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**The objective measurement of facial expression in patients with
right brain damage and Parkinson's disease**

Brozgold, Alizah Zahavah, Ph.D.

City University of New York, 1988

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**The Objective Measurement of Facial Expression
in Patients with Right Brain Damage
and Parkinson's Disease**

by

Alizah Z. Brozgold

A dissertation submitted to the Graduate Faculty in
Psychology in partial fulfillment of the requirements for
the degree of Doctor of Philosophy, the City University of
New York.

1988

This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirements for the degree of Doctor of philosophy.

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INTRODUCTION

The clinical neurological literature has long distinguished between two different types of facial behavior: one that is voluntary or deliberate and one that is involuntary or spontaneous. Two distinct neuro-anatomical pathways have been proposed for the innervation of these systems. Voluntary facial expression is purportedly mediated by cortical or pyramidal pathways, whereas spontaneous expression is controlled by extra-pyramidal or subcortical pathways (Kahn 1964).

One method of examining the brain-behavior relationships involved in posed and spontaneous facial expressions is to compare patients with known cortical and subcortical lesions. Right brain-damaged patients are of interest, not only because they have cortical lesions, but because the right hemisphere has been shown to specialize in the processing of emotion (see Borod, Koff, and Caron, 1983, for a review). Studies with normal subjects have found that the right hemisphere mediates the recognition of emotional facial expression and emotional intonation. Experimental studies with right brain-damaged patients have demonstrated impaired ability to perceive and express facial emotion (DeKosky,

et al., 1980; Bowers, et al., 1985; Borod, et al., 1986a).

Another brain-damaged group of interest is Parkinsonians who are notably characterized by their lack of spontaneous facial expression. There is also clinical and experimental evidence of emotional changes associated with Parkinson's disease (e.g., depression) as well as the suggestion of a distinctive pre-morbid personality among Parkinsonians characterized by a lack of affect and an emotional and attitudinal inflexibility (see Todes and Lees, 1985, for a review).

A study comparing right brain-damaged patients, Parkinsonians and left brain-damaged patients in their spontaneous expression of facial affect (Buck and Duffy, 1980) found that while right brain-damaged patients and Parkinsonians were significantly less expressive than left brain-damaged patients and normals, Parkinsonians were judged as being even less expressive than the right-brain damaged patients. Another study (Borod, Alpert, Brozgold, et al., 1986) examined the facial expressions of right brain-damaged patients and Parkinsonians under posed conditions. In this investigation, right brain-damaged patients were more impaired than Parkinsonians in posing emotional expressions; they were also less accurate at perceiving facial affect in others.

This proposed research seeks to investigate the

ability of right brain-damaged patients and Parkinsonians to express facial emotion under both posed and recollected ("spontaneous") conditions. A dissociation is expected such that right brain-damaged patients will have greater difficulty producing posed facial expressions than producing facial emotion during a more spontaneous, emotion recollection procedure, while Parkinsonians will show the reverse pattern.

A group difference is also expected between the groups relating to upper and lower facial movement. Right brain-damaged patients should demonstrate diminished expressiveness when posing expressions involving the lower, but not necessarily the upper, face. Parkinsonian patients would not be expected to show any differences in upper and lower facial movement. This hypothesis stems from neurological evidence that voluntary facial movement of the lower face is innervated contralaterally, while cell groups of the facial nucleus innervating muscles of the upper face are distributed bilaterally (Carpenter, 1978). While this relationship has been clearly delineated for patients with cortical lesions, it has not been described for patients with subcortical lesions, although the assumption is that innervation is bilateral.

Finally, a possible valence effect is expected such that RBDs will display less negative, and more positive, affect in both their posed and spontaneous emotional ex-

pression. This hypothesis is based on recent evidence of differential hemispheric lateralization for positive and negative emotion (e.g., Sackeim, et al. 1982; Schwartz, et al., 1979). According to this "valence theory," RBDs with destructive lesions would evidence more positive emotion due to the contralateral inhibition of the left hemisphere (which is specialized for mediating positive emotion). The theoretical assumption is that brain damage disrupts the normal process of inhibiting emotional displays, and that these destructive lesions release from inhibition the remaining tissue (e.g., the opposite [left] hemisphere). For PDs, a decrease in positive emotion might be expected based on the high frequency of depressed mood among Parkinsonian patients (Mayeux, et al., 1981).

There have been very few experimental studies of facial expression with brain-damaged populations, and the studies (e.g., Borod, Koff, Perlman Lorch, and Nicholas, 1986; Kolb and Milner, 1981; Buck and Duffy, 1980) which have been carried out have used subjective rating systems. The major contribution of the current project is its use of an objective, theoretically-based, anatomically-linked coding scheme (i.e., Max) which identifies muscular configuration in three facial regions (brows, eyes, mouth) that are associated with prototypical emotional expressions. The use of a quantitative system, such as Max, allows for a more sensi-

tive investigation of the neuroanatomical system underlying emotional facial expression.

STATEMENT OF THE PROBLEM AND LITERATURE REVIEW

Background

Our day-to-day experience confirms the importance of facial expressions as a crucial channel of communication. Through observing facial expressions in others, we receive information about fleeting and often complex emotions, as well as longer lasting moods. More permanent aspects of personality can also be revealed, as in the apparent structural changes in the faces of older adults which give the impression of underlying affect states or "background affect" (Malatesta and Izard, 1984).

Experimental studies have also borne out the importance of the face as a communicator of emotion. Mehrabian (1972) found, for example, that when subjects were asked to convey messages of like and dislike to others, the facial channel contributed more than the vocal channel to the decoding of the messages.

While social psychological research on emotional facial expression has focused on its social and interpersonal determinants, neuropsychological research has examined facial expression in the context of hemispheric lateralization and the effects of specific brain lesions

on emotional communication. In the clinical neurological literature, descriptions of impaired facial expression have long been integral to particular diagnoses. Knowledge of these disorders also bears on the distinction between voluntary or posed and involuntary or spontaneous emotional expression.

According to current knowledge (see review by Rinn, 1984), impulses for volitionally induced movement emanate from the cortical motor strip and course to the facial nucleus through corticobulbar projections. Impulses for involuntary emotional expressions arise from extrapyramidal pathways involving mostly subcortical nuclei. Clinical evidence of this neuroanatomical distinction comes from observation of patients with known cortical and subcortical lesions.

Different types of facial paralysis, for example, can result in the loss of voluntary, but not involuntary, facial movement. In "emotional facial paralysis" or "reverse facial paralysis," there is facial asymmetry during spontaneous expression but not during voluntary facial movement. This phenomenon has been noted among autistic children (Damasio and Maurer, 1978) and has been interpreted as a sign of damage to the basal ganglia or the thalamus (Kahn, 1966).

Damasio and Maurer (1978) also have pointed out that "emotional" or "reverse facial paralysis" can result from damage to the mesolimbic cortex, e.g., the

supplementary motor cortex. Reverse facial paralysis contrasts with central facial paralysis in which voluntary contraction of the contralateral muscles of the lower face is impaired. The probable lesion site is in the lower third of the precentral gyrus or in the pathways connecting to the motor nucleus of the facial nerve.

Another source of clinical evidence comes from case studies of patients who have undergone facial nerve anastomosis, a surgical procedure in which the motor root of the facial nerve is severed, and fibers are spliced onto it from another cranial nerve (e.g., the spinal accessory nerve). The patient initially learns to move his/her face by moving his/her shoulder (which is innervated by the spinal accessory nerve). Yet while the patient regains the ability to make voluntary facial expressions, involuntary emotional movements remain restricted to the unaffected side, as the motor centers for emotional movement continue to send their impulses to the now disconnected stump of facial nerve.

While clinical case studies suggest two separate neuroanatomical systems for facial movement -- one cortical and the other subcortical -- the brain-behavior relationships subsumed by these systems have not been clearly delineated. One way to experimentally ascertain the differences between posed and spontaneous facial behavior would be to compare patients with known cortical

or subcortical damage in their ability to produce facial expressions under posed and spontaneous conditions. According to the neuroanatomical theory outlined above, one would expect to see a dissociation between the patients, such that those with cortical damage would demonstrate impaired expression under posed, but not spontaneous, conditions and those with subcortical damage would show the opposite pattern of behavior. Two groups particularly suited for this type of examination are patients with unilateral, cortical lesions of the right hemisphere and Parkinsonian patients with subcortical brain damage.

Patients with right hemisphere lesions are of interest not only because of the cortical locus of their brain damage but also because of the relationship between the right hemisphere and emotional communication (see Borod, Koff, and Caron, 1983, for a review). Studies with normal subjects have shown a left visual-field advantage (or right hemispheric specialization) for emotional facial identification (Suberi and McKeever, 1977; Ley and Bryden, 1979), as well as a left ear advantage for identifying the emotional intonation of sentences (Ley and Bryden, 1982).

The mediation of affect by the right hemisphere is also manifest in asymmetries of emotional facial expressions in normal subjects. Studies with primarily posed emotional expressions have led to the discovery of left-

sided asymmetry (i.e., greater left-sided mobility) regardless of handedness (Borod and Caron, 1980). Borod, Koff, and Caron (1983) argued that this finding suggests that "facedness" or facial asymmetry does not appear to be due simply to a motor effect but rather that facial expression is related primarily to emotion and is mediated by the right hemisphere.

Further evidence for left-sided facial asymmetry comes out of research that examined facial expressions of emotion using composite photographs made up of either two right sides or two left sides of the poser's faces. Composites are made by splitting a standard orientation photograph and its mirror reversal down the midline and then joining the halves of the right and left sides to form a new facial whole. Experimental investigations have generally demonstrated that left-sided composite photographs of posed emotional expressions are perceived as more intense than right-sided composites due to the right hemisphere's involvement in emotional expression (see Borod and Koff, 1984, for a review).

Studies examining spontaneous emotional expression in normal subjects have used various types of mood induction procedures to ascertain whether facial asymmetry is present under a spontaneous experimental condition (see Borod and Koff, 1984; Rinn, 1984 for reviews). Moscovitch and Olds (1982) found that facial expressions induced while relating emotional experiences were sig-

nificantly left-sided, and the largest asymmetries were found among movements of the lower face. This is consistent with theories that the lower face is innervated primarily by the contralateral hemisphere.

Other investigators have had subjects produce emotional expressions under both posed and spontaneous conditions. Research by Dopson, et al. (1984) and Borod, Koff, and White (1983) has not shown a significant effect of elicitation condition (i.e., posed versus spontaneous) on asymmetry of facial expression. Ekman et al. (1981), however, using an objective measurement system for rating facial movement, found that subjects' deliberate facial actions had significantly more asymmetries of movement than their spontaneous expressions (but see also Ekman, Hager, and Friesen, 1981).

A major problem in comparing the above studies is that each one employed a very different procedure for eliciting the expressions, and only two of them (Dopson, et al., 1984; Borod, Koff, and White, 1983) investigated both posed and spontaneously occurring expressions in the same adult subjects. Examining emotional facial behavior in brain-damaged subjects provides another important avenue for investigating differences in posed and spontaneous emotional expressions.

Right Hemisphere Pathology

Patients with right hemisphere lesions have been

the focus of neuropsychological investigations on both the perception and expression of emotion. The neurologist, Hughlings-Jackson, was the first to call attention to the association between damage to the right hemisphere and the impairment of facial recognition (Hughlings-Jackson, 1876). Experimental studies have also found right brain-damaged patients to be impaired in the recognition of emotional faces (e.g., DeKosky et al., 1980; Borod et al., 1986a). A recent study confirmed this finding of impaired emotional perception even when patients were equated for their ability to identify neutral faces (Bowers et al., 1985).

Right brain-damaged patients have also shown impairment in their ability to express facial emotion. Ross and Mesulam (1979) reported clinical observations of diminished facial expressions and emotional gesturing following right brain damage. A study by Buck and Duffy (1980), looking at subjects' spontaneous facial expressions in response to slides, found that right brain-damaged patients were rated as significantly less expressive than left brain-damaged patients and normal controls.

Finally, in a study by Borod, Koff, Perlman Lorch, et al. (1986a), right brain-damaged patients were significantly less accurate than left brain-damaged patients and controls in expressing both orally elicited and spontaneous facial emotion. The robustness of this

finding of diminished expressiveness is buttressed by additional data of Borod et al. (1986b) indicating that impaired facial mobility was not a critical factor in the diminished expressiveness of the right brain-damaged patients.

In conclusion, the research literature regarding the differences between the posed and spontaneous expression of emotion among right brain-damaged patients is not clear. The only study that has looked at both posed and spontaneous emotional expressions in the same right brain-damaged subjects (Borod, et al., 1986a) found no significant differences. This may have stemmed from the experiment's slide viewing procedure which may have failed to evoke a sufficient emotional response from the subjects.

Parkinson's Disease

Parkinsonian patients, with subcortical lesions, have not been the object of the same experimental scrutiny as right brain-damaged subjects, despite the fact that the absence of spontaneous facial expression or masked facies is regarded as a hallmark symptom of the disease.

James Parkinson, in his (1938) description of "the shaking palsy," was probably the first to describe some of the emotional changes in Parkinsonian patients (see Mayeux, 1983 for a review). He referred to them as

"melancholy" and mentioned a state of delirium in the final stages of the disease. Since his account, both depression (Mayeux, et al., 1981) and drug-related psychosis (Harvey, 1986) have been reported; non-drug-related psychosis has been rarely noted.

There is also some speculation that there may be a distinctive, pre-morbid personality among Parkinsonian patients. Sands (1942), for example, described the Parkinsonian personality as "masked" with chronically suppressed anxiety, aggressiveness, and anger. Lit (1968) found in a study of 50 patients that Parkinsonians had a limited range of emotional expression and a withholding tendency.

In a recent experimental study (Scott, Caird, and Williams, 1984), Parkinsonian patients were tested for their ability to appreciate the prosodic aspects of their own and others' speech in addition to matching facial expressions with sentences said in different emotional tones. The investigators found that the Parkinsonian patients had difficulty in perceiving vocal and facial emotion, in addition to having difficulty saying sentences in different emotional tones.

Buck and Duffy (1980) looked at spontaneous facial expression in response to emotionally evocative slides, comparing right and left brain-damaged patients with Parkinsonian patients and normal controls. Both right brain-damaged and Parkinsonian patients were rated as

significantly less expressive than the left brain-damaged and normal control subjects. In addition, the Parkinsonian patients were judged to be less expressive than the right brain-damaged patients.

The Buck and Duffy (1980) study suggests that right brain-damaged and Parkinsonian patients are impaired in their spontaneous expression of emotion; however, there is no data within this study on posed facial expressions for comparison. The comparison of right brain-damaged and Parkinsonian patients in their ability to produce voluntary versus involuntary facial expression bears on the purportedly distinct neuroanatomical pathways involved in the two types of behavior. As discussed earlier, voluntary facial expression is thought to be innervated by cortical or pyramidal mechanisms, whereas spontaneous expression is thought to be controlled by extrapyramidal or subcortical systems (Kahn, 1964).

Hemispheric Lateralization for Positive and Negative Emotion

While most of the research literature supports the notion of an overall right hemisphere mediation of emotion (see Borod, Koff, and Caron, 1983 for a review), some researchers have posited differential hemispheric lateralization for positive and negative emotion. More specifically, this "valence theory" proposes that the right hemisphere mediates negative affect, while the

left hemisphere is involved in controlling affect of a positive valence.

Evidence for the valence theory comes from studies with both normal and brain-damaged subjects. Schwartz, et al. (1979), for example, using lateral eye movements (LEMs) as an index of relative hemispheric activation, found more right LEMs when normal subjects were asked questions involving positive emotions and more left LEMs when asked questions involving negative emotions.

Dimond, et al. (1976) employed a specially designed contact lens system which projected films to either hemisphere. After viewing the films, subjects rated them using the categories "pleasant," "unpleasant," "humorous," and "horrific." Results suggested that the films projected to the right hemisphere were perceived as both more unpleasant and more horrific. Subjects who saw them in either a "free vision" condition or projected to the left hemisphere did not differ in their ratings of emotional response. The authors proposed that the right hemisphere has a more negative emotional valence than the left, although this negative "emotional vision" is usually suppressed.

Kinsbourne (1974) has proposed a model of the cerebral hemispheres according to which the left hemisphere, as language dominant, is intimately involved in approach behaviors, whereas the right hemisphere mediates avoidance behavior. In the context of this model, the right

hemisphere's hypothesized mediation of negative emotions is related to avoidance behaviors, while the left hemisphere is lateralized for the positive emotions associated with approach behavior.

How does brain damage to the right or left hemisphere affect the expression of positive and negative emotion? In a series of studies presented by Sackeim, et al. (1982), neurologic evidence was assembled from case reports of pathological laughing and crying in patients with destructive or irritative lesions. The authors found that predominantly left-sided destructive lesions were associated with crying and predominantly right-sided lesions with laughing.

Further evidence of lateralization of affect came from hemispherectomy patients: positive affect increased following removal of the right hemisphere, while negative affect (i.e., depression) resulted from a left hemispherectomy. The presumption is that the mood changes were due to the release of contralateral mechanisms subserving emotion.

Finally, in a group of patients whose pathological laughing or crying was associated with seizures, patients with left-sided foci were significantly more likely to have laughing outbursts. This was understood to be the result of disinhibition or excitation within the left hemisphere.

According to this valence theory, one would predict

that RBDs with destructive lesions would evidence more of a euphoric mood and more positive facial emotion due to a contralateral disinhibition of the left hemisphere. The assumption (Sackeim, et al., 1982) is that brain damage disrupts the normal process of inhibiting emotional displays, and that such displays subsequent to destructive lesions reflect the release from inhibition of the remaining tissue (i.e., the left hemisphere with its putative mediation of positive affect).

The Objective Measurement of Emotional Facial Expression

Ekman and Friesen (Ekman, 1964, 1965; Ekman & Friesen, 1968, 1969) have distinguished two methodological approaches for studying non-verbal behavior: a "message judgment" approach and a "measurement of sign vehicles" approach. In the study of facial expression, a message judgment approach involves having observers or raters make subjective judgments about the facial expressions. These judgments might entail assigning people to different diagnostic groups based on their expressions or rating their expressions for emotional intensity or emotion category.

The measurement of facial movement or "measurement of sign vehicles" approach relates explicit movement patterns to specific emotional expressions. This eliminates the need for raters to make judgments or inferences about what emotions are being expressed, and al-

lows the investigator to determine exactly what the raters are responding to when making their judgments. In the comparison of posed and spontaneous facial expressions, for example, this approach can best delineate the specific differences in facial movement which might distinguish these two theoretically-distinct types of behavior.

In neuropsychological research with brain-damaged populations, the measurement of sign vehicles approach has particular value. Based on current knowledge of neuroanatomy, hypotheses can be tested regarding the innervation of different facial regions and how this is affected by various neurological sequelae (e.g., facial paralysis). Yet, despite its evident research value, objective facial measurement systems have not been utilized in neuropsychological research. The major reasons for this are that such systems are extremely time consuming and costly, and usually require extensive training and repeated viewing of the filmed segments that are analyzed.

There have been many systems devised for measuring facial actions (see Ekman, 1978, for a review). Some of these systems have been derived anatomically (based on what the facial muscles can do), while others have devised their units of measurement from theory that relates facial actions to specific emotions.

Comprehensive schemes, such as Ekman and Friesen's

(1978) Facial Action Coding System (FACS), have the advantage of being able to distinguish almost all possible, visually discriminable facial movements. In addition, FACS measures the muscular basis of movement, thereby minimizing inference and maximizing objective description. There are practical considerations, however, which led this investigator to reject the use of FACS: 1) Ekman and Friesen (1978) estimate that it takes 100 hours to become a reliable FACS rater, and 2) the researcher specifically interested in emotional facial expression must first become a trained FACS rater and then learn the EMFACS system -- a system designed to describe facial action units relevant to particular emotions.

Another comprehensive system for measuring facial movement is the Maximally Discriminative Facial Movement Coding System (Max) -- an objective, theoretically-based, anatomically linked system (Izard, 1983) which identifies muscular configurations in three facial regions (brows, eyes, mouth) that are associated with emotional expression.

The Max coding scheme, with modifications for adults (Malatesta and Izard, 1984) was selected for use in this study because of its theoretical and anatomical bases, its ability to separately measure the three facial regions, and its ability to relate facial action to the primary emotions (Izard, 1977). In addition, the

Max system only takes approximately 30 hours to learn -- an important practical consideration.

Max was originally developed for identifying emotional facial expressions of infants and young children (Izard, 1979). It has been modified for use with adults (Malatesta and Izard, 1984) and has subsequently been employed in several more recent studies (e.g., Malatesta, Fiore, and Messina, 1987a; Malatesta, et al., 1987b; Jonas, 1986).

To our knowledge, this study represents the first attempt to apply Max, or for that matter any comprehensive objective coding system, to the study of facial behavior in neurological populations. Consequently, a major contribution of this research is its findings on the application of the Max system to the study of neurologically impaired individuals. Of particular interest is its ability to separately analyze upper and lower facial movement.

Of the direct corticobulbar pathways which send fibers that synapse on the facial nucleus, those synapsing on cell groups that innervate the lower face are almost exclusively contralateral (Courville, 1966). The brows and forehead area, however, is about equally divided between ipsilateral and contralateral motor strips (DeMyer, 1980). Thus, one would predict that voluntary facial expressions involving the lower face would be more impaired by damage to one hemisphere

(e.g., the right) than those involving the upper face which would be more affected by bilateral damage.

While this relationship has been proposed for those with cortical lesions, it is not known whether Parkinsonian patients with subcortical damage would show any differences in upper and lower facial movement. One might expect diminished movement of the upper face based on Rinn's (1984) observation that "punctuation brow movements" are absent in PD patients. Punctuation brow movements are contractions which occur in the context of speech and serve to add semantic emphasis or stress intonation contours. Rinn posits that the basal ganglia may play a major role in generating these movements.

Based on the research findings to date, the following hypotheses are drawn as the basis for investigation:

- 1) There will be a dissociation between the behavior of the right brain-damaged patients and Parkinsonian patients such that:
 - a) the right brain-damaged patients will be impaired in their ability to pose emotional facial expressions relative to their more spontaneous expression of emotion during an emotion recollected condition; and
 - b) Parkinsonian patients with subcortical damage will demonstrate reduced spontaneous expression during the emotion recollection procedure but relatively intact ability to pose

emotional facial expressions.

- 2) There will be a difference between the two patient groups with regard to upper and lower facial movement: right brain-damaged patients will show diminished expressiveness with elicited expressions involving the lower part of the face, as opposed to the upper part of the face. Parkinsonian patients may show reduced expression when upper face (e.g., brow) movements are involved.
- 3) A valence effect is expected such that RBDs will display less negative, and more positive, affect in both their posed and spontaneous expression of emotion. For the PDs, a decrease in positive affect might be expected based on the high frequency of depressed mood in this population (Mayeux, et al., 1981).

CHAPTER II

METHODS

This study was part of a larger research grant being carried out under the direction of Drs. Joan Borod and Murray Alpert at New York University Medical Center studying emotional communication in neurological and psychiatric patients.

Overall Design

Three patients with unilateral right hemisphere lesions and three patients with Parkinson's Disease were tested along with four normal control subjects. The RBDs and PDs had no history of secondary neurologic disease; NCs had no history of neurologic disorder. All subjects were right-handed and screened for a history of psychiatric illness or substance abuse. In addition, as part of a cognitive screening, subjects were given the WAIS-R Vocabulary subtest (Wechsler, 1981) and the Attention and Memory subtests of the Mattis Dementia Rating Scale (Mattis, 1973) in order to ensure that they could comprehend and carry out task instructions. (See Appendix I for detailed descriptions of other control measures.)

Subjects were videotaped while posing emotional facial expressions to verbal instruction (Posed Condition) and while talking about emotional experiences (Emotion Recollection -- Spontaneous Condition). The posed and spontaneous expressions were then objectively measured by two trained raters using the adult-modified Maximally Discriminative Facial Movement Coding System (Max) (Izard, 1983; Malatesta and Izard, 1984).

In addition, four trained raters, naive to the hypotheses of the study, subjectively rated the same videotaped facial expressions for the presence and percent frequency of nine primary emotions coded by Max.

Subjects. Three patients with unilateral right hemisphere lesions (RBDs) and three patients with Parkinson's Disease (PDs) were tested along with four normal control subjects (NCs). The RBDs and PDs had no evidence of secondary neurological disease; NCs had no history of neurological disorder. All subjects were right-handed.

In order to rule out a history of psychiatric illness or substance abuse, the Schedule for Affective Disorders and Schizophrenia (SADS-L) was administered to all subjects in conjunction with the Research Diagnostic Criteria (Spitzer, et al., 1978). Depression, for example, has been shown to affect patterns of facial expression (Jaeger, Borod, & Peselow, 1986) and might have

confounded the results. Depression has also been associated with both right brain damage (Folstein, et al., 1977) and Parkinson's Disease (Mayeux, et al., 1981). For this reason, patients who developed depressive symptoms subsequent to stroke or since the onset of Parkinson's Disease were excluded, if the symptoms were sufficient to warrant an additional RDC diagnosis of major depressive disorder.

Prior to subject selection, ratings were made of a subset of posed expressions of five RBDs, five PDs, and five NCs from the larger research study (Borod, Alpert, Brozgold, et al., 1986). Four judges, naive to the experimental hypotheses, rated the posed expressions for emotional intensity, category accuracy, and valence accuracy. There were no significant relationships found between these variables and the variables of age, education and WAIS-R Vocabulary scores. Consequently, the RBDs and PDs were chosen on the basis of theoretical predictions, while the NCs were selected as being demographically similar to the neurological patients. (See Table I for a description of the subjects.)

In order to carry out a strong test of the research hypotheses stated above, two of the subjects with right hemisphere lesions were selected on the basis of their having lesions which involved frontal areas. The few studies of facial expression among brain-damaged patients (e.g., Borod, et al., 1985; Kolb and Milner,

Table I
Rating Tape - Composition of Subjects

	Subj. #	Sex	Age	Educ.	Mos. Post Onset	Other Defining Features	WAIS-R Vocab.	<u>Mattis DRS</u> Atten.*	Mem.**
I. NCs	48	M	76	16	-	-	13	37	25
	56	M	75	16	-	-	19	36	25
	49	F	72	12	-	-	13	37	25
	65	M	68	12	-	-	15	37	25
II. RBDs	111	M	77	10	29	Fronto- Temporal w/sub- cortical	10	37	25
	112	M	72	12	25	Fronto- parietal	13	35	20
	75	M	75	16	22	Posterior temporal + int. capsule	16	36	23
III. PDs	84	F	67	14	84	Bilat. symptoms	14	36	24
	93	M	71	12	96	Bilat. symptoms	12	37	24
	81	M	52	14	240	Bilat. symptoms	10	35	23

* Maximum score = 37

** Maximum score = 25

1981) have suggested that diminished expressiveness is more likely to occur when the lesion is a more anterior one (i.e., involving frontal structures).

Two RBDs had hemorrhagic infarcts: one in the fronto-parietal region, and the other in the fronto-temporal region with some extension into insula and basal ganglia. The third RBD had lesions in both posterior temporal lobe and the internal capsule. Although this subject was primarily added to be part of a reliability study for training purposes, he offered an interesting contrast to the other RBDs, as well as the PDs. Clinically, he appeared to be flat in both his posed and spontaneous expressions.

The first two PDs (Subjects #93 and #84) were selected to match as closely as possible for duration of illness. In a review of the literature on Parkinson's Disease and its effect on a range of cognitive measures, this variable proved to have a generally significant effect, whereas age and education differences among subjects were not generally significant. (See Streifler and Hofman, 1984; Boller, et al., 1984; Rondot, et al., 1984; Huber, et al., 1986.) The third PD patient (Subject #81) was selected for study, despite a longer duration of illness, based on the clinical impression of a dissociation between his posed and spontaneous facial expressions such that he appeared quite expressive when posing facial affect but showed a markedly reduced range

of expression when discussing his experiences and during the course of normal conversation.

Finally, the normal control subjects were selected from the larger subject pool to match the neurological subjects as closely as possible for age (NC median = 73.5 years; RBD median = 75; PD median = 67) and education (NC median = 14 years; RBD median = 12; PD median = 14).

Procedures

Posed Condition. The aim of this experimental condition was to examine emotional facial expressions which are voluntarily produced. Previous research by Borod, Koff, and White (1983) and others (e.g., Dopson, et al., 1984) indicates that normal, as well as brain-damaged subjects, are able to generate posed facial expressions to verbal command. The following procedure has been successfully employed with both normals and right brain-damaged subjects (Borod, Koff, and White, 1983; Borod et al., 1985).

After a warm-up period during which subjects moved different parts of their faces, they were videotaped while they posed a series of facial expressions. For this investigation, four emotions were included, two of which were negative in valence (i.e., sadness and anger) and two of which were positive in valence (i.e., happiness and interest). These four were selected as being

likely to provide the best posed examples of expressions that might occur spontaneously during the emotion recollection condition. In addition, positive and negative emotions were included in order to test possible effects of emotional valence on the performance of the RBDs.

Subjects were given an oral command, e.g., "Look happy," and were requested to make one complete expression following the cue "Ready, go." Later, subjects were asked to rate the emotional intensity they felt and the degree of difficulty they had in making the emotional expressions. Intensity was rated on a 1-7 scale with "1" being the least intense and "7" the most intense; difficulty was rated on a scale from "1" (least difficult) to "7" (most difficult). The ratings were included as a way of examining the relationship between subjects' internally experienced emotion and their ability to express the same emotions.

Emotion Recollection Condition

Introduction

This experimental condition was designed to evoke emotional expressions which are more spontaneous in nature. How does one define what makes an emotional expression spontaneous? Ekman, et al. (1981, p. 102) described spontaneous expressions as "behavior which is inescapable, irrevocable, difficult to control, automatic, difficult to verbalize, and not dependent on cog-

nitition." Such behavior cannot be easily elicited in the laboratory, nor can it always be reliably discriminated from behavior which is shaped by an experiment's demand characteristics and is presumably under conscious control.

Ekman and Friesen (1975) used the term "display rules" to refer to the cultural roles that modulate our facial expressions. These display rules affect which emotions we are expected to show at different times and with different people. When emotional expressions are governed by display rules, they are generally under more conscious control than the fleeting expressions considered to be spontaneous. In an experimental setting, one would expect some modulation of emotion due to the subjects' observance of display rules.

The distinction between so-called voluntary and spontaneous expressions remains simplistic, however, in light of the wide range of emotional facial behavior. As Ekman, et al. (1982) point out, spontaneous expressions might also include over-learned habits, some of which may or may not be reported into awareness. As Buck (1984) proposes, the distinction between the two types of expressions can ultimately only be resolved empirically.

An important criterion for devising a more spontaneous procedure is, of course, whether an actual emotional response occurs. Several investigators (e.g.,

Dopson et al., 1984; Malatesta and Izard, 1984) interested in emotional behavior have successfully employed mood induction procedures in which subjects were asked to talk about emotional experiences.

The success of such procedures in generating emotional responses can be attested to by subjects' self-report data concerning the intensity of felt emotion while relating emotional experiences (Malatesta, Fiore, and Messina, 1986). In addition, when objective measurement systems (e.g., Max) are employed in conjunction with subjective ratings, the correspondence between decoder judgments of facial emotion and objective coding can be determined.

There is also some evidence that talking about emotional responses may enhance the communication of emotion signals. Buck (personal note, cited in Zuckerman, Hall, DeFrank & Rosenthal, 1976) found in his study of emotional facial expression and sending accuracy that a subject's face was decoded above chance only when he was talking about his emotional response to the "emotion-generating" slides, and not when he/she was simply viewing them. This was not the case, however, in research using the same slide viewing technique by Borod, Koff, and White (1983).

Finally, from an ecological point of view, recalling emotional experiences and relating them to others is a fundamental part of social interaction and everyday

life. The facial expressions produced in this context may not be completely "spontaneous," but they can provide information about how emotion is expressed while engaging in a fundamental human activity.

Emotion Recollection Procedure. Subjects were asked to talk for about five minutes about a pleasant or happy experience and about an unpleasant or sad experience. They were encouraged to "recapture the experience" and "relive it with as much real intensity as when it actually occurred." (See Appendix II.)

After the two five-minute monologues, subjects were asked to rate how pleasant or unpleasant they felt as they spoke about their experiences and also how difficult it was for them to talk about them. This procedure made up the final part of the research protocol and was typically done after approximately three hours of testing in order to maximize rapport with the experimenter. Testing was carried out over one or two sessions and was interrupted by as many breaks as was deemed necessary by the examiner to maintain the subjects' attention.

Facial Coding with the Max System

The adult-modified Maximally Discriminative Facial Movement Coding System (Max) (Izard, 1983; Malatesta and Izard, 1984) was employed to measure the facial expres-

sions. Max is a theoretically based, anatomically linked system which codes appearance changes in three regions of the face (brows, eyes, mouth). Each appearance change is numerically coded and later translated into emotion signals according to formulas provided in the Max manual (Izard, 1983). (See Table II for a list of appearance changes coded by the adult-modified Max and emotion formulas.)

Although Max was originally designed for use with infants, the system has been modified for the analysis of adult faces (Malatesta and Izard, 1984) and has been successfully employed with young, middle, and older adults in several subsequent studies (e.g., Jonas, 1986; Malatesta, Fiore, and Messina, 1987a; Malatesta, et al., 1987b). The modifications are minimal and consist primarily of the addition of several appearance changes which occur only in adult faces, i.e., codes 20-0, 61 and 67.

The procedure for Max coding is as follows: a brief videotape segment is viewed in real time, then replayed on a frame-by-frame basis in order to identify Max-coded appearance changes. Each second of the segment is then coded for the presence or absence of appearance changes in the three facial regions. (See Appendix III for a coding sheet.) Each change is thus time coded for its onset and offset. Subsequent to the coding, the Max codes are translated into emotion signals.

Table II.

Max Appearance Changes and Affect Codes

<u>Code</u>	<u>Description</u>
20	Both brows raised
20-0	Brow flash (less than 1/2")
21	One brow raised
23	Inner corners raised
24	Brows slightly lowered and drawn together
25	Brows strongly lowered and drawn together
30	Rounded eyes
31	Wide eyes due to upper lid raise
33	Squinted eyes
36	Gaze to side; averted; down
39	Chin raised; eyes cast down
42	Nasal bridge furrowed
50	Open roundish mouth
52	Corners back and slightly up
53	Open tense mouth, corners pulled back
54	Angular squarish mouth
55	Open tense mouth
56	Mouth corners drawn downward
59	Open angular mouth, upper lip pulled back
61	Upper lip raised on one side
67	Compressed lips
68	Pursed lips
75	Lowered head
80	Raised chin with lower lip protruding

Anger: Codes 25, 54, 55, 33 (if accompanied by another anger code), 53 (if not accompanied by a 31), 67 (unless accompanied by a 36 or 75), 68 (if accompanied by other signs of anger).

Interest: Codes 68 (if accompanied by other signs of interest such as eyes cast upward), 33 (only if it co-occurs with a 68)

Int/Surprise: Codes 20, 30

Brow-flash: Code 20-0.

Surprise: Code 50

Joy: Code 52

Table II

MAX Affect Component Codes, p. 2

<u>Contempt:</u>	Codes 21, 39, 61, 42 (if accompanied by another contempt code)
<u>Fear:</u>	Codes 31, 53 (only if accompanied by a 31)
<u>Shame/Shyness:</u>	Code 36
<u>Sadness:</u>	Codes 23, 56
<u>Disgust:</u>	Codes 59B, 33 (only if it occurs with a 59B or 42); 42 (if it occurs alone)
<u>Knit Brow:</u>	Code 24 (if it occurs alone). May be a signal of interest or anger.
<u>Code 33:</u>	Indeterminate if it occurs alone
<u>Code 75:</u>	Indeterminate if it occurs alone; otherwise, may be shame or sadness signal.

Becoming a reliable Max coder for adults entails several steps, the first of which is achieving an inter-rater reliability of 80% or more with the original Max codes for infants. This training process, described in detail in the manual (Izard, 1983) takes approximately 30 hours.

Once the author independently achieved a sufficient level of inter-rater reliability, she learned the adult modifications of the Max system with a second rater (BS) who was already a reliable and highly experienced Max coder. Reliability training was carried out at the New School for Social Research Infant Research Lab using videotaped segments of adult subjects from another study (Jonas, 1986). As one of the developers of the adult modifications for Max, Dr. Malatesta recommended obtaining reliability by coding segments from the Jonas (1986) study -- a dissertation under Dr. Malatesta's direction investigating emotional facial expression in a young and middle-aged adult population.

Nine subjects were selected by Jonas as providing a wide range of emotional expressions for Max coding. After blindly coding one to two thirty-second segments per subject, the two coders (the author and BS) achieved a sufficiently high inter-rater reliability level of 82%.

For the current study, all of the subjects were independently Max coded by the two raters and later, as

per the Max coding procedure, disagreements were discussed until a final decision/agreement was made. (See Table III for the percentage of inter-rater agreement for each subject by group.) The final Max data, however, reflect Max ratings for which complete agreement was arrived at, either initially or through conferencing.

An agreement was operationally defined as the concurrence on all of the appearance changes occurring within a given second (plus or minus one second). If the raters agreed on some, but not all, of the codes for a given second, the inter-rater agreement for that second was considered zero. Anywhere from one to about seven appearance changes could occur within a given second; however, one to three appearance changes per second was the norm.

Rating Tape

Prior to the Max coding, a rating tape was created which contained, in random order, the four posed expressions and one-minute segments from both pleasant and unpleasant recollected experiences. In order to assess segments of facial behavior from the emotion recollection procedure which were most likely to contain emotional facial expressions, one minute segments were selected by the author and another rater which were perceived as the happiest and saddest minutes. There was

Table III

Inter-rater Agreement for Max Coding by Group

	Group	Inter-rater Agreement
I.	<u>NCs</u>	
	#49	84%
	#48	77%
	#56	81.5%
	#65	82%
II.	<u>RBDs</u>	
	#75	95%
	#111	79%
	#112	89%
III.	<u>PDs</u>	
	#81	78%
	#84	81%
	#93	72%
Overall mean = 82%		

Inter-rater Agreement

	<u>< 80%</u>	<u>> 80%</u>
NCs	1	3
RBDs	1	2
PDs	2	1

complete agreement of the two raters on all of the selected segments.

The length of the posed expressions varied from five to 10 seconds and extended from the end of the experimenter's "Ready, go" signal to the offset of the expression.

Each subject was presented on the rating tape in a single block with the posed and spontaneous segments counterbalanced within that block. This was done to provide the coder with a sufficient framework in which to judge deviations from the subjects' resting faces. Within the spontaneous presentation, the positive and negative segments were randomized, and within the posed presentation, the four expressions of happy, sad, angry, and interest were randomized.

Subjective Ratings of the Emotional Expressions

Introduction

Subjective ratings of the expressions were made in order to assess how the expressions would be perceived by naive raters and to compare these judgments with the Max coding. This would allow the examination of the relationship between the subjects' ability to communicate emotion and their actual facial movements.

Earlier studies had found mixed results when comparing Max ratings and emotion attributions of naive decoders. Naive raters in the Malatesta and Izard

(1984) study made a great number of errors when they were asked to view a series of videotaped segments and decide which emotion was induced in each segment. A more recent (Malatesta, et al., 1987b) study, however, found a high degree of concordance for six of the nine emotions between the dominant Max-coded expression for any given individual and the predominant emotion attribution of decoders.

Methods

Raters. Four psychology students, naive to the experimental hypotheses, served as raters (two males and two females). They had previously been trained by the author to subjectively rate posed facial expressions for emotional intensity, valence, and emotion category as part of the larger research grant. This training had consisted of familiarizing the raters with photographed exemplars of prototypical emotional expressions (Ekman & Friesen, 1976; Izard, 1971).

Expressions were rated for emotional intensity on a 1 (minimal) to 7 (maximal) scale with "1" denoting extremely unpleasant, "4" neutral, and "7" extremely pleasant. Finally, raters were asked to choose which of seven emotions was being depicted.

Inter-rater reliability based on ratings of a sample of 360 posed expressions was considerably high: for ratings of intensity, $\alpha = .95$; for valence, al-

pha = .78; and for category accuracy, alpha = .80.

Subjective Rating Scheme

Introduction

In prior studies that have compared Max coding and subjective ratings of facial expressions (Malatesta and Izard, 1984; Jonas, 1987), Izard's "Differential Emotion Scale" (DES) was used for the subjective ratings. The DES rates the presence of ten emotions (interest, joy, surprise, sadness, anger, disgust, contempt, fear, shame, shyness, and guilt) on a 1-5 point scale with "1" denoting "very slightly or not at all" and "5" denoting "very strongly."

The author decided against using the DES for several reasons. It seemed critical to include a zero point for the absence of an emotion, with the next point on the scale denoting a slight amount. More importantly, in order to obtain subjective ratings which could be compared most directly to the Max coding, a rating scheme was developed which was based on time. In the Max system, after all, the parameter used in coding is the number of seconds an appearance change is seen from its onset to its offset and not the intensity of the appearance changes themselves.

Pilot Study. Before arriving at the final coding scheme, a pilot study was carried out having the raters

(1) make judgments of the emotion type expressed in several posed and spontaneous segments, and (2) rank where on the face the raters perceived the expression the most. These two types of ratings would then provide information that could be compared to Max.

Methods. For the pilot study, three subjects (one Parkinsonian patient, one right brain-damaged patient, and one normal control) were selected who had been Max coded with high inter-rater agreement and who were also fairly expressive. There were six segments of data from each subject which were rated: their four posed expressions and one segment each from their happy and sad recall. The posed segments ranged from five to approximately 10 seconds, while the recall segments were 7.5 seconds in duration (the mean duration of the posed segments).

The raters made an emotion identification rating and a judgment of facial region for each segment. In order to examine possible differences between a free choice and a forced choice identification procedure, they were given multiple choices of emotion labels for half of the segments and were allowed to freely choose their own emotion label for the other half. The free and forced choice items were randomly distributed across all of the 18 segments.

To rate facial regional differences in the expressions, each rater was given a diagram of a neutral face

divided into six regions (left brow, right brow, left eye, right eye, left mouth, and right mouth). Raters were asked to rank order these facial regions according to where they saw the expression the most. For example, if there were no differences each region would be rated "1." If the brows were the most expressive, the eyes second, and the mouth the least, and there were no right/left differences, the ratings would be: LB = 1; RB = 1; LE = 2; RE = 2; LM = 3; RM = 3.

Results

With one exception all of the free choice emotion identification ratings used labels that were from the forced choices. This was probably due to the raters' previous experience making forced choice judgments using the same labels: it was too compelling for them to slip into their usual multiple choice "set."

For emotion category, half or more of the raters agreed 88.5% of the time:

Emotion Category Inter-rater Agreement

<u>0/4</u>	<u>2/4</u>	<u>3/4</u>	<u>4/4</u>
2	9	6	1
(11%)	(50%)	(33%)	(5.5%)

For emotional valence in general, inter-rater agreement was quite high:

Emotional Valence Inter-rater Agreement

<u>2/4</u>	<u>3/4</u>	<u>4/4</u>
5	4	9
(28%)	(22%)	(50%)

For region, there was substantial inter-rater agreement, yet there was very little agreement between the subjective raters' ranking of facial regions and the Max coded ratings of the facial regions in which appearance changes were observed.

Inter-rater Agreement on Region Rankings

<u>Region</u>	<u>2/4</u>	<u>3/4</u>	<u>4/4</u>
LB	50%	33%	17%
RB	55.5%	33%	11%
LE	28%	39%	33%
LM	33%	33%	33%
RM	39%	28%	33%
	-----	-----	-----
Mean	39%	34%	27%

There was fairly high agreement between the emotional valence (positive or negative) of the segments and the emotional valence of the raters' judgments so that, for example, a segment from the sad recollection was seen by the raters as expressing negative emotion.

It was difficult to make a direct comparison of the subjective ratings and the Max coded emotions because, for any given segment, the Max system codes for appearance changes associated with any of nine emotions.

Typically for example, there were two or three emotions coded by the Max system for each posed expression, whereas the raters were asked to assign only one emotion for each expression. The Max system would then show up emotional blends while the raters rated the expressions as expressing only one emotion.

The raters unanimously reported that 7.5 seconds was a sufficient sample for rating and was neither too long nor too short.

Conclusions

Based on the findings of this pilot study, it was decided to have the raters use a time-based rating system that would be more directly comparable to the Max coding and that would rate the presence and/or absence of each emotion for each posed and spontaneous segment. It was also decided to dispense with the ranking of region. First, it would have taken considerable additional training for the raters to agree more reliably with the Max system in their ranking of region. It would also become too redundant with the Max coding that had already been done.

Final Subjective Rating Scheme

The final system for the subjective ratings consisted of having each posed and spontaneous segment

rated for the percentage of time each of nine emotions was observed. The nine emotions were those coded by Max (i.e., anger, happiness, interest, surprise, sadness, disgust, fear, shame/shyness, and contempt).

For each segment, percentage of time was rated on a scale of 0-10: "0" denoted that the emotion was not seen at all during the segment, "1" indicated that it was seen 1-10% of the time, "2" indicated 11-20%, "3" indicated 21-30%, "4" indicated 31-40%, "5" indicated 41-50%, "6" indicated 51-60%, "7" indicated 61-70%, "8" indicated 71-80%, "9" indicated 81-90%, and "10" indicated 91-100% of the time.

This percentage system was directly comparable to the Max coding. For example, if a particular appearance change was coded by Max for three out of five seconds, it would be said to have been present for 60% of that segment. Similarly, it would have been subjectively rated a "6" (i.e., having occurred 51-60% of the time).

In addition, a nine point interval, rather than a 100 point, scale was used to ensure greater inter-rater agreement. It seemed likely that a 100 point scale would be more difficult for raters to use and would introduce too great a range of responses. A pilot study employing the percentage rating system yielded a mean inter-rater agreement of 88 percent when the raters viewed two posed and two spontaneous segments randomly selected from the data pool.

There were 207 segments rated with approximately 22 segments per subject (range = 18-24; mode = 19). This included per subject four posed expressions (happy, interest, sad, and angry) and 14-20 segments from the more spontaneous emotion recollection procedure. (See Table IV for a list of the number of spontaneous segments per subject per group.)

The posed segments ranged from 5-12 seconds (mean = 7.5), and the happy and sad recollected experiences were divided into 7.5 second segments. When the recollected experiences could not be evenly divided into 7.5 second segments, the last segment might have been briefer (e.g., three seconds instead of 7.5). The posed segments were viewed in their entirety regardless of their length.

The 207 segments were all viewed and rated in one two hour session with several breaks for the raters. The segments were viewed in real time and only once. The Max code sheets were then divided into the same 207 segments which had been subjectively judged. Then, for each segment, the percentage of Max coded emotions was calculated in order to compare it with the subjective ratings.

TABLE IV

Number of Emotion Recollecton Segments by Group

	<u>Happy</u>	<u>Sad</u>
I. <u>NCS</u>		
65	9	11
49	8	9
48	8	8
56	8	7
	Mode = 8	
II. <u>PDs</u>		
81	10	9
84	8	7
93	8	8
	Mode = 8	
III. <u>RBDs</u>		
75	8	12
112	7	8
111	7	7
	Mode = 7	

RESULTS

I. Max Coding of Facial Expressions

Inter-rater Agreement

General findings on the use of Max with neurological patients

Group differences in expressiveness across conditions

Group differences in the valence of emotional expressions -

- i. Negative/Positive difference scores
- ii. Max percentage scores for positive and negative emotions.

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II. Subjective Ratings

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Posing Accuracy

Spontaneous Accuracy

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Zung Depression Scale

IV. Self-Report Ratings

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Spontaneous expression

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sending accuracy

i. Posed expression

ii. Spontaneous expression

V. Additional Data on Facial Behavior

Posed expression

Spontaneous expression

VI. Individual Differences

Posed expression

Spontaneous expression

CHAPTER III

RESULTS

Max Coding of Facial Expressions

Inter-rater Agreement

The Max Coding System (Izard, 1983) with modifications for use with adults (Malatesta and Izard, 1984) was employed to objectively assess the subjects' facial expressions under both conditions. (See Table II for a list of Max Appearance Changes and Affect Component codes.).

Two right-handed raters coded the expressions: the author (AB) and an experienced Max coder (BS) who was naive to the hypotheses of the study. Reliability training was carried out by coding videotaped segments of adult subjects from another study (Jonas, 1986) which had been previously Max-coded and selected as providing a wide range of expressions. After coding nine subjects with approximately one thirty-second segment per subject, the two coders achieved an interrater agreement of 81%. This figure is considered by Izard (1983) to be sufficient for Max coding.

Subsequent Max coding of subjects in the present study yielded a mean inter-rater agreement of 82%. An agreement was operationally defined as the concurrence

on all of the appearance changes occurring within a given second. If the raters agreed on some, but not all, of the codes for that second, it was considered a disagreement. Anywhere from one to about seven appearance changes could occur within a given second; however three appearance changes per second was the norm.

Table III provides the percentage of inter-rater agreement for each subject by subject group. Inter-rater agreement was highest for the normal controls followed by the right-brain damaged. The expressions of the Parkinsonian patients were Max-coded with the lowest inter-rater agreement.

The variation in inter-rater agreement can be attributed to several factors. One of the raters (BS) had greater expertise in Max coding. Another factor was that the experimenter had tested most of the research subjects and had worked extensively with neurological patients, while the other rater (BS) had not had this experience.

Inter-rater agreement was also affected by the degree and range of expressiveness of the individual subjects. For example, subject #75, an extremely "flat" RBD, was Max-coded with the highest inter-rater agreement. This was due to the narrow range of expressions he produced. In contrast, subject #84, an extremely expressive PD patient, produced many expressions (most of which were emotional blends) and was idiosyncratic in

her facial movement (see Individual Differences).

General Findings on the Use of Max with Neurological Patients

The current study is the first attempt, to our knowledge, to employ the Max system in the objective measurement of facial expression in neurological patients. It was not known what, if any, differences there would be in the Max codes observed in these groups and those previously described in normal populations (e.g., Malatesta & Izard, 1984; Jonas, 1986), nor was it known what problems might be encountered in using Max with neurological populations.

One of the major coding decisions centered on how to code the expressions of the RBDs. As a result of their lower facial paralysis, these patients' faces exhibited an asymmetry of expression, e.g. only one side of the mouth would move. Many of these unilateral movements were coded as part of the contempt expression (Code 61 -- upper lip raised on one side). This decision was based on the need to eliminate subjective inference as to whether the patient was actually happy (i.e., smiling). If an RBD displayed a unilateral smile accompanied by the raising of the cheeks and wrinkling of the eyes, that was coded a 52 (the emotion signal for happiness).

The expressions of the PDs presented other diffi-

culties, chiefly a quality of tension in their expressions which was not captured by Max. Although the author created a code 51 to describe the tense, slight smile observed in the NCs, this mouth appearance change was different from the muscular tension of the mouth in the PDs.

When the Max raters had difficulty assigning Max codes to these expressions, the tendency was to code a blend, e.g., a 52/53 -- corners mouth back and slightly up/open tense mouth, corners pulled back.

In addition to creating a new code 51 to describe the slight, tense smile of the NCs, there were other established Max codes which were not observed or rarely seen in this study. Code 39 (chin raised, eyes cast down) was never observed. Code 59 (open angular mouth, upper lip pulled back), an appearance change associated with the emotion of disgust, was only rarely observed.

Group Differences in Expressiveness Across Experimental Conditions

In order to highlight possible group differences, expressiveness scores were created for each subject for both conditions using a procedure developed by Jonas (1986). These scores were ratios derived by dividing the number of Max-coded emotional expressions for a given segment (e.g., happy recall) by the total number of seconds of that posed or spontaneous segment. This

measure provides an index of the frequency of emotional facial expressions occurring per second during a given segment.

Table V presents the mean expressiveness scores by group for the posed and recall conditions. Table VI contains each subject's expressiveness scores for each emotion. As can be seen from the table, the expressiveness scores of the NCs (posed mean = .25; spontaneous mean = .27) were similar in both conditions, while both the RBDs (posed mean = .23; spontaneous mean = .18) and the PDs (posed mean = .25; spontaneous mean = .18) had lower scores in the more spontaneous condition.

When examining individual differences within and across subjects and conditions, two out of three PDs showed greater expressiveness in the posed than the spontaneous condition. The only RBD who was more expressive in the spontaneous than the posed condition was the patient with the fronto-temporal and sub-cortical lesion. The other RBDs did not show the expected dissociation.

Group Differences in the Valence of Emotional Expressions

Positive/Negative Difference Scores

Table VII contains positive/negative difference scores for each subject across emotions and conditions. Positive/negative difference scores were derived by

Table V
Mean Expressiveness Scores By Group

Group	Posed Condition	Recall Condition
NCs	.25	.27
PDs	.25	.18
RBDs	.23	.18

TABLE VI
Expressiveness Scores by Group for Posed and Spontaneous Conditions

GROUP	POSED														SPONTANEOUS					
	Happy			Interest			Pos. X	Sad			Angry			Neg. X	Happy			Sad		
	# E's	# Secs	E's/ Secs.	# E's	# Secs	E's/ Secs.		# E's	# Secs	E's/ Secs.	# E's	# Secs	E's/ Secs.		# E's	# Secs	E's/ Secs.	# E's	# Secs	E's/ Secs.
<u>I. NCs</u>																				
#56	2	8	.25	3	8	.37	.31	1	8	.12	2	8	.25	.18	18	51	.35	7	51	.14
#48	2	10	.20	3	7	.43	.31	3	9	.33	5	10	.50	.41	17	51	.33	19	51	.37
#65	1	7	.14	1	7	.14	.14	2	7	.28	1	7	.14	.21	25	63	.39	11	64	.17
#49	4	9	.44	2	10	.20	.32	1	9	.11	1	8	.12	.11	12	51	.23	13	60	.22
			$\bar{x}=.26$			$\bar{x}=.28$	$\bar{x}=.27$			$\bar{x}=.21$			$\bar{x}=.25$	$\bar{x}=.23$			$\bar{x}=.32$			$\bar{x}=.22$ $\bar{x}=.27$
<u>II. RBDs</u>																				
#75	3	7	.43	2	7	.28	.35	1	7	.14	1	7	.14	.14	5	57	.09	5	82	.06
#111	1	6	.17	2	6	.33	.25	2	8	.25	2	10	.20	.22	11	50	.22	15	50	.30
#112	3	7	.43	1	6	.17	.30	1	5	.20	2	6	.33	.26	13	51	.25	10	51	.19
			$\bar{x}=.34$			$\bar{x}=.26$	$\bar{x}=.30$			$\bar{x}=.19$			$\bar{x}=.22$	$\bar{x}=.21$			$\bar{x}=.19$			$\bar{x}=.18$ $\bar{x}=.18$
<u>III. PDs</u>																				
#81	2	5	.40	3	7	.43	.41	2	8	.25	1	7	.14	.19	5	72	.07	2	65	.03
#95	2	7	.28	2	6	.33	.30	1	7	.14	1	6	.17	.25	11	51	.21	5	50	.10
#84	1	8	.12	4	11	.36	.24	1	8	.12	2	7	.28	.20	23	51	.45	13	52	.25
			$\bar{x}=.27$			$\bar{x}=.37$	$\bar{x}=.32$			$\bar{x}=.17$			$\bar{x}=.19$	$\bar{x}=.21$			$\bar{x}=.24$			$\bar{x}=.13$ $\bar{x}=.18$

TABLE VII

Positive/Negative Difference Scores Across Conditions by Group

	<u>Posed Sad</u>	<u>Posed Angry</u>	<u>Posed Neg. Mean</u>	<u>Posed Interest</u>	<u>Posed Happy</u>	<u>Posed Pos. Mean</u>	<u>Happy Recall</u>	<u>Sad Recall</u>
I. <u>NCs:</u>								
#56	-1.00	-1.00	-1.00	-.26	1.00	-.37	-.19	-.03
#48	.26	.28	.27	.23	.90	.56	-.21	-.29
#65	-1.00	-1.00	-1.00	1.00	1.00	1.00	-.27	-.11
#49	1.00	-1.00	0	1.00	.82	1.00	-.09	-.58
Mean =	(-.18)	(-.68)	(-.43)	(.49)	(.93)	(.73)	(-.19)	(-.25)
II. <u>RBDs:</u>								
#75	-1.00	-1.00	-1.00	.75	.55	.65	-.06	-.01
#111	-1.00	-1.00	-1.00	.71	0	.35	-.78	-.61
#112	-1.00	-.60	-.8	.33	-.08	.12	-.73	-.76
Mean =	(-1.0)	(-.87)	(-.93)	(.60)	(.16)	(.37)	(-.36)	(-.46)
III. <u>PDs:</u>								
#81	-1.00	.33	-.33	1.00	1.00	1.00	.36	.31
#93	-1.00	0	-.5	.20	-.07	.06	-.31	-.89
#84	-1.00	-.75	-.87	.08	1.00	.54	-.08	-.09
Mean =	(-1.0)	(-.14)	(-.57)	(.43)	(.64)	(.53)	(-.01)	(-.22)

* $\frac{P - U}{P + U}$

totalling the number of pleasant (P) and unpleasant (U) expression components for each posed and spontaneous segment and calculating the relative proportion of these components: $(P-U)/(P+U)$. The higher the positive values, then, the higher the number of positive expression components contained in that segment.

According to Izard (1977), of the nine primary emotions, six are unpleasant in valence (i.e., anger, sadness, disgust, fear, contempt, and shame/shyness) and three are considered pleasant in valence (i.e., joy, interest and surprise). An expression of surprise which would be subjectively perceived as unpleasant would, according to Max, be coded as a blend of surprise and fear or surprise and another negative emotion.

Regardless of condition or valence, the RBDs showed more negative components (i.e., lower scores):

	<u>Posed Pleasant Mean</u>	<u>Posed Unpleasant Mean</u>	<u>Spontaneous Pleasant Mean</u>	<u>Spontaneous Unpleasant Mean</u>
NCs	.73	-.43	-.19	-.25
PDs	.53	-.57	-.01	-.22
RBDs	.37	-.93	-.36	-.46

When examining individual differences within and across subject groups and conditions, several differences are evident. For the posed unpleasant expressions, RBDs and NCs both, on the whole, produced the same number of unpleasant emotional expression compo-

nents, while the PDs produced fewer unpleasant expression components when posing anger.

For the pleasant posed expressions, the RBDs were the only group to show a differential use of pleasant expression components, i.e., they showed more pleasant expression components when posing interest and produced fewer pleasant components than the other groups when posing happiness.

This group difference is probably in part related to the RBDs' lower facial paralysis and, hence, their limited mouth movement (see Group Differences in Movement across Facial Regions). The happy emotional expression in Max is coded based on only one appearance change, i.e., corners of the mouth back and slightly up. In contrast, the appearance changes coded in the "interest" expression involve primarily upper facial regions (e.g., the eyes and brows) which would not be affected by central (i.e., lower facial) paralysis.

As will be seen with the subjective ratings, RBDs were also subjectively perceived as producing more unpleasant expressions.

Max Percentage Scores for Positive and Negative Emotions

Another way of looking at valence differences across groups was to calculate Max percentages for each Max coded emotion across all of the subjects' posed and spontaneous segments.

As described in the "Methods" chapter, in order to carry out subjective ratings, all of the videotape data was divided by subject into posed and spontaneous segments. There were 207 segments with approximately 22 segments per subject. This included four posed segments per subject (happy, interest, sad, and angry) and 14-20 segments from the emotion recollection procedure. The posed segments varied in duration from five to 12 seconds (mean = 7.5), depending on how long the subject held the posed expression. The happy and sad recollected experiences were divided into 7.5 second segments with any remaining seconds left as a shorter segment at the end of that subject's recollected experiences.

The Max code sheets for each subject were thus divided into 207 segments, and the percentage of Max coded emotions was calculated for each segment. For example, during a particular segment, appearance changes associated with anger could be present for 12% of the time, sadness appearance changes could be seen for 40% of the time, and none of the other seven Max coded emotions might be present.

These percentages of Max coded emotions were then converted into scores on a 1-10 scale, as follows: "1" = 1-10% of the time; "2" = 11-20% of the time; "3" = 21-30%; "4" = 31-40%; "5" = 41-50%; "6" = 51-60%; "7" = 61-70%; "8" = 71-80%; "9" = 81-90%; "10" = 91-100% of the time.

Means were then calculated for all of the emotions across all of the posed and spontaneous segments by group. These means indicate how frequently each of the nine emotions was coded by the Max raters across conditions (posed, spontaneous) and groups. By separately examining means for the positive and negative emotions, one can determine if there were group differences as a function of both valence and specific emotions.

Table VIII provides the mean percentages by group of Max coded negative emotions for the posed expressions. As you can see, with the exception of disgust, there were group differences for each of the negative emotions. The PDs showed more anger and contempt than the other groups, while RBDs expressed more shame/shyness because of their lower rate of eye contact (shame/shyness is coded by looking down or away from the camera). NCs produced more appearance changes associated with fear and sadness.

Table IX provides the mean percentages by group of the Max coded positive emotions for the posed expressions. The RBDs were least expressive for two out of three positive emotions, particularly for happy (RBD mean = .17; PD mean = 5.17; NC mean = 2.69), but showed more pleasant surprise than the other groups. PDs produced more happy expressions than the other groups, while the NCs showed more interest.

TABLE VIII

Mean Percentages by Group of Max Coded Negative
Emotions for Posed Expressions

	<u>Anger</u>	<u>Contempt</u>	<u>Fear</u>	<u>Shyness</u>	<u>Sadness</u>	<u>Disgust</u>
I. <u>RBDs</u>						
#111	5.00	4.00	.00	3.25	.00	.00
112	2.50	.00	.00	6.50	.00	.00
75	1.75	2.00	.00	.50	.00	.00
Mean =	3.08	2.00	.00	3.42	.00	.00
II. <u>PDs</u>						
#84	5.00	.50	.50	7.50	.00	.00
93	4.50	5.00	.00	.00	.00	.00
81	2.50	2.50	.00	2.50	.00	.00
Mean =	4.00	2.25	.17	3.33	.00	.00
III. <u>NCs</u>						
#48	.50	1.50	2.25	.50	.00	.00
56	5.50	3.25	.75	.00	.00	.00
49	3.00	1.88	.00	.00	.00	.00
65	6.50	.00	.00	.00	1.25	.00
Mean =	3.87	1.65	.75	.125	.31	.00

TABLE IX

Mean Percentages by Group of Max Coded
Positive Emotions for Posed Expressions

	<u>Interest</u>	<u>Pleasant Surprise</u>	<u>Happy</u>
I. <u>RBDs</u>			
#111	5.00	.50	.00
112	1.75	3.25	.00
75	3.00	.00	.50
Mean	3.25	1.25	.17
II. <u>PDs</u>			
#84	4.25	.00	3.00
93	5.00	.00	2.50
81	1.50	3.50	10.00
Mean	3.60	1.17	5.17
III. <u>NCs</u>			
#48	5.00	4.00	3.75
56	5.00	.75	2.00
49	5.00	.00	2.50
65	1.25	.00	2.50
Mean	4.06	1.19	2.69

RBDs showed more interest when recollecting emotional experiences than they had when posing emotions. In the spontaneous emotion recollection procedure (see Tables X and XI), the RBDs also produced more appearance changes associated with happy than they had in the posed condition, although they continued to show the least happy emotion of the groups.

Of the negative emotions, RBDs conveyed more anger, contempt, and shame/shyness during the emotion recollection procedure than the PDs and NCs, i.e., they conveyed more negative emotion than they had when posing. Notably, the NCs expressed more sadness than the other groups in the spontaneous, as well as the posed, condition. PDs, like the RBDs, showed more anger and shame/shyness than the NCs but conveyed the least contempt relative to the RBDs and NCs. Both of the neurological groups were notable in the absence of any expressions of disgust and also in their minimal expression of fear.

Group Differences in Movement across Facial Regions

The frequency of emotional movement for each of the three facial regions was examined by calculating the mean proportion of coded movement averaged across the six segments for each subject. (See Table XII.) For NCs and PDs, the brows (NC mean = 90%, PD mean = 86%) were used most extensively, followed by the mouth (NC mean = 57.5%, PD mean = 71%) and then the eyes (NC mean

TABLE X

Mean Percentages by Group of Max Coded Positive
Emotions for Spontaneous Expressions

	<u>Interest</u>	<u>Pleasant Surprise</u>	<u>Happy</u>	<u>Means</u>
I. <u>RBDs</u>				
#111	1.79	.55	.29	.88
112	2.27	.33	.40	1.00
75	10.00	.00	.13	3.38
Mean	4.69	.29	.27	1.75
II. <u>PDs</u>				
#84	6.25	.13	3.94	3.44
93	1.93	.40	4.13	2.15
81	1.21	.37	10.00	3.86
Mean	3.13	.30	6.02	3.15
III. <u>NCs</u>				
#48	3.44	2.00	3.88	3.11
56	8.67	4.67	3.33	5.56
49	3.59	1.12	1.82	2.18
65	5.30	.00	2.10	2.47
Mean	5.25	1.95	2.78	3.33

TABLE XI
Mean Percentages by Group of Max Coded Negative
Emotions for Spontaneous Expressions

	<u>Anger</u>	<u>Contempt</u>	<u>Fear</u>	<u>Shyness</u>	<u>Sadness</u>	<u>Disgust</u>	<u>Mean</u>
I. <u>RBDs</u>							
#111	6.57	7.14	.00	8.29	.00	.00	3.67
112	7.33	4.00	.20	9.40	.00	.00	3.49
75	.63	2.88	.00	10.00	.13	.00	2.27
Mean=	4.84	4.67	.07	9.23	.04	.00	3.14
II. <u>PDs</u>							
#84	3.25	1.13	.81	6.63	.19	.00	2.00
93	4.13	8.67	.00	3.13	.00	.00	2.65
81	5.58	.74	.00	9.37	.00	.00	2.61
Mean=	4.32	3.51	.27	6.38	.06	.00	2.42
III. <u>NCs</u>							
#48	.44	4.69	.88	3.81	1.75	.00	1.93
56	.47	4.47	4.53	4.07	4.60	.13	3.04
49	.47	8.59	.12	4.94	.12	.00	2.37
65	1.10	.85	.00	8.60	3.00	.40	2.32
Mean=	.62	4.65	1.38	5.35	2.37	.13	1.83

TABLE XII

% Max Coded Movement Frequency by Group

<u>GROUP</u>	<u>BROWS</u>		<u>EYES</u>		<u>MOUTH</u>	
	<u>Posed</u>	<u>Recall</u>	<u>Posed</u>	<u>Recall</u>	<u>Posed</u>	<u>Recall</u>
<u>NCs:</u>						
#65	75	98.5	3.5	86.5	75	58.0
#49	100	100.0	0	89.0	37	46.5
#48	78	94.0	66.0	82.0	78	53.0
#56	100	82.5	44.0	90.0	31	92.0
Mean =	(88)	(94)	(28)	(87)	(55)	(62)
<u>PDs:</u>						
#81	66	71.5	68.0	100.0	75	100.0
#84	95	77.0	97.0	93.0	68	58.0
#93	100	100.0	21.5	54.5	57	28.5
Mean =	(87)	(83)	(62)	(82.5)	(67)	(62)
<u>RBDs:</u>						
#75	60.5	100	71	99	43	51.5
#112	50.0	100	100	99	0	46.0
#111	100.0	78	97	99	25	74.0
Mean =	(70)	(93)	(89)	(99)	(23)	(57)

= 48%, PD mean = 69%). However, the RBDs (all of whom had lower facial paralysis) showed reduced use of the mouth (mean = 34%) and much greater use of the eyes (mean = 92.5%) and the brows (mean = 78%).

The differential movement of the three facial regions does affect the valence of the expressions produced, as indicated earlier. While most of the emotions are Max coded based on appearance changes in two or three facial regions, happiness is coded only when a smile is observed (code 52 - mouth corners back and slightly up). The RBDs showed a striking lack of happy expressions relative to the other groups, probably a partial result of lower facial paralysis.

Subjective Ratings

Subjective ratings of the subjects' facial expressions were made in order to examine the relationship between their ability to communicate emotion and their actual facial movements as coded by Max.

Methods. Four psychology students, naive to the experimental hypotheses, served as raters (two males, two females). They had previously served as raters as part of the larger research grant, making subjective judgments of emotional intensity, valence, and emotion category while viewing posed emotional expressions on videotape. Inter-rater reliability for these ratings (N

= 360) was considerably high: intensity ($\alpha = .95$); valence ($\alpha = .78$); and category accuracy ($\alpha = .80$).

Procedures

The entire data set of videotaped expressions was divided into 207 segments for ratings. For each subject, there were four posed expressions, each one ranging from 5-12 seconds (mean = 7.5), and 14-20 segments containing the two spontaneous recollected experiences (happy, sad). The latter were divided into 7.5 second segments, with any remaining seconds at the end becoming a briefer segment.

These 207 segments were all viewed and rated in one two hour session with several breaks for the raters. They were only viewed once. After seeing each segment, it was rated for the percentage of time each of nine emotions was observed (i.e., anger, happiness, interest, surprise, sadness, disgust, fear, shame/shyness, and contempt).

Percentage of time was rated on a 0-10 scale: "0" denoted that the emotion was not seen at all during the segment, "1" indicated that it was seen 1-10% of the time, "2" indicated 11-20% of the time, "3" indicated 21-30% of the time, "4" indicated 31-40%, "5" indicated 41-50%, "6" indicated 51-60%, "7" indicated 61-70%, "8" indicated 71-80%, "9" indicated 81-90%, and "10" indicated 91-100% of the time.

Inter-rater Agreement

Inter-rater reliability for the subjective ratings was calculated using Cronbach's alpha (Cronbach, 1951). An alpha coefficient was calculated across all raters and for each of the nine emotions. With the exception of two emotions (i.e., contempt and fear), inter-rater reliability was quite high (mean = .91). (See Table XIII for a list of alpha coefficients for each emotion.)

Results

Posing Accuracy. One of the functions of the subjective ratings was to provide an index of sending accuracy, i.e., can the subjects accurately convey emotion signals to others? Table XIV presents by group for each posed emotion the mean percentage of that emotion that was perceived by the raters. Since emotion blends occurred for most of the posed emotions (87.5%), the mean percentages given only reflect the subjective ratings for the requested ("target") emotion and not the other emotions perceived by the raters for that particular expression. For example, subject #65 was rated as showing anger for 91-100% of the time (mean % score = 10.0) when asked to pose anger; however, he also conveyed contempt for 21-30% of that segment (mean percentage score = 2.5).

TABLE XIII

Subjective Ratings - Inter-rater Reliability
Alpha Coefficients Across Emotions

Emotion	Alpha Coefficients	Number of Cases
Angry	.88	74
Interest	.95	135
Surprise	.93	42
Contempt	-.30	35
Fear	.44	21
Happiness	.94	107
Shame/Shyness	.90	110
Sadness	.94	109
Disgust	.84	47

TABLE XIV
Sending Accuracy for Posed Facial
 Expression by Group

<u>Group</u>	<u>SAD</u>	<u>ANGRY</u>	<u>INTEREST</u>	<u>HAPPY</u>
<u>NCs:</u>				
#65	5.0	10.0	3.50	10.00
49	0	10.0	5.00	6.75
48	0	0	6.25	9.25
56	0	2.50	9.75	8.75
Mean	1.25	5.62	6.12	8.69
<u>PDs:</u>				
#81	0	10.00	1.50	6.50
84	2.50	2.50	.50	0
93	2.00	0	2.50	7.50
Mean	1.50	4.20	1.50	4.70
<u>RBDs:</u>				
#75	5.00	9.25	5.50	4.25
112	4.50	0	2.25	0
111	3.25	5.00	7.00	1.00
Mean	4.08	4.75	5.00	1.75

Taking the percentage scores for each emotion as an accuracy measure, there were group differences in the extent to which the subjects were perceived as posing the target emotional expressions. These differences varied as a function of the particular emotion. With the exception of the sad expression, NCs were most "on target," followed by the RBDs who were seen as posing three out of four expressions more accurately than the PDs. The PDs, however, were more "on target" than the RBDs when posing happiness, although they were less accurate than the NCs.

An interesting finding was that the RBDs were more accurate at posing sadness than the other groups. This is consistent with the high subjective ratings of sadness during the emotion recollection expression. In other words, the raters consistently perceived the RBDs as looking sad, regardless of the experimental condition.

Spontaneous Accuracy. It is difficult to speak of accuracy for spontaneous expression in the same way as for posed expression, yet one can examine the extent to which positive affect is displayed when relating a positive emotional experience and the extent to which negative affect is displayed when relating a negative emotional experience.

Although some pleasant and unpleasant affect would be expected during both emotion recollections, one would anticipate, particularly during the happy emotion recollection, that more positive than negative affect would be expressed. For the sad emotion recollection, the expression of greater negative emotion would not be necessarily expected, due to the social display rules (Ekman and Friesen, 1975) which dictate the need to mask the expression of negative affect in a social context.

Table XV presents for the happy and sad recollected experiences the mean subjective ratings across the positive and negative emotions by group.

Results indicate definite group differences in the prevailing valence of affect across positive and negative emotion recollections. The NCs showed more positive than negative emotion with only one exception (Subject #65 displayed more negative emotion during the negative emotion recollection).

Two out of three PDs exhibited a higher positive mean subjective rating when talking about a happy experience and a higher negative mean subjective rating when relating a sad experience. The same subject (#81) was perceived as displaying more negative than positive affect in both conditions.

For the RBDs, the results were indeed striking: all three were seen as showing more negative than positive emotion regardless of whether they were talking about a happy or sad experience.

TABLE XV

Subjective Positive and Negative Means for the Happy
and Sad Emotion Recollection Conditions by Group

Group	<u>Happy Recollection</u>		<u>Sad Recollection</u>	
	Subjective Positive Mean	Subjective Negative Mean	Subjective Negative Mean	Subjective Positive Mean
<u>NCs</u>				
65	4.3	3.8	3.2	2.7
49	5.2	1.6	2.6	3.3
48	4.2	1.8	1.8	2.5
56	5.8	1.8	3.6	4.2
Mean	4.9	2.2	2.8	3.2
<u>PDs</u>				
81	4.2	5.3	5.1	3.8
84	4.4	1.3	3.0	2.8
93	4.8	1.2	1.5	2.0
Mean	3.5	2.6	3.2	2.9
<u>RBDs</u>				
75	2.3	4.4	4.7	2.5
112	1.4	4.6	3.6	1.5
111	2.2	3.7	3.2	1.9
Mean	2.0	4.2	3.8	2.0

Group Differences in the Valence of Emotional Expressions

Tables XVI through XVII present mean scores for each emotion for the posed and spontaneous expressions by group. There were group differences for both types of expressions depending on emotion type, although no systematic patterns emerged for the individual emotions across groups and/or conditions.

Posed Expressions. For the posed emotions, RBDs were perceived as showing the most interest and the least happiness. NCs conveyed the most happiness and pleasant surprise, while PDs expressed the least pleasant surprise and interest and a considerable amount of happiness.

For the negative emotions seen during posing, NCs conveyed more anger and disgust than the other groups but less contempt, fear, shame/shyness, and sadness. Of the two neurological groups, RBDs were rated as expressing more fear, sadness, and disgust than PDs, while PDs were seen as showing more contempt and shame/shyness than RBDs during posing. They were rated as showing an equivalent amount of anger.

Spontaneous Expressions. During the spontaneous recollected experiences, NCs were rated as showing the most interest and pleasant surprise. PDs were seen as conveying the most happiness and intermediate levels of

TABLE XVI

Subjective Means for the Positive
Posed Expressions by Group

Group	Interest	Pleasant Surprise	Happy
I. <u>RBDs</u>			
#111	3.38	.00	.63
112	3.06	.63	.00
75	3.44	.44	1.19
Mean	3.29	.36	.61
II. <u>PDs</u>			
84	.75	.13	.13
93	1.38	.13	2.50
81	.38	.25	3.25
Mean	.84	.17	1.96
III. <u>NCs</u>			
48	2.19	2.25	4.94
56	2.44	1.13	2.81
49	2.88	2.88	3.69
65	.88	1.38	3.56
Mean	2.10	1.91	3.75

TABLE XVII

Subjective Means for the Positive
Spontaneous Expressions by Group

Group	Interest	Pleasant Surprise	Happiness	Mean
I. <u>RBDs</u>				
#111	.55	.36	1.34	.75
112	.53	.10	.15	.26
75	2.59	.09	.36	1.01
Mean	1.22	.18	.62	.67
II. <u>PDs</u>				
84	4.53	.44	3.66	2.88
93	1.30	.40	5.02	2.24
81	.11	.05	3.66	1.27
Mean	1.98	.30	4.11	2.13
III. <u>NCs</u>				
48	2.16	.31	3.39	1.95
56	1.67	.85	4.33	2.28
49	4.72	.56	2.38	2.55
65	3.42	.20	1.90	1.84
Mean	2.99	.48	3.00	2.15

interest and pleasant surprise. RBDs were rated as conveying positive emotion the least amount of time.

For the negative emotions seen during the emotion recollection procedure, NCs showed the least anger and shame/shyness according to the raters. They were seen as expressing a similar amount of disgust as the RBDs and an equivalent amount of contempt as the PDs.

RBDs were rated as showing anger, sadness, and shame/shyness for more of the time than the other groups. PDs were seen as conveying the most fear and the least sadness and disgust.

Correlations between Subjective Ratings and Max Coding

In order to examine the relationship between the subjective ratings and the Max coding, Spearman correlations were computed between Max and subjective ratings across groups for all nine emotions. Correlations were computed in two ways: (1) including all ratings of emotions, even when the emotion was rated as "0" (absent), and (2) only including ratings when an emotion was perceived as present (i.e., excluding zeros).

Table XVIII lists Spearman correlation coefficients computed with and without zeros. For about half of the emotions, there were significant positive correlations between Max and subjective ratings. The highest of these were: Happiness (.81, $p < .002$), Fear (.84, $p < .001$), and Shame/Shyness (.94, $p < .0001$) followed by

TABLE XVIII

Max/Subjective Spearman Correlations
Computed with and without Zeroes

Emotion	Computed With Zeroes	P Values	Computed Without Zeroes	P Values
Angry	.64	.02	-.02	.48
Interest	.72	.01	.50	.08
Surprise	.01	.49	.05	.45
Contempt	.16	.32	.41	.12
Fear	.84	.001	-.15	.40
Happiness	.81	.002	.64	.02
Shame/Shyness	.94	.0001	.96	.0001
Sadness	-.35	.16	.21	.34
Disgust	-.23	.26	-1.0	.50

Interest (.72, $p < .01$) and Anger (.64, $p < .02$). There were insignificant negative correlations between the two measurement systems for sadness (-.35, $p < .16$) and disgust (-.23, $p < .26$) and insignificant positive correlations for surprise (.01, $p < .49$) and contempt (.16, $p < .32$).

Correlations computed without the zeros were considerably lower, with the singular exception of Shame/Shyness (.96) -- $p < .000$. Happiness (.64) was significant at the $p < .05$ level. The other emotions were not significantly correlated.

These findings can be explained by the fact that there was higher agreement between the two systems about what emotions were absent than present. When expressions occurred, there were often substantial disagreements between the Max coders and the raters as to which emotions were conveyed. This is to be expected considering the very different nature of the two systems -- one (Max) involving repeated slow motion viewing of the expressions and the other subjective rating system involving a single viewing of the expression in real time.

One of the findings using both measurement systems was that RBDs consistently were rated as showing the least happiness of the groups and, in general, as displaying more negative emotion. While the Max system rated the RBDs as conveying more anger, contempt, and shame/shyness than the other groups, the subjective

raters perceived them as conveying sadness most of the time, in addition to anger and shame/shyness.

The subjective raters did not see the RBDs as contemptuous. This was an interesting finding in and of itself because the Max appearance changes coded for contempt are both unilateral (i.e., unilateral lip raise and raising one eyebrow). Lower facial paralysis would result in the subject's inability to move one side of the mouth. Indeed, the RBDs were frequently coded by Max as showing contempt because of their unilateral mouth movement. In contrast, the subjective raters perceived the RBDs as showing other negative emotions not dependent on unilateral movement (i.e., sadness and anger).

Both measurement systems were also consistent in their frequent rating of PDs as conveying happy expressions (albeit Max raters judged them to be less happy than NCs, while the subjective raters actually saw them as showing more happy expressions than the NCs). This finding was at least in part due to the PDs' symptom of masked facies: once they had assumed a happy expression, they had difficulty returning to a neutral resting face but retained a "frozen" smile on their faces.

Perceptual and Rating Scale Data

Emotion Perception

As part of the larger research study, subjects were administered control tasks of visual-spatial perception,

neutral face recognition, and emotional facial and prosodic perception (see Appendix I). Examining these data provides valuable information regarding the homogeneity of the groups, as well as information about the relationship between the perception and expression of emotion in these groups. (See Table XIX for perception data by group.)

On the Visual Matrices Test, a 24 item multiple choice test of pattern recognition, NCs performed at a higher level than the brain-damaged groups, who performed at the same level. On a multiple choice test of neutral face recognition, the Benton Test of Face Recognition (SF), the NCs again were most accurate, followed by the RBDs and the PDs.

Looking at the individual scores on both tasks, the groups were quite homogeneous in their pattern recognition but less so in their neutral face recognition. PD Subject #81 performed at a much higher level than the other two PDs and more closely resembled the RBDs.

On two tests of emotional face perception, the three groups were quite homogeneous in their performance. NCs consistently scored higher than the other groups on the more difficult face identification task, with the two neurological groups performing at identical levels. On the emotional face discrimination task, PDs performed at a slightly higher level than NCs, with RBDs performing at a lower level than the other two groups.

TABLE XIX

Perception Data Raw Scores by Group

<u>GROUP</u>	<u>Matrices</u> (24 total)	<u>Benton</u> (54 total)	<u>Face</u> <u>Identifi-</u> <u>cation</u> (21 total)	<u>Face</u> <u>Discrimi-</u> <u>nation</u> (30 total)	<u>Voice</u> <u>Identifi-</u> <u>cation</u> (16 total)	<u>Voice</u> <u>Discrimi-</u> <u>nation</u> (32 total)
<u>NCs:</u>						
#65	24	49	16	24	13	26
#49	21	45	18	27	14	32
#48	24	43	14	23	12	32
#56	24	49	19	25	16	32
Mean =	(23)	(46.5)	(17)	(25)	(14)	(30.5)
<u>PDs:</u>						
#81	20	45	14	27	16	30
#84	19	36	11	26	14	26
#93	17	39	15	27	12	29
Mean =	(19)	(43)	(13)	(27)	(14)	(28)
<u>RBDs:</u>						
#75	18	49	14	21	11	27
#112	19	41	14	25	5	18
#111	21	45	12	21	8	30
Mean =	(19)	(45)	(13)	(22)	(8)	(25)

On the two tasks of prosodic perception, NCs had the highest scores of the three groups on the Voice Discrimination task but were the same as the PDs on Voice Identification. RBDs consistently were the most impaired on these prosodic tasks.

Movement Scale Data

Table XX presents scores on two movement scales, the Extrapyramidal Symptoms Rating Scale (ESRS) and the Abnormal Involuntary Movement Scale (AIMS) which were administered to all subjects in order to assess the effect of disordered movement on the production of facial emotion. The NCs are excluded in the table as they showed no evidence of movement abnormalities on either scale (i.e., their scores were all "0"s).

ESRS. The ESRS rates the presence of disordered movement on a 0 (normal) to 6 (extremely severe) scale. All of the RBDs were rated as showing similar levels of impairment in their "expressive automatic movement" ("2" = mild decrease in facial expressiveness). They also evidenced bradykinesia ("2" = definite slowness in movements) and some decrease of pendular arm movement in their gait.

RBD subject #111 exhibited a more extreme disturbance in gait and posture, in addition to a borderline tremor of the hands. In these symptoms, he more closely resembled a Parkinsonian patient than an RBD.

TABLE XX

Movement Scale DataESRS

	RBDs			PDs		
	#7	111	112	81	74	93
1. Expressive Automatic Movement (Facial mask/speech)	2	2	2	3	1	1
2. Bradykinesia	2	2	2	2	2	2
3. Rigidity	0	0	1	4	2	4
4. Gait and Posture	2	4	2	2	2	2
5. Tremor	0	1	0	1	2	1
6. Akathisia	0	0	0	0	1	0
7. Increased Salivation	0	0	0	1	0	2
8. Acute Dystonia	0	0	0	0	0	0
9. Non-acute dystonia	0	0	0	0	0	0

AIMS

1. Muscles of Facial Expression	0	0	0	1	0	1
2. Lips and Perioral Area	0	0	0	0	0	3
3. Jaw	0	0	0	0	0	3
4. Tongue	0	0	0	2	0	0
5. Upper extremity	0	0	0	0	1	0
6. Lower extremity	0	0	0	0	3	0
7. Trunk movements	0	0	0	0	0	0
8. Global severity	0	0	0	2	2	3
9. Incapacitation	0	0	0	2	2	0
10. Patient's awareness	0	0	0	2	2	0

In this context, his CT scan, in addition to showing a temporal lesion, had an extensive basal ganglia lesion.

Of the PDs, subject #81 was rated on the ESRS as having a rare spontaneous smile, decreased blinking, and a slightly monotonous voice. The other PDs' facial mask symptoms were not as pronounced as even the RBDs (although they showed other anomalous qualities in their facial expressions).

All of the PDs had cogwheel rigidity of the limbs, ranging from mild (subject #84) to moderately severe (subjects #81 and 93), in addition to resting tremor of the hands, ranging from borderline (subjects #81 and 93) to occasional (subject #84). Subject #84 also evidenced mild akathisia. Finally, two out of the three PDs showed increased salivation (subject #81 - very mild; subject #93 - mild).

AIMS. The PD subjects were the only ones with abnormal movements rated on the AIMS. Subjects #81 and 93 both had minimal involuntary grimacing and frowning movements, with #93 also frequently involuntarily opening his mouth and making smacking noises. Subject #84 was notable for minimal to moderate involuntary movements of her upper and lower extremities.

In summary, involuntary movements were at their most severe (i.e., moderate) with PD patient #93 and at the minimal level with the other two. A striking finding was that subject #93 with the moderate symptoms

reported no awareness of any abnormal involuntary movements.

Zung Depression Scale Data

Table XXI gives total and factor scores for each subject on the self-administered Zung Depression Scale. A key to interpreting normal and pathological ranges for the total scores is also provided.

Of the three groups, the RBDs reported the greatest number of depressive symptoms, followed by the PDs and NCs. They also reported more symptoms than the others related to a "Motor" factor, i.e., difficulty doing the things they used to, and to a "Psychological" factor. Scale items relevant to this factor are, for example, "My mind is as clear as it used to be", "I find it easy to make decisions", and "My life is pretty full."

Both neurological groups scored in the same range on items loading on the "Affect" factor. This factor includes the items: "I feel downhearted, blue, and sad" and "I have crying spells or feel like it." The NCs' scores on these items were substantially lower.

For the "Physiological" factor, the PDs scored the highest followed by the RBDs and NCs who scored at the same level. This factor consists of such items as: "I have trouble sleeping through the night", "I eat as much as I used to", and "I get tired for no reason."

TABLE XXI

Zung Depression Scale - Total and Factor Scores

<u>Subject #</u>	<u>Total Score</u>	<u>Affect Factor</u>	<u>Physiological Factor</u>	<u>Motor Factor</u>	<u>Psychological Factor</u>
RBDs: #75	50	2.00	1.75	2.50	3.38
111	42	2.00	1.75	3.00	2.25
112	28	1.00	1.25	2.50	1.38
Mean	40	1.7	1.6	2.7	2.3
PDs: 81	26	1.00	1.13	1.50	1.50
84	46	2.50	2.50	2.50	2.00
93	34	1.50	2.00	1.00	1.63
Mean	35	1.7	1.9	1.7	1.7
NCs: 48	26	.50	1.63	1.00	1.00
49	20	1.00	1.00	1.00	1.00
56	44	1.50	2.13	2.50	2.38
65	36	1.00	1.75	1.50	2.13
Mean	31.5	1.0	1.6	1.5	1.6

Key: <50 within normal range
50-59 minimal to mild
60-69 moderate to severe
>69 severe

Self-Report Ratings

One of the questions this study addressed was whether there would be a relationship between subjects' internally experienced emotion and their emotional expressiveness. For both the posed and emotion recollection procedures, subjects were asked to rate the emotional intensity they felt and also how difficult it was for them to pose/recall the specific emotions or happy/sad experiences. Intensity was rated on a 1-7 scale with "1" indicating a feeling of minimal intensity and "7" indicating a feeling of extreme intensity. Difficulty was also rated on a 1-7 scale with a rating of "1" meaning "not at all difficult" and a rating of "7" meaning "extremely difficult."

Posed Expression. Table XXII presents the self-report data for the posed expressions by group. For both intensity and difficulty, the groups did not markedly differ. When examining the individual scores, however, there were some notable differences. NC #49, for example, reported feeling minimal emotion when posing sad and angry but a great deal of emotion when posing interest and happy. Her ratings of difficulty (like many of the other subjects) were not necessarily related to intensity and varied from "1" (least difficult) for angry, interest, and happy to "7" (most difficult) for sadness.

TABLE XXII
Self-Report Ratings
for Posed Facial Expression by Group

Group	Posed Facial Expression							
	Intensity				Difficulty			
	Sad	Angry	Int.	Happy	Sad	Angry	Int.	Happy
<u>NCs</u>								
65	3	3	3	6	3	3	3	2
49	1	1	5	7	7	1	1	1
48	4	4	3	2	4	4	3	2
56	4	5	4	3	3	5	4	4
Mean	3	3	4	4.5	4	3	3	2
<u>PDs</u>								
81	7	7	4	7	1	1	4	1
84	3	2	4	3	3	2	2	3
93	1	1	4	4	4	1	1	1
Mean	4	3	4	5	3	1	2	2
<u>RBDs</u>								
75	5	5	5	5	1	5	1	5
112	3	3	6	5	2	1	6	2
111	2	2	1	7	2	2	1	1
Mean	3	3	4	6	2	3	3	3

Spontaneous Expression. Table XXIII presents the self-report data for the emotion recollection procedure. For intensity, the PDs and RBDs had equivalent data, whereas the NCs were not at all homogeneous in their ratings. There was, however, no difference between the NCs' intensity ratings as a function of the type of emotion recollection (i.e., negative/positive).

For difficulty, there were group differences: NCs and RBDs both reported relatively little difficulty for either of the emotion recollection experiences. PDs, however, reported more difficulty recalling sad experiences than the other groups. In contrast, recalling happy experiences was easy for them, according to their report.

Relationship between Self-Report Ratings and Sending Accuracy.

Posed expression. When examining group and individual differences in self-report ratings and sending accuracy (i.e., how well emotion was communicated) interesting findings emerged. Table XXIV provides the intensity and difficulty ratings for each subject next to the subjective ratings for each posed emotion.

As can be seen from the table, there was no consistent relationship between the emotion felt by the subjects during posing and the subjective raters' perceptions of the emotion displayed. Subjects' internally

TABLE XXIII
Self-Report Ratings
for Spontaneous Facial Expression by Group

Group	<u>Intensity</u>		<u>Difficulty</u>	
	Negative Recall	Positive Recall	Negative Recall	Positive Recall
<u>NCs</u>				
65	4	5	6	5
49	6	7	3	1
48	3	1	2	1
56	7	5	2	2
Mean	5	4.5	3	2
<u>PDs</u>				
81	7	7	7	1
84	7	6	4	2
93	7	7	7	1
Mean	7	7	6	1
<u>RBDs</u>				
75	7	6	1	1
112	5	7	6	1
111	7	7	2	1
Mean	6	7	3	1

TABLE XXIV

Relationship between Self-Report and Subjective
Ratings of Posed Facial Expression

<u>Group</u>	POSED EMOTION											
	SAD			ANGRY			INTEREST			HAPPY		
	<u>Int.</u>	<u>Diff.</u>	<u>Subj.</u>	<u>Int.</u>	<u>Diff.</u>	<u>Subj.</u>	<u>Int.</u>	<u>Diff.</u>	<u>Subj.</u>	<u>Int.</u>	<u>Diff.</u>	<u>Subj.</u>
<u>NCs:</u>												
#65	3	3	5.00	3	3	10.00	3	3	3.50	6	2	10.00
#49	1	7	0	1	1	10.00	5	1	5.00	7	1	6.75
#48	4	4	0	4	4	0	3	3	6.25	2	2	9.25
#56	4	3	0	5	5	2.50	4	4	9.75	3	4	8.75
<u>PDs:</u>												
#81	7	1	0	7	1	10.00	4	4	1.50	7	1	6.50
#84	3	3	2.50	2	2	2.50	4	2	.50	3	3	0
#93	1	4	2.00	1	1	0	4	1	2.50	4	1	7.50
<u>RBDs:</u>												
#75	5	1	5.00	5	5	9.25	5	1	5.50	5	5	4.25
#112	3	2	4.50	3	1	0	6	6	2.25	5	2	0
#111	2	2	3.25	2	2	5.00	1	1	7.00	7	1	1.00

experienced emotion was generally greater than the extent to which it was conveyed to the raters. This was particularly true for the PDs (91.7% of the time), followed by the RBDs (83.3%), and the NCs (81.2%).

There were also interesting group differences as a function of particular emotions. For the NCs and PDs, self-report ratings more closely approximated subjective ratings for the positive emotions (interest and happy), as opposed to the negative emotions (sad and angry). In contrast, the RBDs' self-report ratings for the negative emotions were more akin to the raters' subjective ratings than the ratings for interest and happy.

This suggests that although the RBDs reported feeling as much positive emotion as the other groups, they were perceived as displaying more negative emotion. In other words, there seemed to be a dissociation between the RBDs' internal emotional experience and what they communicated externally.

PDs also exhibited a dissociation between their felt emotion and communicated emotion, but unlike the RBDs, it did not seem to be affected by valence.

There was also a striking discrepancy for all groups between reported feelings of sadness and subjective ratings of sadness. Apparently, although most of the subjects felt sad when posing sadness, the expressions on their faces (with the single exception of NC #65) conveyed emotions other than sadness.

As can be seen from the self-report ratings of difficulty, the NCs tended to report more difficulty posing the expressions (mode = 3) than the RBDs (mode = 1.5) and the PDs (mode = 1). The PDs, then, showed the greatest dissociation between their reported degree of difficulty and their reported emotional intensity.

Spontaneous expression. Table XXV presents the intensity and difficulty ratings by group, along with the subjective mean of the positive and negative emotions expressed during the happy and sad recollected conditions respectively. The subjective negative mean represents the mean of the subject ratings for all of the negative emotions (i.e., Sad, Angry, Contempt, Fear, Disgust, Shame/Shyness) conveyed during the sad emotion recollection condition. The subjective positive mean represents the mean of the subjective ratings for all of the positive emotions (i.e., Happy, Interest, and Surprise) conveyed during the happy recall condition.

As in the posed condition, high self-report ratings of intensity did not necessarily coincide with greater expressiveness for any of the groups. Subject #48, for example, reported feeling not at all positive while relating a happy experience, yet was quite expressive of positive affect (subjective positive mean = 4.2), albeit below the group mean of 4.9.

The greatest dissociation between self-report ratings of intensity and the mean subjective ratings was

TABLE XXV

Self-Report Ratings and Subjective Ratings
for Emotion Recollections by Group

Group	Spontaneous Emotion Recollection					
	<u>Sad Recall</u>			<u>Happy Recall</u>		
	Intensity	Difficulty	Subjective Negative Mean	Intensity	Difficulty	Subjective Positive Mean
<u>NCs</u>						
#65	4	6	3.2	5	5	4.3
49	6	3	2.6	7	1	5.2
48	3	2	1.8	1	1	4.2
56	7	2	3.6	5	2	5.8
Mean	5	3	2.8	4.5	2	4.9
<u>PDs</u>						
#81	7	7	5.1	7	1	4.2
84	7	4	3.0	6	2	4.4
93	7	7	1.5	7	1	4.8
Mean	7	6	3.2	7	1	4.6
<u>RBDs</u>						
#75	7	6	4.7	6	1	2.3
112	5	7	3.6	7	1	1.4
111	7	7	3.2	7	1	2.2
Mean	6	7	3.8	7	1	2.0

for the RBDs in the happy recall condition. Not only did they report feeling extremely positive while relating their happy experiences, but they also claimed that they had the least difficulty engaging in the task. Yet, their subjective positive mean ratings were the lowest.

For sad recall, the RBDs reported both high negative feeling and also great difficulty when relating their sad experiences. Despite their reported difficulty, however, they were subjectively rated as expressing the most negative affect.

PDs reported high levels of emotional intensity for both happy and sad recall, but were rated as much more positive during happy recall than negative during sad recall. They were, however, fairly consistent in conveying less intense emotion during the condition (i.e., sad recall) for which they reported the most difficulty. In relation to the other groups, they followed the RBDs in their communication of negative emotion, but followed the NCs in their relatively high positive ratings during happy recall.

The NCs maintained intermediate levels of intensity and difficulty for both conditions. As a group, their display of emotion did not consistently vary depending on the emotional intensity and difficulty they experienced.

To summarize, for the sad recollected experience, the NCs reported the least intensity and difficulty and were perceived as displaying the least negative emotion. For the happy recollected experience, they were rated as showing more positive affect than the other groups despite their reports of feeling the least positive and experiencing the most difficulty in talking about a positive experience.

PDs and RBDs reported similarly high levels of negative intensity and difficulty when relating a sad experience and were perceived as showing more negative affect than the NCs (especially the RBDs). While both neurological groups said they felt extremely positive during the happy emotion recollection and said they had no difficulty talking about a happy experience, the RBDs were subjectively rated as showing minimal positive emotion. The RBDs, then, exhibited the greatest dissociation between their reported experience of emotion and the amount of emotion they displayed as perceived by others.

Additional Data on Facial Behavior

Posed Expression. Table XXVI presents data by group for other types of facial behavior observed while posing expressions which were not linked to specific emotions. "No expressive movement" refers to any instance during the posed condition during which the

TABLE XXVI
Posed Facial Expression --
Additional Data by Group

Group	No Expressive Movement	Tremor	Code 80	Code 51	Closed Eyes
<u>NCs</u>					
65	-	-	-	1	-
49	-	-	2	-	-
48	1	-	4	4	-
56	-	-	1	-	-
<u>PDs</u>					
81	-	1	-	-	-
84	-	-	1	-	-
93	-	-	-	-	-
<u>RBDs</u>					
75	2	-	-	-	1
112	-	-	-	-	1
111	-	-	-	-	-

subject's face showed no movement of any kind, emotional or non-emotional. No expressive movement was noted twice for RBD #75 and NC #48.

Another non-emotional movement observed among the RBDs was closing the eyes while posing an expression. This occurred for two out of three RBDs, one with only cortical damage (subject # 112) and the other with both cortical and sub-cortical damage.

Code 80 is a Max code believed to be associated with mild anger, which was observed by Jonas (1986) in her study of adult facial expressions. It involves the raising of the chin with the lower lip protruding. In the present study, code 80 was observed most frequently among the NCs and once in a PD patient.

Code 51 was added by the author and the other Max rater to describe a mouth movement which did not quite fit any of the Max mouth codes. Subjectively, this movement could be characterized as a slight, very tense smile: both corners of the mouth were only slightly raised but rather than being an upward movement, it was more a movement of pulling back the mouth corners. This tense smile was observed during posing only among the NCs.

Spontaneous Facial Expression. Table XXVII presents additional facial behavior data for the spontaneous emotion recollection condition. There was only one

TABLE XXVII

Spontaneous Facial Expression --
Additional Data by Group

Group	No Expressive Movement	Tremor	Code 80	Code 51	Closed Eyes
<u>NCs</u>					
65	-	-	3	1	-
49	-	-	3	-	-
48	1	-	-	-	-
56	-	-	3	2	-
<u>PDs</u>					
81	-	throughout	-	-	-
84	-	-	-	-	-
93	-	*	-	-	-
<u>RBDs</u>					
75	-	-	-	2	-
112	-	-	-	-	-
111	-	-	2	-	-
* Mouth opens and closes during movement.					

instance of no expressive movement, again for subject #48. This NC subject had relatively high Max expressiveness scores (above the group mean) for both conditions, yet was subjectively rated as showing less positive and negative emotion than the other NCs.

As in the posed condition, facial tremor occurred only among the PDs. In both subjects, tremor of the mouth was observed throughout the negative emotion recollection and may well have been due to the psychological stress inherent in relating a sad emotional experience. Both of these subjects related feeling extremely negative while they were recalling their sad experiences.

Code 80, as in the posed condition, was typically seen in the NCs, although it was observed once in the spontaneous facial behavior of RBD #111.

The tense, slight smile or Code 51 was again seen among the NCs, although it occurred twice in this condition in RBD #75. Closed eyes was not observed at all during the spontaneous emotion recollection.

Individual Differences

As described earlier (General Findings on Using Max with Neurological Patients), each of the neurological groups displayed particular characteristics in their facial behavior which affected the Max coding of their expressions. For the RBDs, the facial asymmetry caused

by their lower facial paralysis led to the coding of many unilateral mouth movements, in addition to the emotion blends. For the PDs, the particular quality of muscular tension in their faces resulted primarily in the greater coding of emotion blends.

Posed Expression. In addition to these group differences, there were also individual differences. Appendix IV provides graphic displays of the posed data for each subject. In the left hand margin are the Max codes according to facial region. Each display is divided into an upper and lower area in which the correct Max codes for the posed expressions are displayed at the top and any other appearance changes (not part of the target expression) are given in the lower area.

Each appearance change observed was checked from left to right in a temporal sequence. Subject #65's sad expression, for example, consisted of a code 24 and code 56 occurring simultaneously, immediately followed by a code 24 alone. For NC subject #49's interest expression, codes 20, 52 and 80 occurred simultaneously, followed by codes 20 and 80, then 20 alone.

These graphic displays of the data provide information on the temporal sequence of the expressions and on the presence of emotion blends (the simultaneous presence of appearance changes linked to more than one emotion). They can also illustrate some of the individual

differences observed in the subjects.

Some of the subjects, e.g., NC subject #65, posed the expressions with a minimal number of appearance changes associated with the target emotion. This "posing efficiency" and accuracy were not, however, always associated with higher subjective ratings. Another subject, for example, NC #48, produced numerous emotion blends yet was subjectively rated as showing the target emotions for longer periods of time than #65.

Several interesting differences among the PDs emerged. As you can see from the graph of subject #81's posed expressions, appearance changes associated with happiness were present for three out of four of his posed expressions. This was due to his masked facies which left a wide and tense 'frozen' smile on his face regardless of what he was posing.

The expressions of PD Subject #84, exemplified the muscular tension seen in the PDs. The difficulty of coding her expressions led to the rating of many emotional blends. This caused her to appear almost hyper-expressive: her expressiveness scores, particularly during the emotion recall procedure, were higher than the other PDs and subjectively she was rated as conveying high levels of both positive and negative emotion. Yet, looking at her facial expressions on videotape, they were clearly not "normal."

The RBDs, as described earlier, were notable in their minimal use of appearance changes associated with happiness. Only RBD subject #75 actually smiled when asked to pose happiness. Also of interest was the finding that two of the RBDs (#75 and #112) did not exhibit any of the sadness appearance changes when posing sadness. Instead, both of them looked down and subject #112 closed his eyes at the same time.

Spontaneous Expression. In addition to some of the group and individual differences described earlier related to the subjects' expressiveness scores, expression valence and differential movement of the three facial regions, other individual differences were evident in the subjects' spontaneous expression.

There were striking group and individual differences. For all of the NCs, there were typically many subtly varying emotion blends during the spontaneous condition, often on the average of three different emotions being conveyed in any one second. For certain NC subjects, e.g., subject #56 (happy recall) and #65 (both happy and sad recall), blends of even four emotions were coded in one second.

Among the neurological patients, there tended to be one of two general patterns. Either the subject exhibited a narrow range of the same emotions and emotion blends (i.e., appeared 'flat') or their expressions were

anomalous in other ways and it was difficult to assign Max codes to them.

RBD #75 and PD #81 exemplified the first pattern, displaying the same two to five emotions and emotion blends through the entire one minute segment. The other RBDs showed a similar but less extreme pattern than #75.

Of the two other PDs, subject #93 fit more of the "flat" prototype, and the tremor throughout his sad recall made him difficult to code. PD subject #84, as described earlier, was Max coded as exhibiting many emotion blends due to the difficulty of coding her anomalous expressions.

CHAPTER IV

DISCUSSION

This study involved the use of an objective facial coding system (Max) in assessing the facial emotional expressions of right brain-damaged, Parkinsonian, and normal control subjects. Max proved to be feasible for use with neurological patients and capable of discriminating among brain-damaged groups in their emotional facial behavior. This was the first known study to utilize both objective and subjective systems to measure emotional facial expression in neurological patients, and its findings, even in this small group study, provided support for several of the experimental hypotheses.

Summary of Findings

The Max system was successfully employed to objectively analyze facial behavior in right brain-damaged, Parkinsonian, and normal control subjects. The two Max raters (the author and another rater) achieved a sufficiently high level of inter-rater agreement (alpha = 82%). At the same time, decision rules had to be established regarding the Max coding of expressions which were asymmetrical as a result of lower facial paralysis

(among the RBDs) and those expressions which exhibited an unusual quality of muscular tension (among the PDs).

Mixed support was found for the hypothesized dissociation between posed and spontaneous expression among the neurological groups. Two out of three PDs showed the predicted pattern: expressiveness was diminished while talking about emotional experiences but not during the posed condition. Only one of the RBDs, (with frontal and subcortical damage) produced slightly more expressions per second while recalling emotional experiences than while posing.

All of the groups differed in their extent of movement across the three facial regions coded by Max. As predicted, RBDs showed less mouth movement than the other groups as a result of their lower facial paralysis, although they evidenced substantially greater mouth movement during the more spontaneous condition. They also exhibited relatively more eye movement during both conditions than the other groups but notably less brow movement when posing. Contrary to expectations, PDs moved their brows most, the eyes secondarily, and the mouth the least. In general, the NCs showed the same pattern as the PDs, although they exhibited markedly less eye movement when posing than the other groups.

Clear group differences emerged in emotional facial behavior as a function of valence. RBDs produced more Max components of unpleasant than pleasant expressions

across both conditions, and they were also subjectively rated as displaying negative emotion most of the time. For the pleasant posed expressions, the RBDs were the only group who showed more pleasant expression components when posing interest and fewer pleasant expression components when posing happiness.

To some extent, these group differences probably stemmed from the RBDs' unilateral facial paralysis. A happy expression, for example, is coded only on the basis of a smile -- a bilateral movement which is difficult to produce when the mouth is partially paralyzed. In contrast, the expression of interest also involves brow movement, and RBDs' movement in this region was unaffected by paralysis because of the bilateral innervation of the upper face.

Facial paralysis cannot completely account for the valence effect, however, because many of the RBDs' negative expressions which were Max coded or subjectively rated did not depend on unilateral movement (e.g., sadness or anger).

Subsequent to the Max coding, subjective ratings were carried out with a high degree of inter-rater reliability ($\alpha = 91\%$) by four trained raters. They were asked to view brief segments of posed and spontaneous facial behavior and rate the percentage of time each of nine (Max coded) emotions was observed (i.e., anger, happiness, interest, surprise, sadness, disgust,

fear, shame/shyness, and contempt).

Group differences in posing accuracy did emerge as a function of specific emotions. With the exception of sadness, NCs were most accurate, followed by the RBDs who were seen as posing three out of four expressions more accurately than the PDs. The PDs were more "on target" than the RBDs in their posing of happiness. When posing sadness, the subjective raters perceived the RBDs as looking sadder than the other groups.

There were also striking group differences in the prevailing valence of affect conveyed during the happy and sad emotion recollections respectively. All three of the RBDs were seen by the subjective raters as conveying more unpleasant than pleasant emotion regardless of whether they were asked to talk about a happy or sad experience.

Two out of three NCs and two out of three PDs produced more pleasant expression components during both types of emotion recollections. This finding is in keeping with social display rules which dictate the need to mask the expression of negative affect in a social situation.

As with the objective Max coding, the subjective raters also perceived the RBDs as conveying more negative emotion than the other groups across both conditions. Both measurement systems also consistently rated PDs as conveying more happy expressions. The subjective

raters saw them as showing even more happy expressions than the NCs. This finding was probably due in part to the PDs' symptom of masked facies.

Additional data was collected on control tasks of visual-spatial perception, neutral face recognition, and emotional facial and prosodic perception. The three groups proved to be quite homogeneous in their performance on these tasks. In general, NCs had the highest scores, followed by the PDs and RBDs. RBDs and PDs performed at identical levels on an emotional face identification task but on an emotional face discrimination task, RBDs performed at a lower level than the PDs or NCs. RBDs were also the most impaired on the prosodic measures.

On rating scales of abnormal movement, the RBDs evidenced similar levels of impairment in movement which were consistent with their strokes. All of the PDs showed a range of abnormal movements (e.g., grimacing), in addition to cogwheel rigidity of the limbs, and resting tremor of the hands.

On a self-report depression inventory, all subjects scored within the normal range. Of the three groups, however, RBDs reported the greatest number of depressive symptoms, followed by the PDs and NCs. The RBDs reported more symptoms related to a "Motor" factor (i.e., difficulty doing the things they used to), while PDs endorsed more items related to a "Physiological" factor

(i.e., more vegetative symptoms).

When posing expressions and when recollecting emotional experiences, all of the subjects rated the degree of difficulty and level of emotional intensity they experienced while engaged in both tasks. The groups did not differ in their reported levels of intensity and difficulty when posing expressions. Interesting group differences did emerge when self-report data was compared with the subjective ratings of posing accuracy (i.e., to what extent the subjects conveyed the requested emotion). Subjects' internally experienced emotion generally was greater than the extent to which it was conveyed to the raters. This was particularly true for the PDS, followed by the RBDs and the NCs.

For the emotion recollection procedure, both RBDs and PDS reported feeling extremely sad or happy and having had minimal difficulty. In contrast, NCs claimed not to have felt such intense emotion and also to have had more difficulty talking about the emotional experiences.

There were also dissociations between subjects' self-report data and their expressiveness ratings by the subjective raters. The most striking dissociation was between the RBDs' report of feeling intensely happy and having the least difficulty when recalling a happy experience and the subjective ratings of very minimal positive affect given the RBDs. In contrast, NCs reported

the least intensity and the most difficulty but were rated as showing more positive emotion than the other groups.

For the sad recollected experience, the RBDs and PDs reported similarly high levels of intensity and difficulty but were perceived as exhibiting more negative affect than the NCs. This was especially true for the RBDs.

Posed Versus Spontaneous Expression

One of the main hypotheses of the study was that PD patients would demonstrate a dissociation between their posed and spontaneous facial behavior such that they would show diminished expressiveness in the emotion recollection procedure but not when posing facial emotion. RBDs were expected to show the reverse pattern and NCs not to show any differences as a function of experimental condition. NCs, as expected, did not show any differences in expressiveness between conditions.

The expected dissociation was observed for the PD patients. In terms of expressiveness, two out of three PDs produced fewer expressions per second during the emotion recollection procedure than while posing facial emotion.

Of the RBDs, only one (with frontal and subcortical damage) displayed greater expressiveness in the more spontaneous condition. The other two RBDs (one with

cortical damage only and the other with cortical plus subcortical damage) did not display the expected dissociation.

Examining expressiveness in terms of the number of expressions produced per second is only one way of looking at differences as a function of condition. Table XIV presents group differences across conditions in movement frequency across the three facial regions. All of the RBDs moved their mouth more during the spontaneous emotion recollection procedure as opposed to when they were posing facial emotion.

This finding is in keeping with the neuroanatomical literature which posits contralateral innervation of the lower face for voluntary facial movement (DeMyer, 1980). The fact that there was more mouth movement during the emotion recollecting condition suggests that this movement was more emotional and spontaneous and hence, was not impaired by central facial paralysis.

In summary, while there was some evidence of a dissociation between posed and spontaneous behavior in the two neurological groups, it was not as strong as expected. This was consistent with Borod, et al.'s (1986c.) finding that there were no significant differences among RBDs in the facial asymmetry of their posed and spontaneous expressions. Even when patients with cortical and subcortical lesions were compared in that study, no significant effects for lesion localiza-

tion were found. In addition, facial paralysis did not affect the RBDs' right-sided asymmetry.

The lack of a stronger dissociation between groups across conditions may have stemmed from the inability of the emotion recollection procedure to consistently evoke a truly spontaneous emotional response. Clearly, this cannot be ruled out, and future studies should attempt to develop procedures which will generate more of a spontaneous, involuntary, emotional response.

Another methodological issue in this study is that of the potential artifact introduced by employing a procedure in which subjects talk about their emotional experiences. While emotion theorists like Malatesta and Izard (1984) consider the recollection of emotional experiences as a valid method for eliciting genuine emotion, from a neuropsychological perspective, such a method might contain some cognitive/linguistic confounds due to the verbal nature of the task and the mediation of language by the left hemisphere. Future studies, in order to circumvent this possible artifact, should investigate the use of a variety of verbal and non-verbal (e.g., olfactory) procedures for eliciting spontaneous emotional expressions.

Self-Report Measures

A major difficulty of assessing the validity of a "spontaneous emotion" experimental paradigm is that of

determining whether such emotion occurred. The self-report measures used in this study were only superficial indicators and might have reflected responses to the experiment's demand characteristics, as opposed to the subjects' actual experienced emotion.

In a recent study by Malatesta, Fiore, and Messina (1987a.), subjects were asked, after each emotion induction, to rate their degree of emotional arousal on a 9-point scale for each of 10 fundamental emotions. Such a scale can provide a better indication of subjects' experience, although it, too, could reflect the effects of demand characteristics.

Another scale developed by Malatesta and her colleagues and described in a 1984 study surveyed subjects' emotional experience across several dimensions: (1) Incidence and intensity of feeling specific positive and negative emotions, (2) display role agreement, i.e., attitudes toward the display of specific emotions, (3) the centrality of emotion in one's life, and (4) change in the frequency and intensity with which emotion is experienced. The use of this extensive self-report questionnaire in the Malatesta, et al. (1984) study highlighted several important and subtle differences in the emotional experience of younger versus older adults.

The use of such an extensive questionnaire in a study like this one would have provided a better frame of reference in which to assess subjects' emotional experience both in and out of the experimental context.

Movement across Facial Regions

The three groups differed in their extent of movement across the three facial regions coded by Max. As predicted, RBDs showed reduced mouth movement due to their lower facial paralysis and greater movement of the brows and eyes.

Contrary to Rinn's (1984) finding of diminished brow movements among PDs, this study found that PDs moved their brows the most, followed by the eyes and the mouth. Apparently, for the PDs, a good number of the mouth movements were smiles, for they were rated as expressing more happiness than either of the other groups. This was probably in part related to masked facies: the PDs' smiles tended to become "frozen," remaining on the face longer than the smiles of the NCs.

In contrast, the RBDs were objectively and subjectively rated as conveying happiness less than the others. Happiness is, of course, depicted prototypically by a smile -- a bilateral mouth movement which is difficult to produce for RBDs with unilateral lower facial paralysis.

The Effect of Valence on Emotional Facial Behavior

Right Brain Damaged. A major finding of the study was that there were clear group differences in emotional facial behavior as a function of valence. RBDs produced

more unpleasant than pleasant components across both conditions relative to the other groups. They were also subjectively rated as conveying negative emotion most of the time.

These results for valence also indicate that unilateral facial paralysis alone cannot account for the greater amount of negative emotion expressed by the RBDs, particularly when posing affect. In a recent study by Borod and her colleagues (1986a.), the relationship between emotional and nonemotional movement was examined in right and left brain damaged individuals who all had substantial contralateral facial paralysis. There were no significant relationships found between measures of emotional facial expression and nonemotional movement. This would indicate that the valence effect stems from a mechanism related to emotional processing and the right hemisphere.

The finding of more negative expressions among the RBDs replicates that of another recent study by Borod and her colleagues (1986c.) which also compared right and left brain--damaged groups in their posed and spontaneous emotional behavior. Borod, et al. found that the RBDs had more difficulty producing positive emotions than posing negative affect. The results of this and the Borod, et al. study run counter to the current valence theory regarding the differential hemispheric lateralization for positive and negative emotion.

According to this valence theory, one would predict that RBDs with destructive lesions would evidence more of a euphoric mood and more positive facial emotion due to a contralateral disinhibition of the left hemisphere. The current study found exactly the opposite pattern: two of the RBDs reported some depressive symptoms, and all three of them were more negative in their facial expressions.

Reports of depression and other qualities of negative affect among RBDs have appeared elsewhere in the literature. Folstein, Maiburger and McHugh (1977) rated 20 right and left hemisphere stroke patients on a range of psychiatric and cognitive scales. Seventy percent of the RBDs showed depressed mood, in addition to irritability and loss of interest.

The classic description of RBDs' emotional behavior, put forward by Gainotti in his (1972) paper, contains emotional indifference, generally defined as a combination of denial of illness, lack of interest in others, and a kind of euphoric or fatuous quality. This indifference is most frequently associated with neglect or anosognosia and has also been linked to physiologic hypoarousal (Heilman, Schwartz, and Watson, 1978).

While some researchers have stressed the co-occurrence of unilateral neglect and flat affect among RBDs (e.g., Ruckdeschel-Hibbard, Gordon, & Diller, 1984), Borod, et al. (1986a.) did not find neglect to be

associated with impaired expressiveness among the RBDs in their sample. In this research study, none of the three RBDs evidenced neglect in their neurological exams.

A more fitting model for the interpretation of this study's data is one that focuses on the right hemisphere's role in emotional communication in general and not on emotion of a specific valence. Germane to this model are findings related to the appreciation of humor following right brain damage.

Gardner, et al. (1975) investigated the performance of right and left brain-damaged patients on a Humor Test. It consisted of sets of four captioned and captionless cartoons: patients were asked to point to the funniest cartoon in each set and explain why it was the funniest.

The responses of the RBDs clearly manifested an inability to appreciate the humor of the material. They showed a strong tendency to confabulate an explanation without a basis in fact, sometimes producing "wild and unjustified inferences" or reading the cartoon in an overly literal way. They were also significantly more likely to give either virtually no mirth responses or a large number.

One way of interpreting this finding is that RBDs cannot effectively modulate or moderate their emotional responses. In the context of the current study, the

valence differences observed can be seen as an impaired ability to communicate emotion according to the demands of social display rules (Ekman & Friesen, 1969). These display rules affect what and how much emotion is socially appropriate to convey, when, and with whom.

Malatesta and Izard (1984) described three processes by which adults modulate affective expression. These are: masking, blending of different expressions, and miniaturization of expression. Masking involves the neutralization of expression and, in our society, frequently takes the form of masking negative emotion with positive emotion (e.g., smiling when actually feeling angry). Blending of emotion signals is simply the simultaneous or successive combination of elements of different discrete emotions.

Finally, miniaturization involves the compression of emotional facial expression either by: (1) shortening the duration of the expression, (2) compressing the "physical parameters of the signals" (e.g., a "thin" versus a "wide" smile), and (3) "fragmenting" the expression so that only one or two of the usual expression components occur.

In the context of this study, the RBDs showed an inability to mask negative emotion with positive emotion, in addition to a limited modulation of expressions through the use of emotion blends (particularly subject #75). The expressions of the RBDs (partly as a result

of facial paralysis) also manifested what might be described as both too much and too little miniaturization. Expression components, particularly involving the mouth, tended to either be omitted or exaggerated. One important component of further research with RBDs and emotional facial behavior would be to include a comparison group of RBDs without facial paralysis in order to ascertain if more positive expressions would be produced and also to see if the RBDs are subjectively perceived as more negative because of the unpleasant appearance of a partially paralyzed face.

In addition to their impairment on modulating emotional expression, there was also some indication that the RBDs in this study were emotionally disconnected from their expressions. There were striking dissociations between their high self-report ratings of intensity, low difficulty ratings (e.g., for posing happiness and recollecting a happy experience) and sometimes negligible production of emotion as objectively or subjectively perceived by others.

This discrepancy between their expression and self-report ratings may be related to what Bear and Fedio (1977) described as the RBDs' tendency to be "polishers" or deny dysphoric qualities while exaggerating socially approved qualities.

In their 1977 study of patients with right and left sided temporal epileptic foci, the researchers evaluated

18 personality traits related to psychosocial behavior. One of the key features of their investigation was to have both patients and other raters (e.g., friends or relatives of the patients) make ratings of the traits under study. Not only were the right and left temporal epileptics discriminated on the basis of their self-report ratings, but the type of discrepancies between the raters' judgments and patients' self-report ratings discriminated the groups.

Right temporal epileptics reported more elation but were described as exhibiting more sadness, emotionality, and viscosity. The right temporal epileptics minimized or denied these tendencies in themselves. These dissociations between self-report and judgments of others parallels the discrepancy between the RBDs' expressive behavior and their ratings of intensity and difficulty. Either the patients reported their subjective experience accurately and still exhibited impaired expressiveness, or they may have felt that high ratings of emotional intensity and low ratings of difficulty would be more valued by the experimenter than the opposite (possibly actual) pattern.

This pattern of self-report ratings and expression was notably different from that found in the larger research study among depressed patients. Preliminary data on five depressed subjects (compared with five RBDs, PDs, Schizophrenics, and NCs) indicated that in addition

to reporting lower levels of emotional intensity and higher levels of difficulty, the depressed patients were subjectively perceived as significantly more expressive than the RBDs and PDs (Borod, Brozgold, Martin et al. manuscript submitted for publication).

Parkinsonian Patients and Valence Effects

PD patients were both objectively and subjectively rated as expressing more happiness than the other groups in both experimental conditions. It should be noted that the PDs in this study were not clinically depressed, although their mean total score on the Zung Depression Scale was somewhat higher than the mean of the NCs. It had been hypothesized that the presence of depression in the PDs might result in a higher proportion of negative emotional expressions.

The large number of happy expressions among the PDs appeared to stem, in part, from their masked faces and their tendency to become 'frozen' in a smile. Yet, it should be noted that their faces might also have been 'frozen' in other expressions but were not. In addition, it is especially striking that the PDs manifested greater happiness in both conditions, i.e., even the one in which they were generally less expressive. Could there be another explanation for this interesting finding?

One possible explanation lies in the literature on the "Parkinsonian personality." Sands (1942), for example, described the typical Parkinsonian patient as "masked," with chronically suppressed negative affect. The PDs' greater number of happy expressions observed in this study may be a behavioral manifestation of this personality trait.

Anecdotally, it was noted both by this author and the other experimenter in the larger research study (in which 20 PDs were tested), that the PD subjects were considerably more accommodating and concerned about social appropriateness than the other subjects.

Whether these personality traits are etiologically linked to the development of Parkinson's Disease or whether they are the result of the disease is open to speculation. Further research with objective and subjective measures of facial expression, in addition to personality rating scales, can help to elucidate this question. The use of a comprehensive emotion questionnaire, such as the one used in the Malatesta and Kalnok (1984) study, could be extremely informative in this context.

Facial Feedback Hypothesis

This study's investigation of posed and spontaneous facial expressions among brain-damaged subjects has bearing on a central theory in the emotion literature --

the facial feedback hypothesis. This notion developed out of the James-Lange theory of the centrality of somatic and visceral changes in the experience of emotion. Recent theorists [e.g., Ekman (1972); Tomkins (1962, 1963), and Izard (1971, 1977)] have focused on the role of skeletal muscle activity in emotional experience, i.e., describing how the movement of specific facial muscles can engender the feeling of specific emotions.

Reviews of experimental studies of the facial feedback hypothesis (e.g., Laird, 1984; Buck, 1984) have pointed to mixed results, regardless of whether posed (e.g., Tourangeau and Ellsworth, 1979) or spontaneous expression (e.g., Buck, 1980) was involved.

Applying the facial feedback model to this study, one would predict that subjects who were characterized as less expressive would report less emotion than the others, due to the absence of facial feedback in those individuals. Comparing the self-report data and the Max and subjective ratings reveals the opposite finding. RBDs who were rated as expressing the least positive emotion reported feeling intense levels of positive emotion, both while posing a happy expression and when talking about a happy experience.

These results, on closer examination, might be considered in accord with Laird's (1984) findings on specific individual differences in self-perception and

their relationship to facial feedback effects. Laird differentiates between people who primarily respond to "self-produced" cues and those who rely more on "situational" cues. The former entail the signals which "arise from our actions, such as expressive behaviors, bodily activities in arousal, and instrumental action," while situational cues consist of "normative information from the situation, about what anyone in the situation should or probably would feel" [Laird, 1984, p. 911].

According to Laird's experimental studies, the people who rely on self-produced cues are more likely to be affected by facial feedback, whereas the unaffected subjects seem to define their emotional states on the basis of situational cues.

Applying this self-perception model to this study's data, the RBDs could be described as having been more influenced by situational than self-produced cues and thus not having been affected by facial feedback.

This characterization of the RBDs is compatible with the Bear and Fedio (1977) findings described earlier in which patients with right temporal foci were more dependent and also denied dysphoric, disapproved behavior while exaggerating socially valued qualities.

The situational bias in the self-perception of the RBDs is also in keeping with a Borod, et al. (1985) study in which the verbal responses of RBDs to emotionally evocative slides tended to involve more form

than feeling, i.e., they described the slides as opposed to their emotional responses to the slides.

Homogeneity of the Subject Groups

One of the key features of a small group or single case study design (Shallice, 1979), is the homogeneity of subjects. Subjects are selected who have clearly defined neuropsychological syndromes and are then extensively evaluated to reveal new or unusual dissociations of functions (Caramazza & Martin, 1983).

Right Brain Damaged. In the current study, the attempt was made to ensure homogeneity within groups to the extent that it was practically possible. Although, for the purposes of the study, it would have been ideal to have included only RBDs with solely cortical damage, two of the RBDs revealed sub-cortical, as well as cortical, damage upon closer examination of their CT scans than was done when the study began.

Despite their lesion differences, however, the RBDs were homogeneous in many important respects. They were closely matched for age and months post onset and evidenced similar levels of impairment on tasks of attention and memory and on perceptual measures of pattern recognition and emotional face perception. They also all had central (lower) facial paralysis.

Most importantly, the RBDs showed homogeneous patterns both in their Max coded and subjective ratings.

Individual differences were present, but there were overriding similarities in the valence of their expressions. They were consistently rated as producing more components of negative emotional expressions and as moving their lower face less than their upper face.

When the RBDs differed from each other, there did not appear to be consistent patterns as to which one was the "outlier." For expressiveness, subject #111 was the exception, showing greater expressiveness in the spontaneous, than the posed, condition. He also manifested a more extreme disturbance in gait and posture, in addition to a borderline tremor. This patient had a fronto-temporal and subcortical lesion.

Subject #75, with both fronto-temporal and subcortical lesions, proved to be the most depressed of his cohorts (by self-report and examiner interview) and also the most 'flat' clinically in terms of the range of his expressions. This patient was considerably more expressive in the posed, as opposed to the spontaneous, condition.

Contrary to expectation, this patient's depression did not seem to affect the valence of his expressions. In fact, of the three RBDs, he was Max coded and subjectively rated as showing higher percentages of positive emotions during emotion recall, and he was rated by Max as showing less negative emotion when posing sadness and anger. This was probably related to the fact that sub-

ject #75 had less marked facial paralysis than the other RBDs -- a difference which is evident on the videotape and not from the clinical ratings of facial mask on the ESRS.

Interestingly, he showed the strongest positive relationship between his self-report ratings of intensity and difficulty and his actual sending accuracy of any of the RBDs, i.e., he reported greater intensity and less difficulty across conditions when he was Max coded and subjectively rated as conveying more emotion. For the other RBDs, there tended to be dissociations between their expressiveness and their self-report ratings.

Parkinsonians. The Parkinsonian group was also homogeneous in many important respects. They all had bilateral symptoms, exhibited equivalent impairment on a scale of extrapyramidal symptoms, and scored at similar levels on tests of vocabulary, attention and memory, pattern recognition, and facial and prosodic perception.

In their Max and subjective ratings, they were less expressive as a group in the more spontaneous, emotion recollection condition. They also evidenced consistent valence differences, e.g., they were perceived as showing more happiness than the other groups in both conditions. This appeared to be due, in part, to their masked facies: they had difficulty making a range of expressions, as their faces frequently became 'frozen' with smiling expressions.

In other respects, there were individual differences among the PDs. Subject #81, who had a considerably longer duration of illness than the other two, had more of a facial mask and lower scores on tests of vocabulary, attention, and memory. Yet, his performance on measures of visual-spatial and emotional perception exceeded that of his cohorts.

Consistent with expectation, this more chronic PD showed the most marked dissociation between his posed and spontaneous expression. His expressiveness scores were lower for the emotion recall than the posed condition. This provides further confirmation for the hypothesis that Parkinson's Disease primarily impairs the production of spontaneous facial expression.

Normal Controls. Homogeneity among the NCs was evident both demographically and in their performance on a wide range of cognitive and perceptual measures. In both the Max coding and subjective rating of their expressions, they were consistently similar. They were the most homogeneous group in the study.

In conclusion, although there was sufficient homogeneity of the groups to justify a small group or case study approach, there were also notable individual differences. Additional small group studies including RBDs without subcortical damage and PDs with longer durations of illness would be especially interesting to compare to data from this study.

Subjective Ratings

Posed expression. The subjective ratings both confirmed the central findings of the study and also provided additional important data on the groups' sending accuracy. Although all groups including the NCs produced a majority of emotion blends across both conditions, when posing, the NCs were perceived as posing the target expressions the most, followed by the RBDs and PDs. The RBDs proved to be more accurate posers than the PDs for three of the four emotions. The notable exception was happiness which was conveyed more accurately by the PDs than the RBDs. The higher sending accuracy of the RBDs than PDs was in contrast to the Buck and Duffy (1980) finding that PDs were more impaired in their sending accuracy than RBDs.

The finding of greater sending accuracy in the posing of sadness among the RBDs was interesting in light of their higher self-report ratings of depression on the Zung Depression scale. Recent studies (e.g., Jaeger, Borod, and Peselow, 1986) have shown that patients with unipolar depression are more accurate at posing sadness than communicating positive emotions (e.g., happiness).

If the presence of depression, however, was the critical factor in the display of sad emotion, then one would have predicted that the RBD who was most depressed would be rated as showing the most sadness, and the

least depressed RBD would be rated as conveying the least sadness. Although subject #75 (with the highest self-report ratings of depression) was rated as displaying more sadness and negative emotions than the other two, subject #112 (with extremely low depression ratings) was rated as conveying a substantial amount of negative affect (i.e., intermediate between subject #75 and the other RBD).

Another way of interpreting the subjective ratings of the RBDs is that there is something about the asymmetrical hemiparetic faces of the RBDs which is perceived by the raters as being generally unpleasant or sad. This would account for the discrepancy between the high subjective ratings of sadness for the RBDs in both conditions and their negligible Max coded ratings of sadness (Posed Max mean = 0; spontaneous Max mean = .04).

Spontaneous Expression. In their more spontaneous expression during the emotion recollection procedure, the groups displayed clear differences in the valence of their expressions. For the NCs, the higher mean rating in both happy and sad recollections was of the positive emotions. This was strikingly not the case for the RBDs whose higher mean rating was always of the negative emotions, regardless of whether they were recounting a happy or sad experience.

For the PDs, more positive affect was displayed in the happy recollection and more negative affect was generally displayed in the sad recollection.

Another general finding was of a stepwise progression by groups in the mean positive and negative ratings. For the happy recollection, NCs produced the highest mean positive rating, followed by PDs and RBDs. For the sad recollection, the RBDs had the highest mean negative rating, followed by the PDs and NCs. The PDs appear to be consistently in the intermediate position, evidencing a milder form of emotional disinhibition or impaired emotional modulation than the RBDs.

Implications of the Subjective Ratings

What are the social implications of the subjective ratings? For both neurological groups (and especially the RBDs) the tendency to display more negative emotion could have quite a deleterious effect on interpersonal relations, leading potentially to the withdrawal of critical emotional support.

If, as expressed in the self-report ratings, the RBDs and PDs do feel intense positive emotion at times when they are perceived as conveying negative emotion, the patients would be likely not only to alienate others around them but to be confused and at a loss to account for possible social rejection.

One of the contributions facial expression research can make is to highlight such phenomena and eventually incorporate these findings in rehabilitation and/or counseling/psychotherapy. In recent years, rehabilitation of aphasic patients has utilized the intact emotional communication skills of such patients in the process of restoring verbal skills. With RBDs, perhaps the reverse can be done: language can be used to help mediate deficits in emotional communication.

For the PDs, the problem appears to be different. For one thing, the PDs seem to be less emotionally dissociated from their expressive behavior. In their self-report ratings of intensity and difficulty, they were more likely to report greater difficulty when they were conveying less emotion. Anecdotally, they frequently reported during testing that they were aware of their masked facies and felt that they often could not "wipe a smile" off their face. Finally, because they also show more intense happy expressions, this can probably mitigate against some of their difficulty inhibiting negative affect.

The Use of Max with Neurological Patients

The use of Max in this research extends the scope of its application to include adult neurological populations. The system's adequacy can be attested to by virtue of the sufficiently high inter-rater agreement

achieved by the raters across diagnostic groups and by the system's ability to differentiate the groups in their emotional facial behavior. Notable differences were found in the groups' expressiveness across experimental conditions, in the valence of their expressions, and in the extent of movement across facial regions.

Another index of Max's validity as an objective measurement tool was the generally high correlations between the Max ratings and the subjective ratings. Although there were differences in some of the specific findings of the two systems, the general patterns regarding expressiveness and emotional valence were the same. The high correspondence between Max and subjective ratings found in this study replicated the finding of Malatesta, Fiore, and Messina recent (1987a.) experiment with normal adults.

There is no single measurement system which could provide an all-inclusive picture of the subjects' facial behavior. In certain important respects, Max proved to be inadequate in its capacity to capture group and individual differences.

With the RBDs, the problem was how to describe faces which were asymmetrical in their appearance and movement due to unilateral lower facial paralysis. Although decision rules were established, e.g., as to when to code a happy or a contemptuous expression, inference could not be completely eliminated. There were also in-

stances of expressions which were coded as emotion blends because of the inability of any single Max code to describe a particular anomalous expression.

This was especially true of the PDs who displayed a certain muscular tension that could not be described by Max. One of the PDs, subject #84, appeared almost hyperexpressive because of the great number of emotion blends coded in her expressions. Yet, looking at her facial expressions on videotape, they are clearly not those typically seen in an expressive NC.

One way of improving the measurement of facial expression with Max would be to create additional rating systems, to be used in conjunction with Max, which would code intensity, degree of muscular tension, etc. Extensive piloting with different neurological groups would, of course, be necessary in order to evaluate the usefulness of such rating systems in 'filling the gaps' left by Max.

Perhaps the best way to compensate for the current inadequacies of Max is to incorporate subjective ratings as a way of rounding out the picture of facial behavior. Indeed, one of the central findings of this research was the necessity to incorporate both objective and subjective measurement systems in the study of facial expression. The objective "measurement of sign vehicles" approach allows the researcher to pinpoint the specific facial movements which discriminate subjects' expres-

sions in certain experimental conditions. In neuropsychological research, for example, the ability to differentially examine movement across facial regions enables a more direct test of neuroanatomical hypotheses.

At the same time, the subjective "message judgment" approach provides the critical, socially relevant information on how the subjects' facial expressions are perceived by others. Subjective perceptions may, at times, differ radically from objective ratings. Clearly, either approach by itself cannot fully convey the rich and complex information to be found in the face.

APPENDIX I

Procedures for Control MeasuresCognitive Screening

As part of a cognitive screening, all subjects were given the WAIS-R Vocabulary subtest (Wechsler, 1981) and the Attention and Memory subtests of the Mattis Dementia Rating Scale (Mattis, 1973). These tests were included to control for factors of general cognitive ability, attention, and immediate memory which are necessary for comprehending and carrying out task instructions.

Visual-Spatial Perception

A 24-item test of visual spatial perception (Visual Matrices) was administered which required subjects to choose from a multiple choice array of geometric patterns which they had been presented earlier. This task, which was developed by the author, had been administered as part of the larger research battery to control for visual-perceptual factors which might affect the perception of emotional facial expressions. Analysis of the task's internal consistency yielded a high level of reliability (Cronbach's alpha = .79).

Neutral Face Recognition

The Benton Face Recognition Test (Short Form) (Ref.) was administered to assess subjects' ability to match identical faces given a multiple choice array¹. The Benton Face Recognition Test was included to investigate any possible relationship between the ability to perceive neutral faces and the ability to convey facial emotion.

Emotional Face Perception

Subjects were asked to carry out tasks of emotion identification and discrimination. The stimuli consisted of slides depicting the six basic emotions according to Ekman (1983): happiness, sadness, surprise, fear, anger, disgust, in addition to a neutral expression.

For identification, subjects were presented with a slide of an emotional expression and required to name the emotion depicted given a card on which all of the six basic emotions plus neutral were printed in a vertical array. There were 21 trials on this task (16 male and 16 female posers): each of the seven emotions was presented four or five times. Each slide was shown for approximately three seconds with a one second inter-

1 There were 17 trials on this task.

stimulus interval.

For discrimination, subjects were shown two slides of male or female posers depicting either the same or different emotions. Subjects were then required to orally indicate for each pair of slides whether the emotions depicted were the "same" or "different." There were 30 pairs of slides (15 male pairs, 15 female pairs). Each slide of a pair was presented for one second; there was a one second inter-stimulus interval. For both of the facial perception tasks, there was no time limit for responding.

Vocal Perception

Analogous to the facial perception tasks, there were identification and discrimination tasks for vocal emotion. These tasks were developed by Tucker, Watson and Heilman (1977) and consisted of neutral content sentences spoken by a male poser in a happy, sad, angry, and indifferent tone. In the identification task, subjects were presented 16 sentences on a tape recorder and asked to identify the emotion expressed from a multiple choice array printed on a 5" X 8" card. Each sentence was presented for three seconds with no time limit for responding.

For the discrimination task, subjects were presented with 32 pairs of emotionally-intoned sentences

and required to indicate whether the emotions portrayed in the sentences were the same or different in each sentence pair. There were 16 same trials and 16 different trials; there was a one second intertrial interval between the first and second sentences in a pair. Again, responses were untimed.

Movement Scales

In order to assess the effect of disordered movement on the production of facial emotion, subjects were evaluated by the experimenter for the presence of abnormal movements using the Extrapyramidal Symptoms Rating Scale and the Abnormal Involuntary Movement Scale.

The AIMS measures involuntary movements on a 0 (normal) to 4 (severe) scale in three different categories: 1) Facial and oral, 2) extremity movements, 3) trunk movements, and 4) global judgments.

The ESRS rates the presence of disordered movement on a 0 (normal) to 6 (extremely severe) scale using the following categories:

- 1) Expressive Automatic Movement (facial mask/speech)
- 2) Brady kinesia
- 3) Rigidity
- 4) Gait and Posture
- 5) Tremor
- 6) Akathisia
- 7) Increased Salivation
- 8) Acute Dystonia
- 9) Nonacture ystonia

Finally, a self-report depression scale, the Zung Self-Rating Depression Scale (1965), was administered in order to assess a possible relationship between emotional expressivity and feelings of depression which may not have been severe enough to warrant a diagnosis of Major Depressive Disorder.

APPENDIX II

Instructions for Emotion Recollection Procedure:

We are interested in studying the kinds of emotional events that are important to people. We will ask you to recount two different kinds of emotional experiences.

First I'd like you to talk for a while about a positive or pleasant experience you've had. Please try to remember an experience that made you feel extremely happy. Put yourself back into the situation and try to re-experience it with as much real feeling and intensity as when it actually occurred. Begin to talk about it as soon as you feel you have recaptured the experience.

Good. Now I'd like you to talk for a while about a negative or unpleasant experience you've had. Please try to remember an experience that made you feel extremely sad. (Continue instructions as above.)

APPENDIX IV

Max Appearance Changes Present in Posed Facial ExpressionSUBJECT #65 (NC)

	<u>SAD</u>	<u>ANGRY</u>	<u>INTEREST</u>	<u>HAPPY</u>
<u>BROWS</u>				
Sad: 23				
Angry: 24	X X			
25		X		
Interest: 20			X	
24			X	
<u>EYES</u>				
Angry: 33				
Interest: 30				
<u>MOUTH</u>				
Sad: 56	X			
Angry: 53				
54				
55				
67				
68				
Happy: 52				X

OTHER:BROWS

Surprise: 20
Contempt: 21

EYES

Fear: 31
Shame: 36
Disgust: 33

MOUTH

Fear: 53
Disgust: 59
Contempt: 61
80
51

X

NO EXP. MOVEMENT:

SUBJECT #49 (NC)

	<u>SAD</u>	<u>ANGRY</u>	<u>INTEREST</u>	<u>HAPPY</u>
<u>BROWS</u>				
Sad:	23			
Angry:	24	X		
	25			
Interest:	20		X X X	X X X
	24			

EYES

Angry:	33			X
Interest:	33			
	30			

MOUTH

Sad:	56			
Angry:	53			
	54			
	55			
	67			X
	68			
Happy:	52		X	X X X

OTHER:BROWS

Surprise:	20			X X
Contempt:	21			(R*)

EYES

Fear:	31			
Shy:	36			

MOUTH

Fear:	53			
Disgust:	59			
	61			
	80		X X	
	51			

NO EXP. MOVEMENT:

*(R) = right sided

SUBJECT #48 (NC)

	<u>SAD</u>	<u>ANGRY</u>	<u>INTEREST</u>	<u>HAPPY</u>
<u>BROWS</u>				
Sad: 23				
Angry: 24	X			
25				
Interest: 20		X X X X X X	X X	X X
24				

EYES

Angry: 33				
Interest: 30	X X	X	X X	

MOUTH

Sad: 56				
Angry: 53				
54				
55				
67				
68				
Happy: 52		X X	X (L>R)**	X (L>R)**

OTHER:BROWS

Surprise: 20
Contempt: 21

EYES

Fear: 31		X	X	
Shame: 36				X
Disgust: 33		X X		

MOUTH

Fear: 53				
Disgust: 59				
Contempt: 61	X(L)*	X(L)*	X(L)*	
80	X	X X X		
51		X X X	X	

NO EXP. MOVEMENT: X

*(L) = left sided

**(>R) = predominantly left sided

SUBJECT #56 (NC)

	<u>SAD</u>	<u>ANGRY</u>	<u>INTEREST</u>	<u>HAPPY</u>
<u>BROWS</u>				
Sad: 23				
Angry: 24	X X X			
25		X X	X X X	
Interest: 20			X X X	X
24				

EYES

Angry: 33		X X (R>L)**		
Interest: 30			X	
33			X	

MOUTH

Sad: 56				
Angry: 53				
54				
55				
67				
68				
Happy: 52				X

OTHER:BROWS

Surprise: 20				
Contempt: 21	X X X		X	

EYES

Fear: 31				
Shame: 36			X X	
Disgust: 33				

MOUTH

Fear: 53				
Disgust: 59				
Contempt: 61	X (R)*	X (R)*		
80	X			
51				

NO EXP. MOVEMENT:

*(R) = right sided

**(R>L) = predominantly right sided

SUBJECT #81 (PD)

	<u>SAD</u>	<u>ANGRY</u>	<u>INTEREST</u>	<u>HAPPY</u>
<u>BROWS</u>				
Sad: 23				
Angry: 24	X			
25		X		
Interest: 20			X X	X
24				

EYES

Angry: 33				
Interest: 33				
30		X	X X	X

MOUTH

Sad: 56				
Angry: 53				
54				
55				
67				
68				
Happy: 52		X	X X X X	X X (tremor throughout)

OTHER:BROWS

Surprise: 20				
Contempt: 21	X(L)*			

EYES

Fear: 31				
Shy: 36	X	X		
Tremor of eyelids	X			

MOUTH

Fear: 53		X		
Disgust: 59				
Contempt: 61				
80				
51				

NO EXP. MOVEMENT:

*(L) = left sided

SUBJECT #93 (PD)

	<u>SAD</u>	<u>ANGRY</u>	<u>INTEREST</u>	<u>HAPPY</u>
<u>BROWS</u>				
Sad: 23				
Angry: 24	X	X		
25				
Interest: 20			X X	
24				

EYES

Angry: 33
Interest: 33
30

MOUTH

Sad: 56				
Angry: 53				
54				X
55				
67				
68				
Happy: 52				X

OTHER:BROWS

Surprise: 20				
Contempt: 21		X(L)*		X X(L)*

EYES

Fear: 31
Shy: 36

MOUTH

Fear: 53			X	
Disgust: 59				
Contempt: 61				
80				
51				

NO EXP. MOVEMENT:

*(L) = left sided

SUBJECT #84 (PD)

	<u>SAD</u>	<u>ANGRY</u>	<u>INTEREST</u>	<u>HAPPY</u>
<u>BROWS</u>				
Sad: 23				
Angry: 24	X	X X X		X
25				
Interest: 20			X X X	
24				
<u>EYES</u>				
Angry: 33				
Interest: 30				
33				X
<u>MOUTH</u>				
Sad: 56				
Angry: 53				
54				
55				
67		X		
68				
Happy: 52		X		X (tense)

OTHER:BROWS

Surprise: 20
Contempt: 21

EYES

Fear: 31				X
Shame: 36	X	X X X	X X X X X	
Disgust: 33				

MOUTH

Fear: 53				
Disgust: 59				
Contempt: 61				X
80		X		
51				

*Shakes head
back & forth

NO EXP. MOVEMENT:

SUBJECT #75 (RBD)

	<u>SAD</u>	<u>ANGRY</u>	<u>INTEREST</u>	<u>HAPPY</u>
<u>BROWS</u>				
Sad: 23				
Angry: 24		X		
25		X		
Interest: 20			X X X X	X
24				
<u>EYES</u>				
Angry: 33		X X X(R)*		
Interest: 33			X X	X
30			X	X
<u>MOUTH</u>				
Sad: 56				
Angry: 53				
54				
55				
67				
68				
Happy: 52				X X

OTHER:BROWS

Surprise: 20
Contempt: 21

EYES

Fear: 31
Shame: 36 X
Closed Eyes: 33

X

MOUTH

Fear: 53
Disgust: 59
Contempt: 61
80
51

X

X

X X X(R)*

NO EXP. MOVEMENT: X

X

*(R) = right sided

SUBJECT #112 (RBD)

	<u>SAD</u>	<u>ANGRY</u>	<u>INTEREST</u>	<u>HAPPY</u>
<u>BROWS</u>				
Sad: 23				
Angry: 24		X X		
25				
Interest: 20		X	X	
24				

EYES

Angry: 33				
Interest: 30		X	X	X X

MOUTH

Sad: 56				
Angry: 53				
54				
55				
67				
68				
Happy: 52				

OTHER:BROWS

Surprise: 20				
Contempt: 21				

EYES

Fear: 31				
Shame: 36	X X	X X	X	X X
Closed eyes: 34	X X			

MOUTH

Fear: 53				
Disgust: 59				
Contempt: 61				
80				
51				

NO EXP. MOVEMENT:

SUBJECT #111 (RBD)

	<u>SAD</u>	<u>ANGRY</u>	<u>INTEREST</u>	<u>HAPPY</u>
<u>BROWS</u>				
Sad:	23			
Angry:	24	X X	X	X
	25	X X		
Interest:	20			
	24			

EYES

Angry:	33	X X X X	X X (R)*		
Interest:	33			X X(R)*	X(R)*
	30			X	

MOUTH

Sad:	56
Angry:	53
	54
	55
	67
	68
Happy:	52

OTHER:BROWS

Surprise:	20			
Contempt:	21			X (R)*

EYES

Fear:	31			
Shame:	36	X X	X	

MOUTH

Fear:	53			
Disgust:	59			
Contempt:	61			X (R)*
	80			
	51			

NO EXP. MOVEMENT:

*(R) = right sided

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