were often reported among the undergraduates and Admiration among the mothers. In short, these analyses showed that although responses to each expression varied across participants, there existed a statistically significant tendency for particular responses to be assigned to each Expression Type. Because of experimentwise probability of error, we offer this analysis as suggestive rather than rigorous.

The descriptive and quantitative analyses indicate that each expression type conveys clear and distinct messages to adults, with the message more differentiated for mothers than for undergraduates. For both groups Expression A unambiguously conveyed Comfort and Caring, with some concern (Sad). The undergraduates detected surprise only in Expression B (rendering it equivalent for them to Ekman's 'surprise' facial expression), but the mothers also picked up Interest and Excitement showing that for them, the Surprise conveyed by this expression is decidedly positive. Joy (Happy) is the primary message conveyed by Expression C, but mixed with this is Love, Praise, and Admiration.

## MEASURE FOUR

Included in the questionnaire used in Measure 3 was a section in which the same undergraduates and mothers were asked to rate how well each video image, on a scale of 1 (worst) to 5 (best), represented the full set of expressions in that category. By differentiating poorer from better images we could identify those facial action units that characterize the best representatives. Specifically, a rank correlation was calculated between representativeness ratings of the video images and the results obtained with FACS. We were hopeful that this correlation would help us determine precisely which FACS features are most defining for each expression type. To ascertain whether precisely the same facial features best describe these facial expressions in English and Chinese mothers, the rank order correlations were computed separately for each language group.

## RESULTS

Results of the ratings indicated that the mean representativeness rating varied with facial expression type. Participants rated Expression C significantly higher than Expressions A and B  $F(2, 117) = 14.13, p < 0.001$  but Expressions A and B were rated as not significantly different from each other. This pattern was observed even when the ethnicity of the mothers was taken into account. These results suggest that Expression C formed a more coherent group than did Expressions A or B.

A rank correlation between the average ratings and the FACS results in Measure 2 revealed the facial action units involved in the three expression types that have been rated the highest by subjects. Basically, the best facial action units

were very similar among the Chinese and English mothers, but there were a few differences.

The main characteristic features in Expression A for both groups of mothers are lip pucker (AU 18), and jaw drop (AU 26). In addition, Chinese mothers had lip corner pull (AU 12), and English mothers showed both inner brow raise (AU 1) and brow lower (AU 4). The prototypical Expression B is also quite similar in both cultural groups. The highest rank-order correlations were obtained for Chinese mothers by ranking as first, inner (AU 1) and outer (AU 2) brow raise, lip corner pull (AU 12), and mouth stretch (AU 27). For English mothers inner (AU 1) and outer brow raise (AU 2), and mouth stretch (AU 27) were important, but lip corner pull did not significantly improve the correlation to the highest average ratings. A comparison of the best ranking for Chinese and English mothers suggests that English mothers' best displays of these facial expressions include exaggerated movements of the eyebrows and eyes. For Chinese mothers, the inclusion of a hint of a smile (via lip corner pull) seems to be more central.

Expression C is a little more exaggerated in English than in Chinese mothers. In English-speaking mothers, Expression C is characterized by inner (AU 1) and outer brow raise (AU 2), cheek raise (AU 6), lip corner pull (AU 12), and mouth stretch (AU 27). Among Chinese-speaking mothers only cheek raise (AU 6), lip corner pull (AU 12), and lips part (AU 25) (instead of mouth stretch) are critical. Overall, there is little variability in subjects' mean ratings of the individual C Expressions in both groups of mothers.

## DISCUSSION

The research reported here confirms the presence of three ID facial expressions in mothers from two very different cultures. When interacting with their young infants, every Chinese- and English-speaking mother we examined repeatedly used each of these three distinct types of ID facial expressions. Naïve undergraduates sorted these expressions into three discrete piles. The FACS coding revealed objective facial muscle movements that characterize each expression type, and two of these FACS summaries were unique from the facial expressions that have been identified in adult-adult interactions. The three expression types were found, in an open-ended questionnaire, to convey different emotional messages.

Expression A is characterized by puckered lips and lips slightly apart (noted in the FACS units of lips part and jaw drop). As well, the majority of Chinese mothers demonstrated a slight smile (lip corner pull) and the English mothers raised their eyebrows. This expression type is unlike any described in the adult-to-adult facial expression literature, but is the same one, we believe, as that called 'fish mouth' face by Stern and colleagues (1977). Expression A unambiguously conveyed love and concern to adult viewers. Common words generated in response to this expression type included nurturance, calming, 'don't cry', compassion, reassurance, soothing, comforting, help, affection, caring, love, and protection. This expression has elements of an adult-directed worry expression, but the emotional message of love, concern, and emotional availability is, we believe, what makes this expression type special. We would suggest the term OCHIE be applied to this expression type to capture that sense of comforting, love, and a little playfulness.



Expression B is characterized by inner and outer brow raise, open and stretched mouth, and a hint of a smile (as evident in the FACS unit of lip corner pull). This expression type, which is, we believe, likely the same as the 'mock surprise' described by Stern (1974), is distinct from the adult-directed expression of surprise that has been described by Ekman and Friesen (1975), as the surprise expression does not include lip corner pull. This expression conveys a similar emotional message as that of Surprise to undergraduate viewers. It is noteworthy, however, that to mothers the type of surprise conveyed in the infant-directed expression is clearly a positive rather than a negative one. Indeed, mothers reported a cluster of Surprise, Excitement, and Interest. We suggest that this expression conveys that sense of wonder and engagement parents feel at their infant's accomplishments. We would suggest using the term WOW to label Expression B, to capture that sense of amazement and pride that this expression type communicates.

The third expression identified, Expression C, is characterized by a smile (lip corner pull), cheek raise, and a slightly open mouth (as evident by either lips part or jaw drop). Again, the English but not the Chinese mothers tended to raise their eyebrows when exhibiting this expression. This expression type is not distinct from the adult-directed HAPPY expression described by Ekman, but we believe it is noteworthy that in virtually every case, the mouth was slightly open in the infant-directed instances whereas open mouth is optional in the adult-directed case. We chose the term JOY (as used by Izard, 1977, for describing infant facial expressions) rather than HAPPY as we felt it more aptly reflects the set of adjectives generated by adult viewers in response to the expression type. These included, in addition to Happy type words (joyful, glad, etc.), praise words such as admiration, adoration, and pride among the mothers and love and caring among the undergraduates. In addition, and perhaps more importantly, the term JOY more closely captures the feature that we have not been able to quantify—an unmistakable look of love in the eyes. A similar observation made by Charles Darwin over a century ago captures this sentiment: 'Although the emotion of love, for instance that of a mother for her infant, is one of the strongest of which the mind is capable, it can hardly be said to have any proper or peculiar means of expression; and this is intelligible, as it has not habitually led to any special line of action. No doubt, as affection is a pleasurable sensation, it generally causes a gentle smile and some brightening of the eyes. A strong desire to touch the beloved person is commonly felt' (Darwin, 1892, pp. 224–225).

The expressions of WOW and OCHIE are distinct from those described in the adult-directed facial expression by Ekman (1982) or Izard (1977). The JOY expression, although not clearly distinct in FACS from an exaggerated adult Happy (or the Duchenne smile identified by Ekman *et al.*, 1990), conveys as well an unambiguous message of love, signifying that it may also entail subtle characteristics that make it distinct from the adult-directed (AD) HAPPY. We conducted two exploratory pilot studies to assess the feasibility of this hypothesis. In the first exploratory study, we asked adult viewers (half of them English and half Chinese) to sort 14 pairs of facial expressions (7 of Chinese and 7 of English mothers) into an ID and an AD pile. Each pair comprised the ID JOY expressions we had used in Measures 1–4 paired with an exaggerated AD HAPPY face from the same mother. Adult judges were accurate over 80% of the time in judging whether the person was talking to an adult or talking to an infant. In the second exploratory study<sup>7</sup>, we videotaped two women addressing either their 4-month-old infant or an adult confederate (in this case, a close friend), and selected a single ID JOY and a single AD (exaggerated) HAPPY from each

mother. We then tested 8 infants aged 6 months in a visual habituation procedure on their ability to discriminate the ID JOY from the AD HAPPY. The infants showed evidence of discriminating the ID from the AD expression, with marginally significant recovery to the change ( $t(5)=1.9$ ,  $p=0.05$ ). These pilot studies, although only exploratory, support the hypothesis that the ID JOY may be distinct from the AD HAPPY, and point to the need for further research to explore this question.

## CONCLUSION

The identification of three distinct (and possibly unique) ID facial expressions and the unambiguous messages they conveyed even to judges from diverse backgrounds and of different ages, strengthens the conclusions from the more naturalistic, interactional studies of the importance of facial expressions in modulating adult-to-infant interactions. Finding these same ID facial expressions in mothers from two very different cultures raises the possibility that these facial expressions may be common, or even 'universal' across cultures. The notion of universally available facial expressions that convey common communicative messages across cultures is an attractive, but far from established hypothesis despite massive efforts by Ekman, Izard, and others (see Russell, 1994). We would suggest, however, that if there is any domain in which special and universal facial expressions might be seen, one domain would be that of parent-infant interaction. Thus, one area for future inquiry involves testing the cross-cultural generalizability of this work by extending it to other cultural groups including those with no contact with one another, to fathers as well as mothers, and eventually to non-parents (including children).

A second exciting area for further research involves an examination of the functional utility of these expression types. Naturalistic studies of mother-infant interactions have shown that the modifications in the parents' face, voice, and body movements maintain positive parent-infant interactions, and help modulate the infant's emotional state (Papousek *et al.*, 1986; Trevarthen, 1977). Empirical studies using the 'still face' procedure have confirmed that infants do become upset when the normal style of affective engagement from their mother is withdrawn (e.g., Tronick *et al.*, 1978) and show an eventual recovery in positive affect when the mother resumes affective interactions (e.g., Weinberg and Tronick, 1996), confirming the importance of maternal affective engagement on infant emotional state. Social referencing studies have shown the central role that an encouraging vs. fearful maternal facial expression can have on infant behavior, i.e., in their willingness to attempt to cross a visual cliff (Sorce *et al.*, 1985). One area for future research will be to experimentally test the role the three ID facial expressions described herein play in parent-infant interactions. Do these expressions occupy three distinct roles in the emotional exchanges between parents and infants, or are they just part of a large class of positive affective expressions that can be used interchangeably? Experimental studies using the static images we identified, as well as more dynamic interactional studies, will be able to assess the specificity of the roles these three ID facial expressions play in modulating parent-infant interactions, and potentially in influencing infant behavior and affect.

In summary, in this study we have identified and systematically described three ID facial expressions. These findings broaden our understanding of the interaction style mothers use when communicating with their infants, and

support the existence of a unique set of facial expressions to complement the unique vocal register which has been previously described. It will be exciting in further work to systematically document the role these ID facial expressions play in infant development.

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## APPENDIX A: TOPICS FOR PARENT AND CHILD INTERACTION

Please tell your baby a little story about each of the following topics.

- (1) Your feelings towards your baby.
- (2) The day you brought your baby home from the hospital.
- (3) The first time you changed your baby's diapers.
- (4) Your baby's first bath.
- (5) Your baby's first shot.
- (6) The first time your baby met his/her grandparents or some other special person.

### Notes

1. The four students, Winston Yeung, Cindy Peacock, David Chan, and Myra Chui participated in the project to satisfy a research requirement in a statistics course. Winston Yeung continued to work on the project in a volunteer capacity throughout the summer.
2. Of the 10 mothers in each language group, 7 were videotaped specifically for this study, and the other 3 were selected from videotapes in our existing archives.
3. The 3 mothers from each language group from our archives had not been given a list of topics to talk about. At the time of taping, they had been asked to talk to their infants about events in that day. Both these mothers, and the 7 taped specifically for this project, used the topics given to them to get started interacting with their infants, but moved on to just talking to their infants in a much more spontaneous fashion. All 10 mothers showed all expression types.

4. This best exemplar from each mother as selected by the first two authors, plus two other close contenders from each mother were shown to 5 other members of the lab. Final selections reflected the joint agreement of the group.
5. We did not analyze the AD interactions in depth for evidence of these facial expressions. We did note, however, in examining the videotapes, that there were very few instances of each in the AD interactions, none of which were held for the full 1 sec required.
6. See Russell (1993) for evidence that preselected words influence participants' responses.
7. This study was undertaken by Jamie Afiffi as the research component of an undergraduate research methods course.

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