MULTIPLE MESSAGES: FACIAL RECOGNITION ADVANTAGE FOR COMPOUND EXPRESSIONS

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ABSTRACT: The impact of singular (e.g. sadness alone) and compound (e.g. sadness and anger together) facial expressions on individuals' recognition of faces was investigated. In three studies, a face recognition paradigm was used as a measure of the proficiency with which participants processed compound and singular facial expressions. For both positive and negative facial expressions, participants displayed greater proficiency in processing compound expressions relative to singular expressions. Specifically, the accuracy with which faces displaying compound expressions were recognized was significantly higher than the accuracy with which faces displaying singular expressions were recognized. Possible explanations involving the familiarity, distinctiveness, and salience of the facial expressions are discussed.

One of the most interesting aspects about nonverbal communication is that as a communication system, it is multiform; the system is diverse both in the types of messages that are sent and in the ways that the messages are relayed. That is, a great deal of information may be relayed by individuals via a number of different communication channels such as, the body, tone of voice, and facial expression (DePaulo & Friedman, 1998). The different channels through which messages are communicated are often used independently, but simultaneously (DePaulo, Rosenthal, Green, & Rosenkrantz, 1982).

Multiple messages, or messages in which multiple channels of communication are used simultaneously, have often been studied in terms of their consistency or inconsistency across different verbal and nonverbal

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channels. A number of individual difference variables, such as sex of receiver, sex of sender, mental health, age, and affective state, seem to have a significant impact on how consistent and inconsistent multiple messages are used and understood (Baril & Stone, 1984; Bugental, Kaswan, & Love, 1970; Hortacsu & Ekinici, 1992; Reilly & Muzekari, 1979; Roy & Sawyers, 1990; Zuckerman, Blanck, DePaulo, & Rosenthal, 1980). Inconsistent multiple messages, in particular, have been found to influence important behaviors, such as patient compliance with doctors' orders, student learning, and subordinate work satisfaction (Hall, Roter, & Rand, 1981; LaPlante & Ambady, 2000; Woolfolk, 1978).

While multiple messages have been examined across different channels, very little work has examined the communication of multiple messages within a single channel, such as the face. In non-deceptive situations, the human face has long been considered a highly influential source of information about the feelings, intentions, and beliefs of individuals (Kleck & Mendolia, 1990; Stanners, Byrd, & Gabriel, 1985). Further, the face is a unique source of nonverbal information, because unlike other nonverbal sources of information such as the body or the tone of voice, the face can convey multiple messages *as a single channel* (DePaulo & Rosenthal, 1979). For example, the face can display multiple emotional expressions (e.g., surprise and happiness) simultaneously. In this article, we examine the processing of multiple messages relative to the processing of singular messages communicated by a single channel, the face. We call facial expressions with the elements of more than one expression *compound emotional expressions* (CEEs), and expressions with the elements of one facial expression *singular emotional expressions* (SEEs).

Most work examining compound facial expressions has focused on the frequency of blended facial expressions (two or more simultaneous emotional facial expressions) in children. For example, Hyson and Izard (1985) found that as infants become toddlers, they display more emotional blends than pure facial expressions, with the most frequent blend in distressing situations being a blend of the expressions of sadness and anger. Other developmental studies also indicate a greater frequency of blended over pure emotional displays with age (Hiatt, Campos, & Emde, 1979; Matias & Cohn, 1993) and the presence of blends during infancy (Izard, Huebner, Risser, McGinnes, & Doughtery, 1980). Adults may show more complex emotional expressions and emotional blends than they do pure emotions (Malatesta & Izard, 1984). Further, adults can recognize blended emotions from photographs (Ekman, Friesen, & Ellsworth, 1972). Some evidence even suggests that adults can recognize certain blended expressions more accurately than some pure emotions. Thus, one study found that although, in general, both pure and blended expressions were recognized with about equal accuracy, blends of fear with other emotions were more accurately judged than pure fear (Nummenmaa, 1988).

While some research has suggested that blended expressions may be perceived categorically rather than continuously (Etcoff & Magee, 1992; Young, Rowland, Calder, Etcoff, Seth, & Perrett, 1997), no work to our knowledge has determined whether singular expressions are processed differently from compound expressions. The present study uses a face recognition paradigm to address this issue. Research on face recognition has demonstrated that recognition accuracy is impeded by the transformation of faces via processes such as facial inversion, visual angle change, and reversal to photographic negative (Inui & Miyamoto, 1984; Johnston, Hill, & Carman, 1992; Kottoor, 1989; Shapiro & Penrod, 1986; Terry, 1994). The addition of an emotional expression also influences the accuracy of face identity recognition (Bruce, 1982; Bruce & Young, 1986; Galper & Hochberg, 1971; Kottoor, 1989; Sorce & Campos, 1974). This implies that, although not central to the task of face recognition, added information to the face is processed regardless of whether subjects are asked to process it or not. To avoid attending to an altered facial expression would be akin to trying to hear words spoken without hearing the tone with which they are said. Thus, through an examination of the accuracy levels for CEE transformed faces versus the accuracy levels for SEE transformed faces, a direct comparison of the processing ease of CEEs relative to SEEs is possible.

In the past, reaction time has also been used as an indicator of the ease with which information is cognitively processed (Christensen, Ford, & Pfefferbaum, 1996; Ross, Jurek, & Oliver, 1996; Schultz, 1983; Shieh & Lai, 1996). Rapid processing may be the result of several factors including, salience, priming, and regularity of exposure (Allen, McNeal, & Kvak, 1992; Connine, Titone, & Wang, 1993; Fraser, Craig, & Parker, 1990; Jacobs, Grainger, & Ferrand, 1995; Lin & Murphy, 1997). If compound emotions do indeed occur more often and more spontaneously than singular expressions in daily life, as suggested by the research reviewed earlier, it follows that faces with compound expressions might be recognized more quickly as well as more accurately than those with singular emotions.

We conducted three studies to examine the effects of singular and compound facial emotional expressions on the accuracy and latency of facial recognition. We restricted our investigation to compound expressions of the same hedonic tone due to previous evidence indicating that emotions of opposite tones do not blend well (Nummenmaa, 1988, 1990). We hypothesized that faces with compound emotions will be more quickly and accurately recognized than faces with singular emotions because it is likely that compound expressions occur more often and spontaneously in everyday behavior and consequently are processed more efficiently than SEEs (Hiatt et al., 1979; Matias & Cohn, 1993; Malatesta & Izard, 1984).

General Methodology

Studies 1, 2, and 3 utilized the same methodology. The goal of Study 1 was to determine the ease with which individuals process singular and compound *negative* facial expressions (anger/sadness). Specifically, it was hypothesized that participants show increased latencies and would be less accurate when responding to faces with singular facial expressions than when responding to faces with compound facial expressions. The goal of Study 2 was to replicate Study 1 with alternative negative expressions of emotion (disgust/anger). It was expected that the results would replicate Study 1. The goal of Study 3 was to determine the ease with which individuals process relatively singular and compound *positive* facial expressions. The expressions of happiness and surprise were used. While surprise might not be a purely positive expression, the pairing of happiness with surprise was believed to provide sufficient weight to the compound expression to make the overall expression positive. It was expected that the results would replicate Studies 1 and 2.

Method

Participants

For Studies 1 and 3, thirty-two undergraduates (16 male, 16 female) were tested. For Study 2, forty undergraduates (18 male, 22 female) were tested. They were either paid for their participation or received course credit.

Materials

All stimuli were 4 × 6 inch black and white computer images obtained from Ekman and Friesen's (1978) photograph set. Stimuli intended to approximate compound expressions were created by combining two different photographs of singular emotional expressions (sadness and anger, disgust and anger, or happiness and surprise) of the same individual. The transformed stimuli were constructed using Macintosh software, PhotoFlash. Thus, for Study 1 the top half of sadness and bottom half of anger were blended, for Study 2, the top half of disgust (no visible nose wrinkling) and the bottom half of anger were blended, and for Study 3, the top half of surprise and the bottom half of happiness were blended. There were no visible seams on the stimuli.

While these stimuli may not be similar to traditional naturally posed blended expressions, they were examined by a Facial Action Coding System (Ekman & Friesen, 1978; FACS) expert. The expressions in Studies 1 and 2 were found to be ecologically valid expressions. The expressions in Study 3, however, were found to be less ecologically valid. But, in the interest of exploring how positive CEEs were processed relative to positive SEEs, the study was included. All of the stimuli were presented via Maclab, on a Macintosh Performa 6115CD.

Design

The three studies utilized a 2 $\times$ 2 $\times$ 2 mixed-model design, with participants' sex and test set as between subjects variables and type of expression (singular vs. compound) as the within subjects variable.

Procedure

For each study, participants were shown a set of 10 presentation faces with neutral expressions. They were instructed to try to remember the faces. They were then shown one of two sets of test faces. Each test set consisted of 8 faces, 4 of which displayed singular expressions (e.g., sad or angry) and 4 displayed compound expressions (e.g., sad/angry composite). Two of the singular expression faces and 2 of the compound expression faces were part of the original presentation set. The other 4 faces were new faces that the participants had not previously seen. The faces in the two test sets were identical, but to ensure that any differences between singular and compound expressions were due to the expressions themselves and not order of the faces, the order of the faces in one test set varied from the second test set.

Half of the participants were tested with one test set and half were tested with the other test set. Participants were asked to press the key "B" on the computer keyboard if they had seen the face before and "N" if they had not seen the face. Latency for response and accuracy of response were measured. Latency was measured in milliseconds. Accuracy was measured in 3 ways, (a) the percent of correct responses, (b) the percent of false alarms, and (c) positive hit rate.

Results and Discussion for Study 1: Anger/Sadness

Latency

In order to meet the criteria that the data be normal, the log of the latency scores was taken. There was no main effect of test set. There was a significant main effect for type of expression (F (1, 28) = 4.26, $p < 0.05$, $r = 0.36$) such that faces displaying compound negative expressions were recognized faster than faces displaying singular negative expressions (see Table 1 for means and standard deviations). Thus, singular negative expressions of sadness or anger were associated with an increased latency in facial recognition compared to compound negative expressions.

Accuracy

There was no significant main effect for test set for any of the accuracy variables. For the percent of correct responses, there was a main effect for the type of expression displayed (F (1, 28) = 8.0, $p < 0.01$, $r = 0.47$) such that participants were relatively more accurate when identifying faces with compound negative expressions than they were for faces with singular negative expressions. Similarly, the main effect of type of expression for hit rate approached significance (F (1, 28) = 3.07, $0.05 < p < 0.1$, $r = 0.31$) such that participants were more likely to positively identify faces display-

TABLE 1

Mean Latency and Accuracy for Compound and Singular Negative Expressions: Anger and Sadness

	Type of Expression	
	Compound	Singular
Dependent Variable	*M* (*SD*)	*M* (*SD*)
Latency	3.17 (0.22)	3.21 (0.24)
Percent Correct	0.81 (0.18)	0.69 (0.22)
False Alarm Rate	0.27 (0.31)	0.47 (0.38)
Hit Rate	0.97 (0.12)	0.89 (0.21)

Note. Numbers in parentheses are standard deviations. Latency is log transformed.

ing compound negative expressions than faces displaying singular negative expressions. Finally, participants were relatively more likely to falsely report that faces with singular negative expressions were part of the original set of faces when they were not (false alarms) than faces with compound negative expressions ($F(1, 28) = 6.68$, $p < 0.05$, $r = 0.44$). In sum, faces with singular negative expressions were associated with higher false alarms and lower recognition accuracy than faces with compound negative expressions.

Results and Discussion for Study 2: Disgust/Anger

Latency

In order to meet the criteria that the data be normal, the log of the latency scores was taken and the upper and lower 5% of the data were trimmed. The main effect of test set was not statistically significant. Similarly, the main effect of the type of expression was in the predicted direction, but not statistically significant ($F(1, 29) = 2.10$, $p > 0.05$, $r = 0.26$) (see Table 2 for means and standard deviations).

Accuracy

There was no significant main effect for test set for any of the accuracy variables. For the percent of correct responses, there was a main effect for

TABLE 2

Mean Latency and Accuracy for Compound and Singular Negative Expressions: Anger and Disgust

	Type of Expression	
	Compound	Singular
Dependent Variable	*M* (*SD*)	*M* (*SD*)
Latency	3.17 (0.13)	3.23 (0.20)
Percent Correct	0.82 (0.18)	0.62 (0.21)
False Alarm Rate	0.24 (0.30)	0.59 (0.34)
Hit Rate	0.86 (0.30)	0.84 (0.24)

Note. Numbers in parentheses are standard deviations. Latency is log transformed.

the type of expression displayed (F (1, 36) = 19.87, $p < 0.01$, $r = 0.60$) such that participants were relatively more accurate when identifying faces with compound negative expressions than they were for singular negative expressions. The main effect of type of expression for hit rate, however, did not reach significance (F (1, 36) = 0.30, $p > 0.05$, $r = 0.09$). Finally, participants were relatively more likely to report that faces with singular negative expressions were part of the original set of faces when they were not (false alarms) than faces with compound negative expressions (F(1, 36) = 24.08, $p < 0.01$, $r = 0.63$). In sum, faces with singular negative expressions were associated with higher false alarms and lower recognition accuracy than faces with compound negative expressions, replicating the results of the previous study.

Results and Discussion for Study 3: Happiness/Surprise

Latency

In order to meet the criteria that the data be normal, the log of the latency scores was taken. The main effect of test set was not statistically significant. Similarly, the main effect of the type of expression was in the predicted direction, but not statistically significant (F (1, 28) = 0.04, $p > 0.05$, $r = 0.04$) (see Table 3 for means and standard deviations).

TABLE 3

Mean Latency and Accuracy for Compound and Singular Positive Expressions: Happiness and Surprise

	Type of Expression	
	Compound	Singular
Dependent Variable	*M* (*SD*)	*M* (*SD*)
Latency	3.12 (0.18)	3.13 (0.21)
Percent Correct	0.79 (0.18)	0.60 (0.15)
False Alarm Rate	0.25 (0.28)	0.67 (0.33)
Hit Rate	0.91 (0.20)	0.92 (0.18)

Note. Numbers in parentheses are standard deviations. Latency is log transformed.

Accuracy

There was no significant main effect for test set for any of the accuracy variables. As in Study 1, participants obtained a higher percentage of correct responses when responding to faces with compound expressions as opposed to singular expressions (F (1, 28) = 23.44, $p < 0.01$, r = 0.68). The main effect of type of expression for hit rate was not statistically significant (F (1,28) = 0.09, $p > 0.05$, r = 0.06). However, as predicted, there was a main effect for type of expression on false alarm rate (F (1, 28) = 32.92, $p < 0.01$, r = 0.735) such that participants made more false alarm errors for singular positive expressions relative to compound positive expressions. While the results of this study should be viewed cautiously, because of the ecological validity of the stimuli, they nevertheless replicated the results of the previous two studies. Participants seemed to recognize faces displaying compound positive expressions more accurately than those with singular expressions. For all three studies, this seems primarily to be due to an increased false alarm rate to SEEs.

Manipulation Check

It is possible that individuals perceived the created CEEs as pure expressions and not mixed expressions. Research on blended expressions is suggestive of this (e.g., Young et al., 1997). In order to demonstrate that the CEEs used in these studies were viewed as mixed and not pure expressions, stimuli (positive and negative expressions from studies 1 and 3) were rated using a 1–9 Likert scale (1 = not at all true, 9 = very much true) by 24 undergraduates (12 male, 12 female) to obtain an estimate of the degree to which each type of expression was viewed as "mixed" and "pure." Consistent with expectations, positive and negative compound expressions (M = 4.49 SD = 1.39) were rated as significantly more mixed than positive and negative singular expressions (M = 3.86 SD = 1.02; F (1, 22) = 7.07, $p < 0.01$, r = 0.49) and positive and negative singular expressions (M = 4.39 SD = 1.20) were rated as significantly more pure than positive and negative compound expressions (M = 3.77 SD = 1.19; F (1, 22) = 6.04, $p < 0.05$, r = 0.46).

General Discussion

The results of these three studies were remarkably consistent, supporting predictions that faces with compound emotional expressions would by recognized more accurately than those with singular emotional expressions.

Specifically, the presence of both positive and negative singular emotional expressions significantly reduced absolute accuracy of facial recognition and elicited a greater likelihood of false alarms for faces than the presence of both positive and negative compound emotions. Thus, faces with CEEs were recognized more accurately than those with SEEs. Three potential explanations for these findings are discussed below.

First, faces with compound expressions might be recognized more accurately because such expressions are more familiar. Previous research shows that familiarity is associated with superior facial recognition (Ellis, Shepherd, & Davies, 1979; Klatzky & Forrest, 1984). As mentioned earlier, a number of researchers have suggested that blended facial expressions occur more often and more spontaneously in everyday life, especially when the blended expressions possess a similar hedonic tone (Ekman & Friesen, 1969; Ekman et al., 1972; Hiatt et al., 1979; Hyson & Izard, 1985; Malatesta & Izard, 1984; Nummenmaa, 1988; Plutchik, 1962; Tomkins & McCarter, 1964). Thus, the observation of higher overall accuracy for CEEs relative to SEEs may have been a product of familiarity with CEEs relative to SEEs.

Alternatively, the CEEs might be particularly distinctive. Research has shown that memory for faces is enhanced by distinctiveness (Bartlett, Hurrey, & Thorley, 1984). But, this might be a less plausible explanation for the results of these studies. Rather than increase accuracy, distinctiveness in these studies was likely to decrease accuracy. Specifically, the distinctiveness of a particular face was not apparent during facial presentation; all of the faces were neutral in their expressions at encoding. Because the study uses facial transformation, or the addition of emotional expressions after the initial presentation of the face, the potential distinctive aspects associated with a given facial expression were not present until the memory test. Distinctiveness in this case would be more distracting than helpful for facial recognition. An examination of the hit rate and false alarm rate of CEEs and SEEs supports this argument.

First, the hit rate for CEEs and SEEs was close to identical for all three studies. Thus, while any benefit obtained from CEEs being distinctive should be observed in hit rate, this was not the case. The real differences between these types of expressions seemed to emerge in the false alarm rate. The false alarm rate for CEEs was low, indicating that participants distinguished previously presented faces displaying CEEs from novel faces displaying CEEs quite well. In contrast, the high false alarm rate observed with SEEs suggests that participants were unable to accurately distinguish the two types of SEE faces. In fact, the data may even imply that a yea-saying bias occurs for SEEs.

One possible reason for this difference in false alarm rates could be that singular expressions are more distracting, or attention-grabbing than compound expressions. Thus, the third, and most likely, explanation for these findings is that SEEs are simply more salient than CEEs and consequently draw the attention of the perceiver away from the memory task at hand to the added expression. Certain facial expressions have been found to be more attention-grabbing than others (Hansen & Hansen, 1988; cf. Purcell, Stewart, & Skov, 1996; von Grunau & Anston, 1995). Thus, it is not inconceivable that CEEs and SEEs have differential attention-inducing properties. Indeed, an examination of the false alarm rate suggests that the differences in overall accuracy might best be explained by the high false alarm rate to SEEs. In contrast to compound expressions, singular expressions debilitated facial recognition by increasing false alarm rate. Thus, perhaps the SEEs attracted the attention of the participants to a greater degree than the CEEs, resulting in a higher false alarm rate and lower overall accuracy.

Certain limitations of the present research should be kept in mind. A greater number of stimuli should be used in future research so that signal detection statistics (such as d') can be used as a measure of accuracy. To achieve greater ecological validity, a racially diverse stimulus set with naturally posed expressions should be used and additional methods of study should be employed, such as utilizing morphed or naturally posed expressions. Finally, because the predicted pattern for latency was not observed, future research should examine whether this difference in processing does not occur at this level, or if the method of measurement was not sensitive enough to detect a difference in processing.

In sum, the present studies demonstrate the importance of investigating both compound expressions as well as singular emotional expressions in facial processing, perception, and recognition. Much research on emotional expressions and emotional experience has focused on singular expressions, perhaps because such expressions are simpler to examine than more complex compound expressions. However, the present research has shown that these expressions do not elicit identical responses from perceivers. Individuals demonstrate greater proficiency in dealing with information contained in CEEs, and these expressions deserve greater attention.

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