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Perception and expression of emotional words and sentences in patients with unilateral brain damage

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PERCEPTION AND EXPRESSION OF EMOTIONAL WORDS AND SENTENCES IN PATIENTS WITH UNILATERAL BRAIN DAMAGE

by

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Abstract

PERCEPTION AND EXPRESSION OF EMOTIONAL WORDS
AND SENTENCES IN PATIENTS WITH UNILATERAL BRAIN DAMAGE

by

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In studies of the mechanisms underlying emotional processing, a special role has been attributed to the right hemisphere (e.g., Silberman and Weingartner, 1986). However, there is some experimental evidence to suggest a differential hemispheric specialization as a function of emotional valence, that is, negative emotions being associated with the right hemisphere and positive emotions being associated with the left hemisphere (e.g., Davidson, 1985). Both hypotheses of hemispheric specialization for emotion have received some support.

Whereas the majority of the work in this area has examined facial and prosodic channels of emotional communication, the lexical (verbal) channel has received very little direct study (e.g., Wechsler, 1973). Understanding the variables involved in the lexical emotional channel could explain how emotional speech is sometimes spared in very severely aphasic patients. If the right hemisphere subserves mediation of emotion, this spared function may somehow be able to improve the compromized linguistic functions of the left hemisphere.

This study examined the contribution of the lexical channel to emotional processing in right brain-damaged, left brain-damaged, and normal control right-handed adults. Lexical tasks were developed for perception and expression of a range of emotional feelings, including positive and negative valence items. Word identification, sentence identification, and word discrimination comprised the three perceptual tasks. Expressive tasks involved posed (requiring a special cortical effort) and spontaneous verbal expression of emotions. Parallel perceptual and expressive tasks using nonemotional lexical stimuli were created to control for cognitive and linguistic factors. Sixteen subjects with left cerebrovascular pathology, 16 subjects with right cerebrovascular pathology, and 16 neurologically intact normal controls participated in the study. Subjects were matched for sex, age, education and socio-economic status.

The results of this experiment are different for perception and production of emotion. Results of the perceptual portion of the test offer support to the right hemisphere hypothesis for hemispheric specialization of emotion. Results of the expressive portion of the test did not support either of the hypotheses. Trends based on lesion data that were available, suggest the importance of the right temporal lobe in lexical production of emotion.

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I. INTRODUCTION AND LITERATURE REVIEW

A. Purpose of the Study

Historically, emotional deficits have been viewed as a psychiatric disorder. Recent research has suggested that deficits in emotional communication can result directly from neurological damage to the brain. It has been observed (e.g., Gainotti, 1972) that patients with left hemisphere lesions frequently display catastrophic reactions, characterized by negative affect and pessimism, while patients with right hemisphere lesions have a tendency to joking and indifference reactions.

Studies on brain-behavior relationships underlying emotional processing have been performed with brain-damaged subjects and with neurologically intact adults. Studies with normal subjects utilized such overt indexes of lateralization of function as facial asymmetry and facial muscle movements. They employed such methods of investigation as lateral eye movement (LEM), tachistoscopic viewing, and dichotic listening. Studies with brain-damaged subjects examined deficits in performance on tasks requiring emotional perception or expression. Impairment in performance on these tasks implicated the importance of the damaged brain region for the postulated function.

Studies on brain-behavior relationships underlying emotional processing performed with brain-damaged and with neurologically intact subjects suggest a special role for the right hemisphere. It has been observed that right hemisphere pathology can produce impairments in emotional processing (Bradshaw and Nettleton, 1983). While most studies suggest the right hemisphere dominance for emotion, there is evidence in favor of hemispheric specialization of emotion as a function of valence (Davidson, 1985), i.e., the right hemisphere

being associated with processing of negative emotions and the left hemisphere being associated with positive emotions. The question of hemispheric specialization of emotion remains unresolved.

Emotional communication is a complex behavior consisting of an interplay of many neural and behavioral factors. Systematic studies of emotional communication in neurological patients and normal subjects have usually been focused on examining one of the channels of communication, e.g., facial (Borod, Koff, and Caron, 1983), intonational (Haggard and Parkinson, 1971), or lexical (Wechsler, 1973). The studies were usually performed for one processing mode, that is, perception or expression. While most studies investigated perception or expression of emotion through facial and intonational channels, very little attention has been given to the lexical channel of emotional communication.

The purpose of this study was to investigate patterns of lexical emotional communication in left brain-damaged (LBD) and right brain-damaged (RBD) stroke patients and in normal controls (NC), matched for age, sex and education. The term lexical communication, as used in this paper, refers to the verbal expression and perception of a range of emotional feelings. These emotions include happiness (H), pleasant surprise (R), interest (I), sadness (S), anger (A), disgust (D), and fear (F). The first three of them are pleasant emotions (positive valence) and the latter four are unpleasant emotions (negative valence). This study, therefore, investigates perception and expression of positive and negative emotions via the lexical channel of communication. Two theoretical propositions concerned with hemispheric specialization for emotion are tested: right hemisphere dominance for emotion versus hemispheric specialization as a function of emotional valence.

B. Right Hemisphere Dominance for Emotion

1. Perception

Studies of normal and brain-damaged subjects have suggested that there are inter- and intra-hemispheric differences in the processing of emotions. Most of the current literature supports right hemisphere specialization for emotional processing ("right hemisphere hypothesis") (Borod, Koff, and Caron, 1983; Bradshaw and Nettleton, 1983; Bryden and Ley, 1983; Ley and Bryden, 1979; Silberman and Weingartner, 1986).

Perception of emotion has been largely studied using the facial and the intonational channels of communication. In tachistoscopic studies of perception of facial emotions (Hansch and Pirozzolo, 1980; Ley and Bryden, 1979), a left visual field advantage (LVF) in perception of emotional facial expressions was demonstrated. In the Ley and Bryden study, subjects were required to recognize emotional faces tachistoscopically presented to each visual field. They found a left visual field advantage, implicating the right hemisphere, for this task for both positive and negative emotions. These findings were interpreted to suggest that the right hemisphere is specialized for emotional perception.

Hansch and Pirozzolo studied task parameters (verbal vs. nonverbal) in the perception of emotion. Neurologically intact subjects were tachistoscopically presented with four conditions of recognition: facial emotion, neutral faces, emotional words, and neutral words. Reaction time was measured. They found that only facial emotion produced a significant visual field advantage (in favor of the left visual field). The authors, thus, emphasize that task parameters are important in studying perception of emotion.

Another experimental paradigm, the dichotic listening technique, was used in studying emotional tone of speech in normal adults (Haggard and Parkinson, 1971; Safer and Leventhal, 1977). In these studies, sentences with different

intonation contours were dichotically presented to the subjects. Reaction time for identification of neutral versus emotionally toned speech was measured. In both studies, a left ear advantage, implicating the right hemisphere, was demonstrated for emotional tone of speech.

Still another experimental method, the lateral eye movement paradigm, was employed in investigating hemispheric specialization for emotion (Schwartz, Davidson, and Mayer, 1975). In this experiment, lateral eye movements were observed in response to emotional and nonemotional questions. It was found that normal adults had a tendency to shift their gaze to the left when responding to emotional questions, implicating the contribution of the right hemisphere in performance of this task.

In an experiment using the tachistoscopic technique to study lexical perception of emotional words (Graves, Landis, and Goodglass, 1981), a LEM advantage was again demonstrated. In this study, subjects were tachistoscopically presented with two lists of words, emotional and nonemotional. Reaction time of identification was measured. It was found that emotional words were identified faster when presented to the left visual field, implicating right hemisphere superiority in lexical perception of words of emotion. Thus, the studies discussed above, using different experimental methods, demonstrated right hemisphere superiority in the perception of emotion through facial, intonational and lexical channels in neurologically intact adults.

In brain-damaged subjects, performance measures, and not laterality indexes, were used to study perception of emotion. In these studies, patients with unilateral brain lesions were presented with tasks of identification or discrimination of emotional material. The emotional material involved presentation of facial expressions (e.g., Borod, Koff, Lorch, and Nicholas, 1986), of emotional tone of sentences (e.g., Heilman, Scholes, and Watson, 1975; Tucker, Watson,

and Heilman, 1977), or of lexical material (Semenza, Pasini, Zettin, Tonin, and Portolan, 1986; Tompkins and Mateer, 1985; Wechsler, 1973).

Borod et al. (1986) examined perception of facial emotion in patients with unilateral cerebrovascular pathology. It was found that the right brain-damaged patients were significantly impaired, relative to the left brain-damaged patients and normal controls in perceiving facial emotion. These findings support the notion that the right cerebral hemisphere is dominant for perceiving facial emotion.

Perception of intonational contours of speech was studied by Heilman et al. (1977). In this study, patients with unilateral left and unilateral right temporo-parietal lesions were asked to judge the emotional tone of spoken sentences. The patients with right temporo-parietal lesions were significantly less able to perform this task. It was concluded that the right temporo-parietal area is crucially involved in processing emotional intonation. In this study, the precise location of the lesion, its depth and its size were not specified. Thus, possible subcortical involvement or the extent of cortical damage could account for the results.

There are a few studies performed on lexical perception of emotion. In the Semenza et al. (1986) study, right brain-damaged patients, left brain-damaged patients, and normal controls were presented with a task of hierarchical cluster analysis of a number of words. It was found that the right brain-damaged patients did not cluster the emotional words as the normal controls did. However, the nonemotional words were clustered by these patients in a way similar to that of normal controls. Such a dissociation between emotional and nonemotional processing of words was not found for the left brain-damaged patients. In this experiment, the authors managed to discriminate linguistic failure from specific failure to process emotional material. They conclude that it is in the

right hemisphere that emotions are organised and receive appropriate understanding at the conceptual level.

Wechsler (1973) investigated performance of unilateral brain-damaged subjects on the task of immediate recall of two short stories that were read to them aloud. One story was affective in tone, the other was neutral. He found that performance on this task was dependent on the content of the material presented. Quantitative analysis of recall showed a "reasonably good correlation" between the severity of impairment and the number of items recalled. Qualitative analysis of the errors that were distortions of content, such as additions and substitutions of words and phrases, revealed that patients with right hemisphere lesions made more errors on the emotionally charged story than patients with left hemisphere lesions. These findings were interpreted to suggest that there may be asymmetry of the cerebral mechanisms responsible for subserving affect, the right hemisphere playing the dominant role. While this study focused on the intake of lexical materials, one drawback was that perceptual and expressive processes were not clearly separated. It is not clear whether impairment in performance was due to emotional perceptual failure or formulation of emotional response.

Tompkins and Mateer (1985) studied perception of implicit attitudes via prosodic and lexical cues in patients with right and left temporal lobe seizures. The subjects were asked to judge the consistency (congruency) of verbal and intonational meanings of sentences. They found that more errors of judgement were made in the right temporal group than in the left temporal or in the normal control group. Subjects with right temporal lobe seizures had difficulty in answering inferential questions about the paragraphs. This study suggests the importance of the right temporal lobe in mediating affective information.

In summary, the majority of studies on the perception of emotion in brain-

damaged subjects and in neurologically intact adults conducted for facial, intonational, and lexical channels of communication suggest a dominant role for the right hemisphere. There are numerous studies on perception of facial emotion and of intonational contours, however, there were only three studies performed on lexical perception of emotion. Two of these studies focused on a single aspect of lexical perception, namely perception of single words, leaving larger linguistic units unexplored, making the proposed generalizations weak. The third study failed to dissociate perceptual from productive aspects of lexical emotional processing.

2. Expression

Expression and perception are considered to be two different processing modes that for the most part, have been studied separately. No clear relationship between perceptual and expressive modes has been demonstrated in the literature. In Borod, Koff, Lorch, and Nicholas (1986), no correlation was found between the expression and perception of facial emotion in brain-damaged subjects. As mentioned before, most studies suggest a dominant role for the right hemisphere in the perception of emotional messages. For expression, too, most studies attribute an important role to the right hemisphere.

Studies on the expression of emotion have investigated posed and/or spontaneous expression through facial and intonational channels (e.g., Campbell, 1978; Ekman, Hager, and Friesen, 1981; Sackeim and Gur, 1978). There have been no systematic studies of lexical expression of emotion in brain-damaged subjects. Different mechanisms of control have been implicated for posed versus spontaneous expression of emotion (Borod, Koff, and Caron, 1983). Cortical pyramidal control has been implicated in posed or deliberate expression of emotion. Subcortical, extrapyramidal, and limbic structures are thought to contribute to spontaneous expression of emotion. An example of a posed facial

task would be to make a happy face on verbal command, while an example of a spontaneous facial task would be the facial expression during the task of imagining oneself in an emotional situation. In this dissertation, the lexical analogue of the posed task was the generation of word lists to verbal command, while the lexical analogue of the spontaneous task was a description of an emotional event from the patient's past experience. These tasks are described in detail in the Methods section.

Important evidence for the role of the right hemisphere in emotional expression has been collected by Borod and her associates (Borod and Caron, 1980; Borod, Kent, Koff, Martin, and Alpert, 1988; Borod, Koff and Caron, 1983; Borod, Koff and White, 1983; Moreno, Borod, Welkowitz, and Alpert, 1990). These studies were done with normal subjects, in which face asymmetry was considered a behavioral index of emotion. It was found that, overall, the face was more expressive on the left than the right side. The differences were particularly significant for negative emotions. Since the lower part of the face is contralaterally innervated, the results were considered to support the dominant role of the right hemisphere in non-verbal emotional expression. Studies with brain-damaged subjects investigated performance (rather than face asymmetry) as a behavioral index of emotion (Borod, Koff, Lorch and Nicholas, 1985; Borod, Koff and Buck, 1986; Borod, Koff, Lorch, Nicholas and Welkowitz, 1988). These studies showed that in emotional expression tasks, the right brain-damaged subjects used facial expression and intonation less frequently than left brain-damaged subjects and normal controls. These results suggest an impairment in non-verbal emotional communication in right brain-damaged subjects.

Hager and Ekman (1985), on the other hand, present evidence to suggest that only posed facial expressions are lateralized, while spontaneous expression

of facial emotion involves bilateral engagement. In a series of experiments performed with normal subjects, they measured asymmetry of facial muscular actions under different elicitation conditions. In the "deliberate" condition, the subjects had to look happy, sad, fearful, disgusted, angry, and surprised. In the "spontaneous" condition, the subjects had to respond to the question "Now, that it's all over, are you glad?" The intensity of contraction of facial musculature was measured. They found asymmetrical contractions only in the "deliberate" condition. The authors conclude that hemispheric asymmetry is a function of deliberateness of movement.

Intonation during the lexical production of spontaneous emotion has been studied by Tucker, Watson, and Heilman, (1977). The study demonstrated that patients with right hemisphere lesions in the task of verbal expression of emotion had monotonous voices, lacking emotional inflection.

In related studies, it has been shown that the emotionality factor facilitates performance of aphasic patients on tasks of auditory comprehension (Boller, Cole, Vrtunski, Patterson, and Kim, 1979), bucco-facial praxis (Borod, Lorch, Koff, and Nicholas, 1987), oral reading (Landis, Graves, and Goodglass, 1982), and writing (Landis, et al., 1982). Since the aphasics in these studies had left hemisphere damage, it has been argued that the right hemisphere is somehow able to facilitate the performance. This observation emphasized the importance of the right hemisphere functions.

In the Buck and Duffy (1980) study, a slide-viewing paradigm was used with RBDs, aphasic patients, Parkinson's Desease patients, and normal controls. Affectively-loaded colored slides, that reflected a range of emotional categories, were presented to subjects, in whom facial and gestural responses were evoked. No specific directions were given to the subjects, they were only told to watch the slides. Subjects' responses were rated by independent raters.

Aphasic patients were equal to or were more expressive than normal controls, while RBDs and Parkinson patients were less expressive than NCs. The authors conclude that spontaneous nonverbal emotional expression is mediated by the right hemisphere. However, it is important to note that perceptual mode was not clearly distinguished from expressive mode. It is not clear whether the RBDs failed to perceive the emotions in the slides, or they were deficient in overt reactions to them.

There are some studies on the relationship between language and emotion in psychiatric literature. A cognitive-affective disturbance that affects the way in which individuals express their emotions has been known in psychiatric literature under the term alexithymia ("a"=lack, "lexis"=word, "thymos"=emotion) (Taylor, 1984; TenHouten, Hoppe, Bogen and Walter, 1986). This term was initially described in the context of psychosomatic disease, but was later used in studies on hemispheric specialization. Gazzaniga and Sperry (1967) suggest that integration of propositional and affective components of language occurs by the way of corpus callossum. They report on a patient who after commisurotomy would occasionally display mismatching of emotional behavior to the propositional content of the conversation. Ross, Edmondson, Seibert, and Homan (1988) report a study where the patients underwent left-sided and subsequently right-sided Wada testing. All patients became aphasic after left-sided Wada test, and lost the ability to use intonation in their speech after right-sided Wada test. The authors conclude that the right hemisphere is dominant for the affective components of language.

Most investigators agree that language abilities are lateralized predominantly to the left side of the brain. Studies on the language faculties of the right hemisphere (e.g., Gardner, Brownell, Wapner, and Michelow, 1983; Perecman, 1983; Searleman, 1977) suggest that some aspects of language processing oc-

cur in the right hemisphere, like comprehension of humor, metaphorical meanings, and other understatements. The right brain-damaged patients' use of language is often literal, as is his or her comprehension. Some investigators (e.g., Shipley, Dingwall, and Berlin, 1988) suggest that the right hemisphere can have the ability to control most linguistic functions when the left hemisphere is damaged. Others say that when the right hemisphere is damaged, only subtle linguistic deficits can occur. For example, Gainotti, Caltagirone, Miceli, and Mazullo (1981) suggest that comprehension deficits in auditory and reading tasks in right brain-damaged subjects are due to impaired lexical-semantic discrimination of words and not to deficits in phonemic analysis. These deficits manifest in the use of abstract concepts, naming, extraction of meaning from stories, and appreciation of humor. It has been proposed that a general information processing difficulty may account for these deficits in the right hemisphere damaged patients. This difficulty may involve intellectual, language, and emotional factors. If these faculties are compromised in a patient, a differentiation between language and emotional factors in an experimental situation is necessary. That is, if an RBD patient fails on an emotional/lexical task, the failure may be due to either high level language deficits or emotional processing difficulties. The question to what extent emotional and language factors interact and contribute to the overall comprehension and expression of a verbal emotional message is still unanswered. Another question is what is the relative contribution of each hemisphere in lexical emotional perception and expression. As can be seen from the above literature review, there is substantial evidence in favor of the right hemisphere dominant role in perception and expression of emotion.

C. Lateralization of Emotion According to Valence

1. Perception

While most studies suggest that the right hemisphere is dominant for emotional processing, there also exists experimental evidence in favor of the "valence hypothesis", i.e. negative emotions being associated with the right hemisphere and positive emotions being associated with the left hemisphere. The evidence comes mainly from studies with neurologically intact subjects, using EEG, LEM, and tachistoscopic presentation methods (Ahern and Schwartz, 1979; Davidson, 1985; Ehrlichman, 1987; Reuter-Lorenz and Davidson, 1981; Schwartz, Ahern and Brown, 1979).

In a tachistoscopic study (Reuter-Lorenz and Davidson), where perception of facial emotion was studied, it was found that happy faces were responded to more quickly when presented to the right visual field (left hemisphere), while sad faces were responded to more quickly when presented to the left visual field (right hemisphere). These results suggested to the authors that there may be a differential specialization of positive and negative emotions.

There are a few studies using the LEM paradigm (Ahern and Schwartz, 1979; Schwartz et al., 1979) to investigate laterality of emotional processing that support the valence hypothesis of hemispheric specialization of emotion. Ahern and Schwartz recorded lateral eye movements in response to a series of reflective questions that were designed to manipulate affective tone. Positive emotion questions evoked movements suggestive of relative left hemisphere involvement, while negative emotion questions evoked movements suggestive of relative right hemisphere movements.

However, in a tachistoscopic study of perception of facial emotions (Hirshman and Safer, 1982), the investigators failed to find evidence in favor of the valence hypothesis. In this study, facial expressions of positive and neg-

ative emotions were briefly presented to the left and the right visual fields of normal subjects. The authors measured the accuracy and latency of response in a naming task, where the subjects were instructed to name the emotion depicted in a number of facial expressions. The results were that each emotion was named more accurately with the right hemisphere presentation.

In a related study, where the pleasantness/unpleasantness dimension was examined in the perception of odors (Ehrlichman, 1987), it was found that unpleasant odors presented to the right nostril were judged as being more unpleasant when presented to the left nostril. There was no difference in judgement of the pleasant odors. Since the olfactory nerve is ipsilaterally connected, the findings suggested to the author that only negative valence is lateralized.

To summarize, there is some experimental evidence in support of the hypothesis of perception of emotion according to valence. There were no studies that directly examined the valence hypothesis in regards to perception of lexical emotion.

2. Expression

There is some evidence in favor of the valence hypothesis for expression of emotion (Davidson, 1985; Sackeim and Gur, 1978). In the Sackeim and Gur study, left- and right-sided composites of human faces were made. The raters were asked to judge the intensity of these photographs. The left-sided composites (right hemisphere) were judged as expressing emotions more intensely than the right-sided composites, especially for negative emotions.

Davidson (1985) has collected a lot of experimental evidence in favor of hemispheric specialization of emotion according to valence. The author suggests that there are also intrahemispheric differences in emotional processing, namely that only frontal regions are associated with a differential emotional

response. He maintains that there is frontal but not parietal asymmetry for emotion. The author discusses the relationship between emotional state and cognitive processes. He found that people with symptoms of clinical depression, who show right hemisphere frontal activation, tend to receive lower scores on visual-perceptual tasks and other tasks involving right parietal lobe functions. He hypothesized that right frontal cerebral activation may be coupled with right parietal inhibition, or, in other words, there may be a reciprocal relationship between frontal and parietal cerebral activation within the right hemisphere. If this hypothesis is true (and further evidence for it is needed), one could predict the patterns of neuropsychological deficits in depressed patients. Davidson suggests that depressed subjects exhibit selective impairments on right hemisphere tasks such as visuo-perceptual, visuo-spatial and visuo-constructive tasks. The author argues that there is a frontal asymmetry for affect and temporo-parietal asymmetry for cognition and that there is a reciprocal relationship between these asymmetries. He suggests that asymmetries in the frontal region are related to affective behavior and posterior cortical asymmetries are associated with cognitive functions. He reports that subjects' ratings of intensity of their affective experiences were correlated with frontal asymmetry and uncorrelated with parietal asymmetry.

Intrahemispheric specialization for emotion has also been studied by Ross (1981) and Ross, Harney, and de Lacoste-Utamsing (1981). In these studies it is proposed that the right hemisphere is dominant for modulating the affective components of language, analogous to the left hemisphere being dominant for the propositional aspects of language. As there are left hemisphere aphasias, there are right hemisphere aprosodias. There are receptive, expressive, and conductive aprosodias, depending on the site of lesion. Thus, receptive aprosodia is a deficit in the perception of emotional intonation associated with right

posterior lesions. Expressive aprosodia is a deficit in modulating intonational contour of one's speech and is associated with right anterior lesions. Conduction aprosodia is an inability to repeat the intonation of a sentence. This notion has not yet received any additional experimental support.

Syntactic aspects of positive and negative verbal emotional expressions were studied in normal adults (Collier, Kuiken, and Enzle, 1982; Rintell, unpublished manuscript). Collier et al. studied syntactic variations associated with verbal expression of three positive (happiness, liking, curiosity) and four negative (anger, fear, sadness, disliking) emotions. Syntactic variables included the use of embedded sentences, adverbial modifications, number of transformations, and others. The authors found that much of the variation in grammatical structure occurring during the description of different emotions was due to their relative degree of pleasantness or unpleasantness. Descriptions of unpleasant emotional experiences contained more modification and were more grammatically complex than description of positive emotional experiences, so that they were longer, contained embedded sentences, more phrase structure modification, and more negation. The authors' explanation for differences in grammatical complexity as a function of valence is that they are a function of circumstances that cause reluctance to acknowledge unpleasant truths about unwanted feelings, such as anger. The person is, thus, motivated to subtly qualify and carefully delimit explicit negative emotional content. Rintell, in her study of grammatical variation of verbal descriptions of emotions in native English speakers and learners of English as a second language, has also observed that descriptions of negative emotions were more grammatically complex than descriptions of positive emotions. There were no studies of lexical emotional expression as a function of valence in brain-damaged subjects.

In summary, the literature on hemispheric specialization of emotion sug-

gests that there are a number of important hemispheric differences in the regulation of affective behavior. The complexity of the issue is emphasized by the number of contradictory theories and controversial issues. Is only one hemisphere responsible for regulation of affective behavior or are both hemispheres differentially involved, depending on emotional valence? Are there anterior/posterior differences in emotional processing? Is there a parallelism in processing via different channels of emotional communication? Are perception and expression of emotion mediated by two separate processing mechanisms? These are some of the more salient questions that arise from a review of pertinent literature.

The purpose of this study was to investigate the patterns of lexical perception and expression of positive and negative emotions in left brain-damaged and right brain-damaged stroke patients and in neurologically intact normal adults. Special tasks and procedures to study the largely unexplored lexical channel of emotional communication were developed. Parallel nonemotional tasks to control for cognitive and linguistic factors were included. Subjects group (RBD, LBD, NC) was the between-subject variable, and Condition (Emotional, Nonemotional) and Valence (Positive, Negative) were the within-subject variables. The following were the two competing hypotheses.

D. Statement of Hypotheses

- *Right hemisphere dominance for emotion hypothesis.* If this hypothesis is correct, the relative difference between the experimental (emotional) and the control (nonemotional) tasks will be greater for RBDs than for LBDs or NCs. RBDs will do worse on the emotional than on the nonemotional tasks. LBDs will be impaired on both tasks (because of aphasia), or, in light of some findings on the right hemisphere facilitation of language in LBDs, they will do better on the emotional than on the nonemotional

tasks. The NCs will do equally well on both tasks. It is predicted that there will be significant Group by Condition interactions.

- *Valence hypothesis.* The right hemisphere is dominant for negative emotion, while the left hemisphere is dominant for positive emotion. If this hypothesis is correct, the RBDs will do worse on the negative than on the positive emotional tasks, relative to NCs. The LBDs will do worse on the positive than on the negative emotional tasks, relative to NCs. The NCs will do equally well on the positive and the negative emotional tasks. It is predicted that there will be significant Group by Valence interactions.

II. METHOD

The assessment battery was designed to parallel measures developed by Drs. Joan Borod, Joan Welkowitz and Loraine Obler as part of a larger program of research examining facial and prosodic, as well as lexical, channels of emotional communication in brain-damaged subjects. The battery includes perceptual and expressive measures of positive and negative emotions. The perceptual tasks include identification and discrimination of written lexical material, using words and sentences. The expressive tasks include generation of emotional words and recollection of emotional experiences. Each task included positive (happiness, pleasant surprise, interest) and negative (sadness, anger, disgust, fear) emotions. Parallel perceptual and expressive control tasks using nonemotional lexical stimuli were developed to control for cognitive and linguistic factors.

A. Subjects

Subjects were 16 RBDs, 16 LBDs, and 16 matched normal control (NC) adults (See Appendices 1 and 2). The LBD group included 11 males and five females, the RBD group included nine males and seven females, and NC group included 10 males and six females. There were no significant group differences in the proportions of males to females (χ^2=.53, df=2, p=.77). The age range of the LBD group was 39 to 78 years (mean=64.38, SD=12.40), the age range of the RBD group was 47 to 80 years (mean=68.88, SD=9.86), the age range of the NC group was 45 to 78 years (mean=59.5, SD=10.51). There were no significant age differences(F(2,45) = .41, p=.67) among the subject groups. Among the LBDs, there were seven high-school graduates, seven college graduates, and two Ph.D.s (mean years of education = 15.0,

SD=2.83). Among the RBDs, there were 13 high-school graduates, and three college graduates (mean=13.13, SD=1.93). Among the NCs, there were six high-school graduates, eight college graduates, and two Ph.D.s (mean=15.88, SD=2.68). There were no significant differences in years of education (F(2,45) = 1.48, p=.24) among the subject groups. Information on occupation and other demographic data is reported in Appendices 1 and 2. The patients were tested at least four months post onset (MPO) of illness. It was thought that at that point their medical condition would be stable. In the LBD group, the mean MPO was 12.31, SD=6.82 (range = 4 to 30); in the RBD group, the mean MPO was 13.87, SD=7.47 (range = 4 to 30). There were no significant MPO differences (F(1,30)=.08, p=.77) between the subject groups. The subjects were Neurology Department outpatients at the Mount Sinai Hospital in New York City and rehabilitation outpatients at the Morristown General Hospital in New Jersey (see Appendix 3 for a sample of the Morristown Hospital consent form).

The following selection criteria applied to the two patient groups: (a) unilateral right hemisphere or unilateral left hemisphere damage resulting from cerebral pathology of vascular origin, as determined by CT scan, (b) age between 35 and 80 years, (c) right-handed (by self or family report, with no history of converting from left-handedness), (d) native English speaker, (e) at least 12 years of education, (f) no history of mental retardation, (g) no history of serious alcohol or substance abuse, and (h) no history of psychiatric disorder. Eleven patients in the LBD group were aphasic. They were informally categorized into four fluents and seven nonfluents. The Reading Comprehension Subtest of the Boston Diagnostic Aphasia Examination (Goodglass and Kaplan, 1983) was administered to the aphasic patients to screen out reading comprehension difficulties. A score of seven or better out of ten possible points

was used as the criterion for participation in the experiment. The control subjects were matched for age, sex, years of education and on the selection criteria listed above, except (a).

B. Experimental Procedures

1. Emotional Perception

a. Sentence Identification

i. Development. Fifty-six sentences were generated by a group of experimenters, one professor of linguistics and two psychology graduate students. These were simple and declarative sentences, seven words in length. Each sentence contained a key word which was associated with the emotion that the sentence represents but was not the verbal label for that emotion, e.g., for "interest", one of the sentences was:

THIS SET OF LECTURES WAS TRULY FASCINATING.

The key word in this sentence was "fascinating". The emotion words were selected from the following sources: Davitz (1969), Thorndike and Lorge (1944), and Webster's Dictionary of Synonyms, Antonyms and Homonyms (1962). The words were matched for frequency of occurrence in English.

These sentences were then presented to eight speech sciences graduate students who had to identify "the most appropriate emotion for each sentence" (Appendix 4). Thirty-five sentences with the highest reliability score were then selected to be the test stimuli for the sentence identification task. Each emotional category included five words. The mean percentages of complete interrater agreement for each emotion (7 emotions x 5 sentences= 35 sentences), are seen in Table 1.

ii. Task. Each of the 35 sentences was printed in the center of a standard size (8.5x11 inches) white piece of paper (Appendix 5). They were presented to

Table 1

Mean Percent of Complete Interrater Agreement for Sentences in the Sentence Identification Task

category	mean (%)	range (%)
Happiness	85	75-88
Pleasant Surprise	95	75-100
Interest	100	
Sadness	93	75-100
Anger	100	
Disgust	95	88-100
Fear	95	75-100

the subjects one at a time. Each subject had to identify the emotion that the sentence represented from a list of seven emotions printed out in bold letters on a card (Appendix 6). The response was made either by pointing to the emotion printed on the card or saying the word aloud. There was no time limit for responding.

b. Word Identification

i. Development. Eighty-two words that were associated with the seven emotions studied, were selected from Davitz (1969), Thorndike and Lorge (1944), and Webster's Dictionary of Synonyms, Antonyms and Homonyms (1962). They were presented to nine raters, who were speech sciences graduate students, whose task was to identify the most appropriate emotion for each word (Appendix 7). Sixty three words with the highest reliability score were chosen as the test stimuli for the word identification task. The words were grouped in clusters of three words, each emotion appearing three times in the text (3-word clusters x 7 emotions x 3 times = 63 words), e.g., for fear,

DANGER

DREAD

TERROR

The mean percentages of complete interrater agreement for each cluster are reported in Table 2.

ii. Task. Each of the 21 clusters of words was vertically printed, as shown in the example above, on a standard size (8.5 x 11 inches) white paper (Appendix 8). The subjects were presented with one cluster at a time. They were asked to identify the emotion that these words represent, by either a spoken response or by pointing to the word of emotion printed on the list of seven emotions. There was no time limit for responding.

Table 2

Mean Percent of Complete Interrater Agreement for Words in the Word Identification Task

category	cluster 1	cluster 2	cluster 3	mean
Happiness	93	93	96	94
Pleasant Surprise	79	79	81	79.7
Interest	93	96	93	94
Sadness	100	96	96	97.3
Anger	93	89	93	91.7
Disgust	93	85	96	91.3
Fear	93	100	89	94

c. Word Discrimination

i. Development. Fifty-one emotion words taken from the sources described above, partly new words and partly the words used in the word identification task, were presented to 21 raters who were nine speech sciences graduate students and 12 psychology undergraduate students. The raters had to identify the most appropriate emotion for each word. Forty-five words with the highest reliability score were selected for the word discrimination task (Forty-one of those words also appeared in the word identification task)(Table 3).

These words were then grouped into pairs, according to the following principles. There were 21 "same" and 21 "different" pairs. For the "same" pairs, there were three pairs per emotion, or 21 pairs (7 emotions x 3 pairs= 21 pairs). For the "different" pairs, there were six pairs of positive emotions (e.g., happy/pleasant surprise), six pairs of negative emotions (e.g., sadness/anger), and nine mixed pairs of positive and negative emotions (e.g., happiness/sadness). The purpose of these combinations was to make all possible comparisons among the emotional categories. Equal numbers of positive and negative and same and different pairs were used in order to balance the task characteristics and for purposes of statistical analysis. For example:

Stimulus Pair	Correct Response
TERROR	
DREAD	same
TERROR	
LUCKY	different

ii. Task. Each of the 42 pairs of words was vertically printed in the center of a standard-size white piece of paper, as shown in the example above

Table 3

Mean Percent of Complete Interrater Agreement for Words in the Word Discrimination Task

category	number of words in a category	mean	range
Happiness	7	91	85-100
Pleasant			
Surprise	7	74	62-86
Interest	7	90	75-100
Sadness	6	88	76-100
Anger	6	90	67-100
Disgust	6	95	91-100
Fear	6	97	86-100

(Appendix 9). The pairs of words were presented to the subjects one at a time. The subject's task was to say whether the pair of words represents the same emotion or two different emotions. The subjects could consult the list of seven emotions printed on a standard size white piece of paper. There was no time limit for responding.

2. Emotional Expression

a. Emotional Word Fluency Task

i. Development. The Emotional Word Fluency Task was designed to be a lexical parallel to the "posed emotional expression" task for face, as defined by Borod, Koff and White (1983). The task of posing facial expressions required effortful and deliberate movement mediated by the cortico-pyramidal system. It was thought that in an analogous manner, generation of a list of words on command would involve the same system, requiring a maximal amount of deliberate control and cortical involvement. The output, however, involves oral speech rather than facial musculature.

ii. Task. The task required generation of emotional words related to each of the seven emotional categories. The examiner read the name of the emotion and showed the subject its written label (Appendix 10), while the subject had to generate as many words as he or she could think of, that related to that emotion in one minute, excluding proper names. Standard examples were given, e.g., birthday party and pleased, for the category "happiness". No additional coaching or prompting was given. See Appendix 11 for examples of subjects' responses.

b. Recollected Emotional Experiences Task

i. Development. This task was designed to be parallel to the spontaneous emotional expression task, used by Borod with brain-damaged and normal sub-

jects (Borod, Koff, Lorch, and Nicholas, 1985). This task, also known as an "emotional induction procedure", has been used as a technique to elicit various emotional expressions (Malatesta and Izard, 1984; Martin, Borod, Alpert, Brozgold, and Welkowitz, 1990). This technique involved the subject recalling emotional events. Special instructions were given to maximize an authentic recreation of the emotional experiences. Subjects were instructed to recapture as much of the original feeling accompanying the events as possible.

ii. Task. The subjects were asked to recall an emotional experience related to each of the seven emotions. They were asked to talk for about a minute or longer about each emotion. During that time, the written label of the emotion was in plain view (Appendix 10). Their speech was audiotaped for later analysis. The following were the instructions used.

> "We are studying emotional things [experiences] that happen to people. I will ask you to tell about several different emotional things that happened to you, like when you were angry or happy. It is important to try and tell how you were feeling and what happened to make you feel that way. The first thing I would like you to talk about is a happy time you remember. Please try to remember a time when you felt extremely good or happy, for example at a birthday party. Try to remember everything that happened, try to remember exactly how you felt at that time. Begin to talk when you are ready."

This was the only standard example given, no examples for the other emotions were given. No additional examples, coaching or prompting were provided. "The next thing I want you to talk about is a particular sad time you remember. Try to remember something that happened that made you feel very unhappy." See Appendix 12 for examples of subjects' speech.

C. Control Procedures

Nonemotional lexical control tasks were developed to control for cognitive, linguistic and speech output factors that could confound performance on the lexical emotional tasks. The category "characteristics of people" was chosen as a nonemotional analogue to the emotional category. This category was chosen because the words also pertain to humans and there was an appropriate number of lexical items in each of its subcategories. In addition, it was considered to have a similar degree of abstractness as the emotional words.

In order to make the stimuli parallel to the emotional category, "positive" and "negative" items were included. This subcategorization reflected general attitudes towards human characteristics, that can be regarded as negative or positive. The control stimuli had three positive subcategories (intelligence-I, beauty-B, strength-S), three negative subcategories (stupidity-U, weakness-W, fatness-F), and one neutral subcategory (hair color-HC). The words associated with each category were taken from Webster's Dictionary of Synonyms, Antonyms and Homonyms (1962). These lexical items were incorporated into tasks that were similar in structure and format to the emotional tasks.

1. Perception

a. Sentence Identification.

This task included 35 sentence stimuli developed by a professor of linguistics and a psychology graduate student. The sentences were simple, declarative and seven words in length. Each sentence had one key word that was associated with but not the actual label for that category, e.g., for weakness,

THE NEWBORN SEEMED TO BE VERY FRAIL.

Each sentence (Appendix 13) was printed on a standard-size white piece

of paper and presented to the subjects, one at a time. The subject had to identify the category that the sentence represented by naming it or pointing to its written label. The list of seven nonemotional categories was printed on a standard size piece of paper (8.5x11 inches) (Appendix 14). There was no time limit for responding.

b. Word Identification.

The word identification task included 21 clusters of three words. The words were selected from Webster's Dictionary of Synonyms, Antonyms and Homonyms (1962). Each of these clusters was vertically displayed on a standard size white piece of paper (8.5 x 11 inches) (Appendix 15). They were presented to the subject one at a time. The subject had to read each cluster of words and identify the emotion it represents by naming it or pointing to its written label, e.g., for strength:

ATHLETIC
MUSCULAR
TOUGH

c. Word Discrimination.

This task included 42 pairs of words. The pairs were construed on the basis of the same principles as their emotional analogue, namely, there were 21 "same" pairs, and 21 "different" pairs. The "same" pairs included three pairs per category, the "different" pairs included six pairs of positive categories (e.g., beauty/intelligence), six pairs of negative categories (e.g., fat/stupidity) and nine pairs of positive and negative categories (e.g., intelligence/stupidity). For the construction of this task, hair color was treated as a positive category. The lexical items were taken from Webster's Dictionary of Synonyms, Antonyms

and Homonyms (1962). Each of the pairs was vertically displayed, as in the example shown above, on a standard-size (8.5x11 inches) white paper (Appendix 16). The subject's task was to say whether the pair of words represents the same category or two different categories, e.g.,

Stimuli Pair	Appropriate Response
CLEVER	
SMART	same
CLEVER	
PLUMP	different

2. Expression

a. Word Fluency Task.

This task was parallel to the emotional word fluency task. The examiner spoke the word indicating the category to be responded to and the label of the category (Appendix 17) was shown to the subject. The subject was asked to produce as many words as he could think of related to or associated with that category in one minute. See Appendix 18 for examples of words produced for each category. No examples or coaching were provided.

b. Recollected Experiences Task.

This task was parallel to the recollected emotional experiences task. The subject was presented with the written label of a category (Appendix 17) and asked to talk for about a minute, relating an experience or describing a person associated with that category. See Appendix 19 for examples of subjects' responses. The responses were audiotaped for later analysis. The following were the instructions to the subjects:

"Now I would like to ask you to talk for about a minute about the word "beauty". You can describe a beautiful experience that you had or a beautiful person that you know". These were the only instructions given. No additional examples, coaching or prompting were provided.

D. Scoring and Rating

1. Perception - Scoring

The three tasks of emotional perception and the three tasks of non-emotional perception were scored for accuracy. A correct response received a score of 1, and an incorrect response received a score of 0. The total possible scores were 21 for the word identification task, 35 for the sentence identification task, and 42 for the word discrimination task, for both, emotional and nonemotional tasks. These scores were then converted to percent correct.

2. Expression - Rating

a. Raters

Five undergraduate students, two males and three females served as raters in this experiment. All of them were native speakers of English with no history of psychiatric or neurological disorders. Their mean age was 25 years (range 23 to 27), and they were all right-handed (by self-report). All of them had two years of college education. Three students were majoring in literature; two students were majoring in economics. The raters were naive with respect to the hypotheses being tested and to the characteristics of the subject groups. They were debriefed after completion of the ratings. The raters were paid for their services. The words of the Word Fluency Task (emotional and nonemotional) were rated in one session that lasted three hours. The monologues (emotional and nonemotional) were rated in three sessions, each lasting

three to four hours, with breaks as necessary. The ratings were performed under the experimenter's supervision. The materials were rated in the following order: emotional words, accuracy; emotional words, intensity; nonemotional words, accuracy; emotional monologues, accuracy; emotional monologues, intensity; nonemotional monologues, accuracy. The words were rated before the paragraphs. The emotional words were rated before the nonemotional words, and the emotional paragraphs were rated before the nonemotional paragraphs. Accuracy ratings were performed before the intensity ratings, since for accuracy ratings the category labels were eliminated from subjects' speech. The treatment that the materials have undergone will be described below.

b. Materials

i. Word Fluency Task. Preparation of the rating materials was completely computerized. The words which the subjects had generated, were entered in the computer in a subject by subject order (Appendix 20). Emotional and nonemotional words were treated separately. The repeated words were deleted by the computer, so that for the raters each word appeared only once. After deletion of the repeated words, there were 800 emotional and 549 nonemotional words. The order of the emotional and the order of the nonemotional words was completely randomized by the computer (appendix 21). The emotional words were rated for accuracy and intensity, the nonemotional words were rated for accuracy only, as nonemotional intensity was not considered to be a meaningful entity. The emotional and the nonemotional words were rated separately.

ii. Recollected Experiences Task. Four hundred emotional and 390 nonemotional monologues, whose duration ranged from a few seconds to a minute and a half, were tape- recorded and transcribed. The monologue of each subject was segmented into 15-second segments. The 15-second segments

were rated (as opposed to the whole monologue) in the hope that this analysis would provide a more precise measure of subject's performance. If a passage ended in the middle of a word or of a noun phrase or a verb phrase, the syllables and words that belonged to it were kept in. That is, the 15-second segment never ended in the middle of a word or of a syntactic phrase. There were a total of 636 15-second emotional segments and 583 15-second nonemotional segments. These segments were entered in the computer, with the emotional and nonemotional segments as two separate lists. The segments were then completely randomized by the computer across all subjects and subject groups, as well as across all categories. For example, the emotional segments were randomized across the emotional categories, e.g., happiness, sadness, etc. The nonemotional segments were randomized across nonemotional categories, e.g., beauty, fat, hair color, etc. The emotional passages were rated for accuracy and intensity of expression, the nonemotional passages were rated for accuracy. The nonemotional passages were not rated for intensity as intensity was not considered a meaningful dimension for the nonemotional materials. The results of the ratings of the 15-second passages were then averaged for each of the emotional and the nonemotional categories. These procedures will be described below, in the expression scoring section.

c. Rating Procedures

Six different types of ratings were performed. A training session preceded each of the six ratings. The purpose of the training sessions was to establish the baseline levels of interrater agreement to see if the raters were appropriate for these ratings. It was decided in advance that the minimal level of complete interrater agreement should be 75 %.

i. Emotional Word Fluency - Accuracy Rating. This type of rating was done to get an objective measure of the accuracy with which the subjects

expressed their emotions using single words. A training session preceded the actual rating. Five raters were first presented with the seven emotional categories (Appendix 6). Two examples of appropriate responses for each emotion randomly taken from the pool of 800 words, produced by the subjects in the experiment, were presented and discussed with the experimenter. The raters were then presented with a different set of 14 emotional words, two words for each category, that were also taken from the pool of words, and asked to identify the emotion they represent. No discussion was allowed here. The following were the words rated: mad, glad, football, scared, stench, swell, rage, story, filth, dread, anniversary party, lucky, depressed, and gloomy. For example, the word "glad" was rated as HHHHH, i.e. all raters indicated that this word represents the category "happiness". This word received a score of 100% of interrater agreement. The word "swell" was rated as HHHHR, i.e., four raters indicated that this word represents the category "happiness" and one rater indicated that it represents the category "pleasant surprise". This word received a score of 80%. The mean percent of interrater agreement for 14 training words was 92.86%. This was considered an acceptable level of interrater agreement. The raters were then presented with the data - a list of 800 emotional words. The 14 training words were rated again, as part of the data. The instructions to the raters were as follows: "For each word, check the emotion that the word best represents" (Appendix 22).

ii. Nonemotional Word Fluency - Accuracy Ratings. This rating was done to get a measure of the accuracy with which the subjects expressed the intended meaning using single words. A training session preceded the ratings. Five raters were presented with the seven nonemotional categories (Appendix 14). Two examples of appropriate responses for each category, taken from the pool of subjects' responses, were presented and discussed. The raters were

then presented with a set of 14 different words, also taken from the data, and asked to identify the category they represent. The following were the words rated: pretty, smart, slow, faint, frail, obese, knowledgeable, powerful, dumb, well-built, black, gorgeous, plump, and blond. The mean percent of interrater agreement was 90%. This was considered an acceptable level of interrater agreement. The raters were then presented with a list of 549 nonemotional words. The instructions were: "For each word, check the category that the word best represents" (Appendix 23).

iii. Emotional Word Fluency - Intensity Rating. This rating was performed to get a measure of intensity with which subjects expressed emotions using single words. Only emotional words were rated for intensity. It was believed that intensity ratings for the nonemotional data were not meaningful. An instruction phase again preceded the rating phase. The Likert 7-point scale, ranging from minimal to maximal intensity was presented to the raters (Appendix 24). Each of the seven anchor points was explained and discussed. Two words, taken randomly from the pool of 800 emotional words produced by the subjects, were presented and discussed as examples. Following this step, 14 different emotional words (taken from the pool of 800 words) were rated for intensity of expression. No discussion was allowed at this point. The following were the words rated: mad, glad, football, scared, stench, swell, rage, story, filth, dread, anniversary party, lucky, depressed, and gloomy. If the raters agreed to within one number in the range of one to seven, the agreement was considered "complete". For example, the following rating results exhibit "complete agreement": 45554=100% or 32222=100% or 44444=100%. The following is an example of partial agreement: 55557=80%. In the latter case, the difference between four raters and the fifth rater exceeded one point, lowering the agreement to 80%. The mean percent of interrater agreement

for the training words was 75.71%. It was decided on an apriori basis that the mean level of interrater agreement should be at least 75% to proceed with these particular raters, therefore, the percentage obtained for intensity was considered appropriate. Following that step, the list of 800 emotional words, including the training words, was presented to the raters. The following were the instructions to the raters: "For each word, indicate on a scale of 1 to 7 how intensely the emotion is expressed in each word" (Appendix 24).

iv. Recollected Emotional Experiences - Accuracy Rating. These ratings were done to get a measure of accuracy with which subjects expressed emotions using connected speech. The monologues have undergone the following treatment for accuracy ratings. The words of seven emotions and their derivatives (e.g., fearless, fearful, etc.) were deleted from the text. If the label for the emotional category (e.g., happy, sad, etc.) appeared in the text, for example, if the subject started his monologue "A happy experience that I had was...," it was changed to "An experience that I had was ...." If the words of emotions had been left in the text, the rater's task would have been too easy: they could identify the emotion that the passage represents from that one word. Our purpose was to get a measure of a verbal description of emotion.

During the training phase, the raters were presented with the seven emotional categories via visual display. Two verbal passages taken from the pool of the data were used for explanations. Fourteen different passages (two for each category) were rated for accuracy. The mean percent of interrater agreement was 92.86%. The raters were next presented with 636 verbal passages. The following were the instructions to the raters: "For each paragraph, check the emotion that the paragraph best represents" (Appendix 25).

v. Recollected Nonemotional Experiences - Accuracy Rating. These ratings were performed to get a measure of the accuracy with which the in-

tended meanings were expressed by the subjects using connected speech. The same treatment as in the emotional monologues was applied to the nonemotional monologues. Namely, the category labels and their derivatives, if they appeared in the text, were deleted. The purpose was the same: to avoid making the rater's task obvious. During the training period, the categories were presented to the raters, and two sample passages (taken from the pool of data) were presented and discussed. Then, 14 different passages taken from the pool of data were rated. No discussion was allowed here. The mean percent of interrater agreement was 86.43%. The raters were then presented with 583 verbal passages. The following were the instructions to the raters: "For each paragraph, check the category that the paragraph best represents" (Appendix 26).

vi. Recollected Emotional Experiences - Intensity Rating. These ratings were performed to get an objective measure of the degree to which emotional intensity was expressed by the subjects using connected speech. The Likert-type rating scale was presented to the raters; the anchor points were explained and discussed. Two verbal passages, taken from the pool of data, were used for discussion. The verbal labels of emotions and their derivatives were kept in the text, as it was believed that for intensity ratings they did not provide any bias or oversimplify the rater's task. Fourteen different passages taken from the pool of data (two for each category) were rated without any discussion. The rating yielded a mean of 77.14% of interrater agreement. As this was considered an acceptable level of interrater agreement, the raters were presented with 636 emotional passages to rate, including the training passages. The following were the instructions to the raters: "For each paragraph, indicate on a scale of 1 to 7 how intensely the emotion is expressed in each paragraph" (appendix 27).

3. Expression - Scoring

The individual rating results (Appendix 28) were analyzed by computer. Six lists corresponding to the six types of ratings were treated separately. The computer restored the original order of lexical items in each of the six lists carrying with it the results of the ratings. The output was six lists of lexical items (including all the repeated words) arranged in the original order (Appendix 29). This output was used for manual calculation of the following scores.

a. Word Fluency Task

i. Frequency Score. Frequency score refers to the actual number of words generated by the subjects for each emotional and nonemotional category, regardless of raters' agreement. This score yielded a verbal fluency measure.

ii. Accuracy Score. There were two types of accuracy scores: "percent correct" and "correct total". "Percent correct" refers to the mean percent correct of five raters for each word, i. e., mean percent correct among the five raters with respect to the target category. For example, for "happiness" for Subject A, the mean percent was 90%:

	Raters 1 2 3 4 5	
Responses:		
swell	H H H H H	= 100%
happy	H H H F H	= 80%
		mean=90%

The "correct total" score refers to the total of the correct scores for the

words in each category for each subject. The rationale for this score was to obtain a measure of both the amount of verbal output and its accuracy - the total amount of correct output. To compute this score, percent agreement for each word was calculated and these percentages were then added up to obtain the total score for each emotional and nonemotional category. For example, for the same subject, the correct total score was 180%:

	Raters 1 2 3 4 5	
Responses:		
swell	H H H H H	= 100%
happy	H H H F H	= 80%
	Correct Total	= 180%

The following nine summary scores were computed for the one frequency and the two accuracy score types. There were a total of 27 frequency and accuracy scores computed for every subject (9 summary scores x 3 score types). The total emotional score was the arithmetical mean of seven emotional categories (H, R, I, S, A, D, F). The positive emotional score was the arithmetical mean of three positive emotional categories (H, R, I). The negative emotional score was the arithmetical mean of four negative emotional categories (S, A, D, F). The total valence emotional score was the arithmetical mean of two categories: negative emotional and positive emotional categories. The total nonemotional score was the arithmetical mean of seven nonemotional categories (B, S, I, HC, U, W, F). The positive nonemotional score was the arithmetical mean of three positive nonemotional categories (B, S, I). The negative nonemotional score was the arithmetical mean of three negative nonemotional categories (U, W,

F). The total valence nonemotional score was the arithmetical mean of two categories: negative nonemotional and positive nonemotional categories. The neutral nonemotional score was HC.

iii. Intensity Score. This score refers to the mean of intensity of emotional expression. The raters had to judge each word and each passage as to how intensely it represented the emotion. The raters assigned a number, ranging from 1 (least intense) to 7 (most intense) to each emotional word and, separately, to each 15-second segment. The mean of intensity was then computed for every emotional category for every subject. In addition, a total intensity score and separate scores for positive and negative emotions were computed. For example, for "happiness" category for Subject B, the intensity score was 4.5:

	Raters	
	1 2 3 4 5	
Responses:		
successful	4 3 5 5 4	mean =4.2
satisfied	4 6 4 5 5	mean =4.8
		mean=4.5

b. Recollected Experiences Task

i. Frequency Score. The frequency score refers to the number of 15-second segments produced by the subjects, whether correct or incorrect. For example, if the happiness monologue lasted 45 seconds, constituting three 15-second segments, that subject's frequency score for that category would be 3. In this way, the following summary scores were computed: a mean score for

every category, a mean score for positive emotions, a mean score for negative emotions, a mean score for positive nonemotional categories, a mean score for negative nonemotional categories, and a mean score for the neutral nonemotional category.

ii. Accuracy. There were two accuracy score types: "mean percent correct" and "correct total". The "mean percent correct" score refers to the mean percent of interrater agreement on each monologue and was computed in the following way. If the 15-second passage was correctly identified by the rater, it received a score of 1; if it was incorrectly identified, it received a score of 0. First, the mean of five raters' agreement on each 15-second segment was computed. These means were then averaged. In this way, scores for every category, emotional and nonemotional, were calculated. In addition, scores for the positive and negative categories and a score for the neutral nonemotional category were computed. For example, for "happiness" for Subject C, the mean percent correct score was .60:

	Raters	
	1 2 3 4 5	
15-second Intervals		Mean
1st:	0 0 0 0 0	= .00
2nd:	1 1 1 1 1	= 1.00
3rd:	1 1 0 0 1	= .60
4th:	1 0 1 1 1	= .80
	mean	= .60

The "correct total" score refers to the sum of the means for each 15-second interval. Computation of this score required calculating the means of interrater

agreement on every 15-second segment of a monologue and summarizing the means. Correct total scores were computed for every emotional and every nonemotional category, for the negative and positive categories, and for the neutral nonemotional category. For example, for the "happiness" category for Subject C, the correct total score was 2.40:

	Raters	
	1 2 3 4 5	
15-second Intervals		Mean
1st:	0 0 0 0 0	= .00
2nd:	1 1 1 1 1	= 1.00
3rd:	1 1 0 0 1	= .60
4th:	1 0 1 1 1	= .80
	correct	
	total	= 2.40

iii. Intensity Score. This score refers to the mean intensity rating for a monologue. It was computed in the following way. First, the mean intensity between five raters was calculated for every 15-second interval. Second, these means were averaged across the whole monologue. In addition, scores for positive emotional and negative emotional categories were computed. For example, for the "happiness" monologue, for Subject D, the mean intensity score was 4.5:

	Raters 1 2 3 4 5	
15-second Intervals		Mean Score
1st:	4 3 5 5 4	= 4.2
2nd:	4 6 4 5 5	= 4.8
	overall mean	= 4.5

Statistical analysis was performed on the scores obtained from the perceptual measures, from the word fluency tasks and from the recollected experiences tasks.

E. Pilot Study 1 - Experimental Tasks

1. Subjects and Procedures

This pilot study was conducted for methodological reasons. The purpose of the study was to find out whether the experimental tasks were sensitive to group differences.

The perceptual and expressive emotional tasks were piloted on 15 subjects: five RBDs, five LBDs and five NCs. There were four males and one female in the RBD group, four males and one female in the LBD group, and four males and one female in the NC group. The mean age of the RBD patients was 69.2, SD=9.36; the mean age of the LBD patients was 58.6, SD=12.24; and the mean age of the NCs was 70.8, SD=3.27. The patients were neurology outpatients at the Mount Sinai Hospital in New York City. All subjects were paid for their participation and informed consent was obtained. The same

criteria for subject selection as were used in the experiment were applied in the pilot study.

All subjects were administered the complete emotional test battery. In addition, LBDs and RBDs received the Auditory and Reading Comprehension subtests of the Boston Diagnostic Aphasia Examination (Goodglass and Kaplan, 1983) to screen out severe language and reading comprehension deficits. Subjects' responses were recorded, and the same procedures for scoring of the perceptual tasks and rating and scoring of the expressive tasks, as described above, were used in the pilot study.

2. Results and Discussion

Group differences on total scores were examined by a series of one-way analyses of variance (ANOVA). Group differences on valence scores were examined by two-way repeated measures ANOVAs with Group (RBD, LBD, NC) as the between-subject factor and Valence (positive, negative) as the within-subject factor. These ANOVAs were conducted on three perceptual and two expressive tasks. For perception, ANOVA was conducted on the accuracy scores; for expression, separate ANOVAs were conducted for accuracy and for intensity.

a. Perception

i. Word Identification Task. In the one-way ANOVA, the group effect ($F(2,12) = 3.28$, $p > .05$) was not statistically significant. When valence was examined, the two-way ANOVA did not yield significant results for Group ($F(2,12) = 3.35$, $p > .05$), Valence ($F(1,12) = .24$, $p > .05$), or the Interaction ($F(2,12) = 1.29$, $p > .05$).

ii. Sentence Identification Task. There was a significant main effect of Group ($F(2,12) = 4.43$, $p < .05$) in the one-way ANOVA. Tukey's post-

hoc method of pairwise comparison showed that LBDs (M=59%) performed significantly worse than NCs(M=93%) on this task. The difference between RBDs (M=83%) and NCs did not reach statistical significance. The low performance of the LBD patients could be attributed to either emotional or linguistic deficits, an issue to be examined through comparison with the lexical control tasks.

When valence was examined, by conducting a two-way ANOVA, there was a significant main effect for Group ($F(2,12) = 4.48$, $p < .05$). Tukey's post hoc test showed that LBDs (M=59%) performed significantly worse than RBDs (M=83%) and NCs (M=93%). There was also a significant effect for Valence ($F(1,12) = 6.87$, $p < .05$), such that negative emotions (M=81.3%) were identified more accurately than positive emotions (M=75.3%). In addition, there was a significant interaction between Group and Valence ($F(2,12) = 8.37$, $p < .001$) (Figure 1), in which an interesting trend was observed: while both NCs and LBDs performed better on negative than positive emotions, the RBDs performed better on positive than negative emotions. Tukey's test showed that LBDs (M=53%) performed significantly worse than RBDs (M=88%) and the NCs (M=85%) on the positive emotional tasks. On the negative emotional tasks, all pairwise group comparisons were statistically significant (LBD=66%, RBD=81%, NC=97%).

iii. Word Discrimination Task. A one-way ANOVA did not yield significant results ($F(2,12)$=.48, $p > .05$). The two-way ANOVA examining the valence effects did not yield significant effects for Group ($F(1,12)$=.20, $p > .05$), Valence ($F(1,12)$=.79, $p > .05$) or the Interaction ($F(2,12)$=.49, $p > .05$) (Table 4 and Table 5).

b. Expression

i. Emotional Word Fluency Task. There was a significant main effect

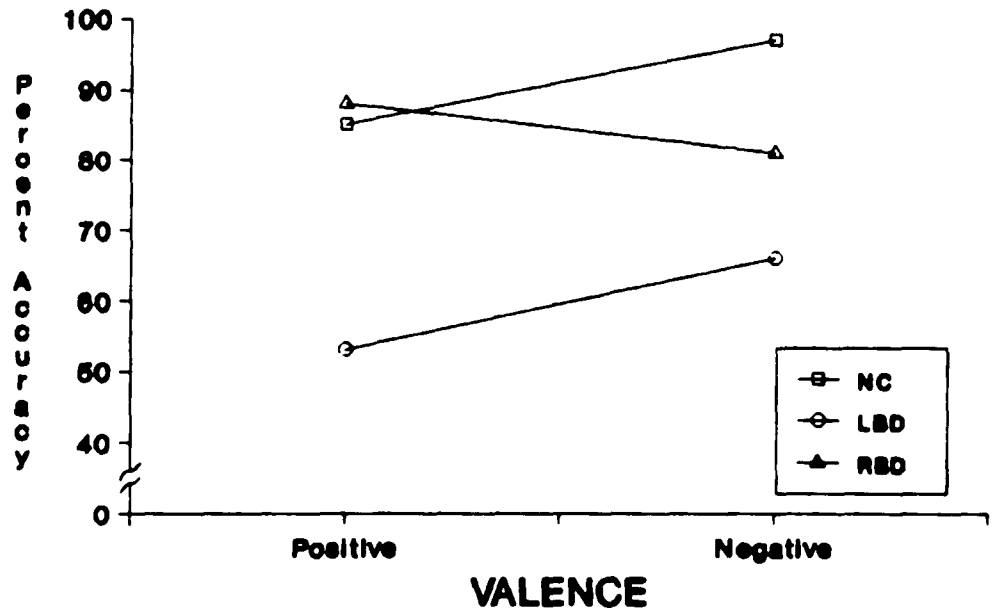

FIGURE 1 Interaction of Group and Valence for the Sentence Identification Task in Pilot Study 1.

Table 4

Statistically Significant Results of Pilot Study I

	one-way Anova	Tukey	Two-way Anova	Tukey
PERCEPTION				
1. Word identification				
2. Sentence identification	*	NC > LBD	*Group	RBD > LBD
				NC> LBD
			*Valence	
			*Interaction	RBD> LBD (-)
				NC> RBD (-)
				RBD> LBD (+)
3. Word discrimination				
EXPRESSION				
4. Word frequency	*	RBD > LBD	*Group	NC > LBD
				RBD> LBD
5. Word accuracy			*Valence ($p < .001$)	
6. Word intensity			*Group *Valence ($p < .001$)	NC > LBD
7. Whole monologues accuracy				
8. Whole monologues intensity				
9. 15-second intervals accuracy			*Valence	
10. 15-second intervals intensity				

Note. * designates statistically significant results.
$p < .05$, unless stated otherwise
df (group)=2, 12
df (valence)=1, 12
df (interaction)=2, 12

Table 5

Mean Percent Accuracy Scores of the Perceptual Tasks in Pilot Study I

	TASK		
	WI	SI	WD
GROUP			
LBD	70	59	75
RBD	84	83	78
NC	97	93	81
VALENCE			
	(+) (-)	(+) (-)	(+) (-)
LBD	78 65	53 66	76 75
RBD	82 87	88 81	76 79
NC	97 97	85 97	79 81

Note. Each cell value represents % correct.

of Group ($F(2,12) = 4.32$, $p < .05$) for the frequency score. Tukey's post-hoc analysis showed that LBDs (M=2.1) generated a significantly lower number of emotional words than either RBDs (M=5.5) or NCs (M=6.2).

When valence was considered, a two-way ANOVA yielded a significant main effect of Group ($F(2,12) = 4.90$, $p < .05$). Tukey's post-hoc method of pairwise comparisons showed that NCs (M=6.2) and RBDs (M=5.5) generated significantly more words than LBDs (M=2.1). The Valence ($F(1,12)$=.8, $p > .05$) and Interaction ($F(2,12)$=.60, $p > .05$) effects were not significant.

For the mean percent correct accuracy score, a one-way ANOVA did not yield a significant Group effect ($F(2,12) = 1.70$, $p > .05$).

A two-way ANOVA, examining valence effect, did not show a significant effect for Group ($F(2,12)$=3.80, $p > .05$). There was, however, a significant Valence effect ($F(1,12) = 13.79$, $p < .001$), such that negative items (M=46.67) were less accurate than positive items (M=49.33). The Interaction was not statistically significant ($F(2,12)$=3.11, $p > .05$).

A one-way ANOVA on intensity scores did not yield significant results for Group ($F(2,12) = 3.60$, $p > .05$).

When valence was considered, by conducting a two-way ANOVA, there was a significant main effect for Group ($F(2,12) = 5.08$, $p < .05$). Tukey's post-hoc analysis showed that emotional words produced by LBDs (M=3.9) were of significantly lower intensity than those of NCs (M=4.4). There was also a significant effect for Valence ($F(1,12)$= 11.20, $p <$ 001). Positive emotional words (M=3.8) received lower intensity scores than negative emotional words (M=4.3). The interaction effect was not statistically significant ($F(2,12)$=.71, $p > .05$) (Table 6).

ii. Recollected Emotional Experiences Task. The main effect of Group performed on the accuracy score was not statistically significant ($F(2,12)$ =

Table 6

Summary of Means of the Emotional Word Fluency Task in Pilot Study I

		LBD	RBD	NC
Total number of words produced		94	189	212
	Mean number of words per emotion	2.1	5.5	6.2
	Mean number of animal names	7.4	15.4	16.2
Accuracy score		51%	41%	51%
	Mean percent correct			
	positive	49%	47%	52%
	negative	53%	37%	50%
Intensity score		3.9	4	4.4
	positive	3.5	3.8	4.2
	negative	4.2	4.1	4.6

Note. Intensity scores have a range from 1 (least intense) to 7 (most intense).

.50, $p > .05$).

When valence was considered, a two-way ANOVA did not yield significant results for Group ($F(2,12)=1.87$), $p > .05$). There was a significant valence effect ($F(1,12)=12.40$, $p < .001$). Negative emotional monologues ($M=26.3$) received lower accuracy scores than positive emotional monologues ($M=73$). The interaction effect was not statistically significant ($F(2,12)=.51$, $p > .05$).

A one-way ANOVA performed on intensity of expression did not yield significant results ($F(2,12) = .66$, $p > .05$). When valence was examined, a two-way ANOVA did not yield significant effects for Group ($F(2,12)=.79$, $p > .05$), Valence ($F(1,12)=.93$, $p > .05$) or the Interaction ($F(2,12)=.87$, $p > .05$) (Table 7).

The most important trend observed in this pilot study was that RBDs showed deficits in perception and expression of lexical emotion. This trend was particularly evident in the emotional word fluency task, in which RBDs performed significantly worse than LBDs and NCs. RBD patients' performance on the sentence identification task suggested that they may also have problems in perception of lexical emotion. Their performance was particularly impaired for negative emotions. The low scores that LBDs obtained on the perceptual tasks could be attributed to either emotional or language deficits. These results showed the need for control tasks for all measures. The control tasks should be similar to the experimental tasks in all respects, except one - they should be nonemotional. The function of control tasks is separation of emotional from the language factors and, thus, isolation of the emotional factor in lexical communication of emotion. The first pilot study made it clear that what is of interest is the relative difference in performance between lexical emotional and lexical nonemotional tasks in all groups. The absolute differences among the groups should be viewed in light of relative differences between emotional

Table 7

Summary of Means of the Monologues Task in Pilot Study I

		LBD	RBD	NC	overall
accuracy					
	total score	58	36	42	
	positive	95	54	70	73
	negative	33	23	23	26.3
intensity					
	total score	4.9	4.4	5	
	positive	5.5	4.6	5	5.03
	negative	4.5	4.3	5.1	4.63

and nonemotional conditions. Development of control tasks was the purpose of the second pilot study.

F. Pilot Study 2 - Control Tasks

Lexical control tasks were developed to control for cognitive and linguistic factors in performance on the lexical emotional tasks. The perceptual and expressive tasks were piloted on four LBDs, four RBDs and six NCs. There were three males and one female in the LBD group, four males in the RBD group, and three males and three females in the NC group. The mean age of LBDs was 51.75 years, SD=10.43; the mean age of RBDs was 70.75, SD=6; and the mean age of NCs was 71.17, SD=6.14. The experimental subjects were outpatients at the Mount Sinai Hospital in New York City.

1. Perception

Emotional and Nonemotional tasks were administered to these 14 subjects. Since the group numbers were small, the data will be described rather than analyzed statistically. The mean group accuracy scores are presented in Table 8. All subject groups tended to perform better on control tasks than on experimental tasks.

2. Expression

Emotional and nonemotional word fluency and recollected experiences tasks were administered to these subjects. The data are presented in Table 9. Again, all subject groups had a tendency to perform more accurately on the control tasks than on the experimental tasks. These findings suggested that the control categories and their lexical items may be slightly easier than the emotional categories and their lexical items. However, since it was the relative difference between the emotional and nonemotional conditions which was of interest, it was decided to proceed with these stimuli. That is, if the

Table 8

Mean Percent Correct Accuracy Scores of the Experimental and Control Tasks in the Perceptual Portion of Pilot Study 2.

	task	LBD	RBD	NC
emotional part				
	word identification	63	86	97
	sentence identification	54	88.5	92
	word discrimination	70	78.5	83
nonemotional part				
	word identification	76	92	95
	sentence identification	71	96	96
	word discrimination	83	93	95

Table 9

Mean Scores of the Experimental and the Control Tasks in the Expressive Portion of Pilot Study 2

Word Fluency Task		
	emotional	nonemotional
mean percent correct		
LBD	67.9	76
RBD	43	79
NC	53	87
frequency score		
LBD	1.3	2.3
RBD	5.3	4.3
NC	5.3	4.7

Monologues		
	emotional	nonemotional
mean percent correct		
LBD	94.5	62.5
RBD	32	83
NC	36	86

RBDs show a significantly greater difference between the two conditions than the LBDs or the NCs, it could be hypothesized that RBDs have deficits in one of these conditions.

The experimental and the control tasks were then applied to 16 LBDs, 16 RBDs and 16 NCs.

III. RESULTS

A. Treatment of the Data

A series of analyses of variance were performed to compare the three diagnostic groups on the perceptual and expressive data. For perception, the effects of group (RBD, LBD, NC), Condition (emotional, nonemotional) and Valence (positive, negative) in the three lexical tasks were examined. For expression, the effects of group, condition and valence in the two expressive tasks were examined. Post hoc tests, with the conventional significance level ($p < 0.05$), were performed using the Tukey's multiple comparison method (Ramsey and Ramsey, 1985).

For the perception data, accuracy scores (% correct) were used. For the expression data, scores for frequency, accuracy (% correct) and intensity were used. Separate ANOVAs were run for each type of score.

B. Perception Data

1. Tests of Primary Hypothesis

The right hemisphere dominance for emotion hypothesis predicted that there would be significant interactions between Group and Condition. RBDs would show a greater emotional vs. nonemotional difference than LBDs or NCs. RBDs would be less accurate on the emotional than the nonemotional tasks, the LBDs would be equally impaired on both tasks because most of them had aphasia, and the NCs would do equally well on both tasks. Two-way repeated-measures analysis of variance (ANOVA) was performed on the accuracy percentage scores for Group (LBD, RBD, NC) and Condition (Emotional, Nonemotional) for each of the three perceptual tasks. Group was the

between-subject factor and Condition was the within- subject factor. In addition, a one-way ANOVA on the discrepancy score between emotional and nonemotional conditions [(N-E)/(N+E)] was performed. This analysis provided a measure of correction for individual differences in base performance in emotional and nonemotional conditions. On a post-hoc basis, Tukey's multiple comparison procedure, using a .05 level of significance, was used to compare the means.

a. Emotional vs. Nonemotional Conditions

i. Word Identification Task (WI). There was a main effect of Group ($F(2,45) = 9.95$, $p < .001$). Tukey's post-hoc multiple comparison procedure showed that RBDs (M=78.31) were significantly less accurate than NCs (M=94.69). There was also a significant main effect for Condition ($F(1,45) = 18.14$, $p < .001$). Accuracy scores in the nonemotional condition (M=88.29) were higher than in the emotional condition (M=82.35). Finally, there was a significant Group by Condition interaction ($F(2,45) = 13.35$, $p < .001$) which can be seen in Figure 2. Within the groups, Tukey's analysis showed that only RBDs performed significantly worse in emotional (M=70.25) than in nonemotional (M=86.38) conditions. Within the nonemotional condition, both RBDs (M=86.38) and LBDs (M=83.44) were significantly less accurate than NCs (M=95.06). Within the emotional condition, again, both RBDs (M=70.25) and LBDs (M=82.50) were significantly less accurate than NCs (M=94.31), and RBDs were significantly less accurate than LBDs. See Table 10 for group means for each subject group, separately for emotional and nonemotional conditions.

ii. Sentence Identification Task (SI). There was a main effect of Group ($F(2,45) = 10.35$, $p < .001$). Tukey's test showed that both RBDs (M=81.22) and LBDs (M=78.97) were significantly less accurate than NCs (M=94.97).

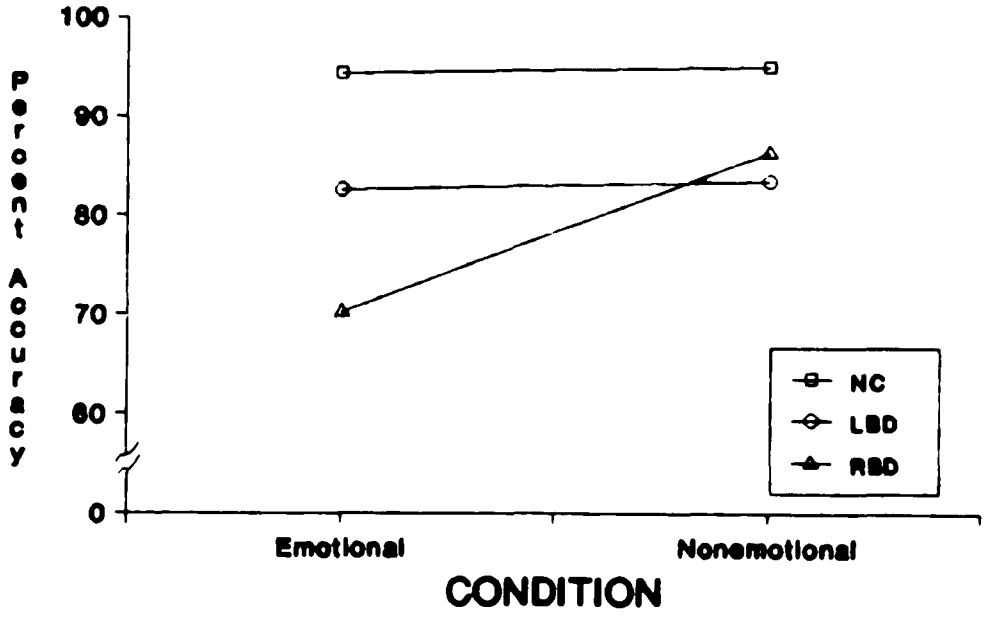

FIGURE 2 Interaction of Group and Condition for the Word Identification Task.

Table 10

Group Means as a Function of Condition for the Perceptual Tasks

	condition		total
	NE	E	
word identification			
RBD	86.38	70.25	78.31
LBD	83.44	82.50	82.97
NC	95.06	94.31	94.69
all Ss	88.29	82.35	
sentence identification			
RBD	87.38	75.06	81.22
LBD	79.43	78.50	78.97
NC	95.5	94.44	94.97
all Ss	87.44	82.67	
word discrimination			
RBD	85.07	70.73	77.9
LBD	86.57	81.57	84.07
NC	93.56	87.38	90.47
all Ss	88.4	79.89	

Note. Each cell represents percent accuracy score.

There was a significant main effect of Condition ($F(1,45)=14.01$, $p < .001$), such that nonemotional sentences ($M=87.44$) were identified more accurately than emotional sentences ($M=82.67$). Finally, there was a significant Group by Condition interaction ($F(2,45)= 8.75$, $p < .001$), seen in Figure 3. Within the groups, Tukey's post-hoc multiple comparison of means revealed that only RBDs were significantly less accurate in identifying the emotional ($M=75.06$) than the nonemotional ($M=87.38$) sentences. Within the emotional condition, both RBDs ($M=75.06$) and LBDs ($M=78.50$) were significantly less accurate than NCs ($M=94.44$). Within the nonemotional condition, both RBDs ($M=87.38$) and LBDs ($M=79.43$) were significantly less accurate than NCs ($M=95.50$), and LBDs were significantly less accurate than RBDs. This finding is not surprising in view of syntactic processing demands in the sentence identification task that might impair aphasic patients differently. See Table 10.

iii. Word Discrimination Task (WD). There was a significant main effect of Group ($F(2,42) = 9.59$, $p < .001$). Tukey's test showed that RBDs ($M=77.90$) were significantly less accurate than NCs ($M=90.47$). There was also a significant main effect of Condition ($F(1,42) = 42.04$, $p < .001$), such that nonemotional words ($M=88.40$) were discriminated more accurately than emotional words ($M=79.89$). Finally, there was a significant Group by Condition interaction ($F(2,42)=5.00$, $p < .025$) seen in Figure 4. Within the groups, Tukey's post-hoc tests showed that only RBDs were significantly less accurate in discriminating emotional words ($M=70.73$) than nonemotional words ($M=85.07$). Within the emotional condition, RBDs ($M=70.73$) were significantly less accurate than LBDs ($M=81.57$) or NCs ($M=87.38$). Within the nonemotional condition, RBDs ($M=85.07$) and LBDs ($M=86.57$) were significantly less accurate than NCs ($M=93.56$). See Table 10.

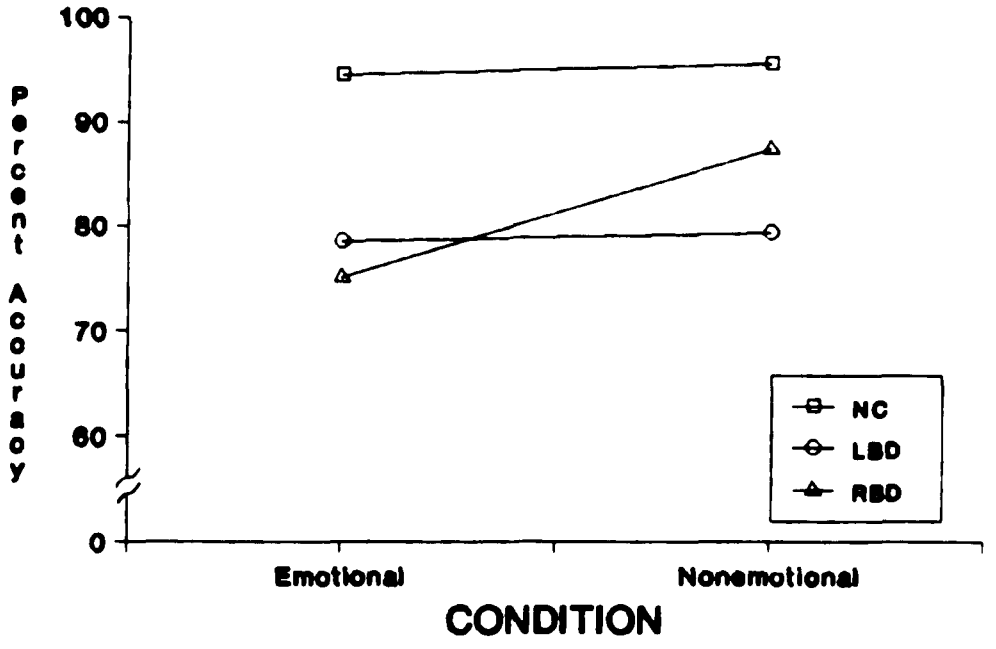

FIGURE 3 Interaction of Group and Condition for the Sentence Identification Task.

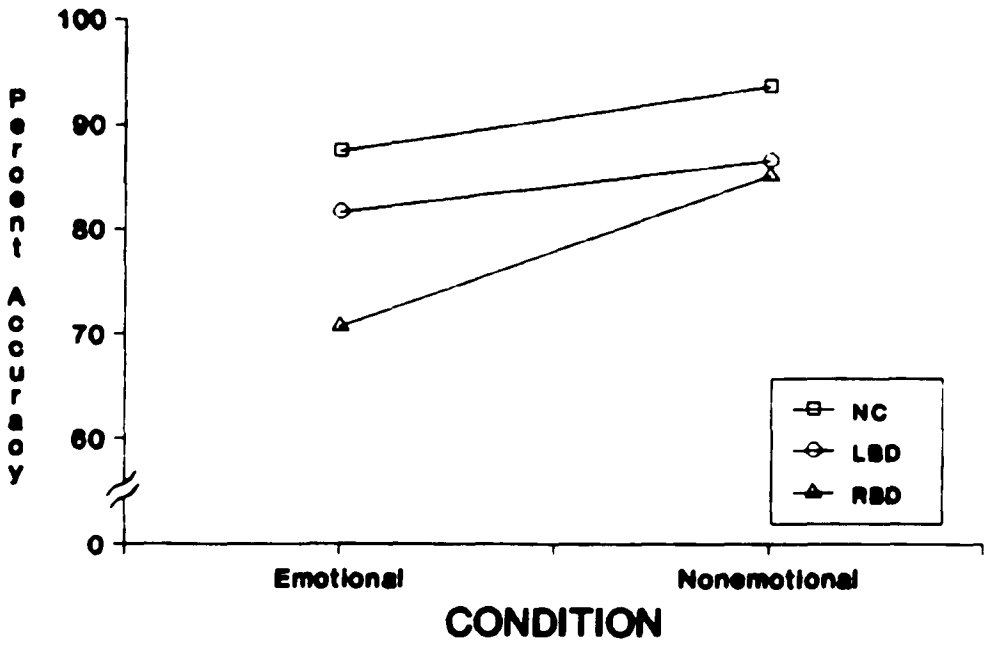

FIGURE 4 Interaction of Group and Condition for the Word Discrimination Task.

b. Discrepancy Score Analysis (N-E)/(N+E)

This analysis was performed to get a measure of correction of the individual differences in base performance between the experimental and the control conditions. One-way ANOVAs for Group (RBD, LBD, NC) were performed on the discrepancy scores for the three experimental tasks. For the word identification task, there was a main effect of Group ($F(2, 45) = 9.91$, $p < .001$). Tukey's pairwise comparison procedure showed that the discrepancy score for RBDs ($M=.11$) was significantly greater than the scores for LBDs ($M=.01$) or NCs ($M=.004$). For the sentence identification task, again, there was a main effect of Group ($F(2,45) = 3.90$, $p < .05$). Using post-hoc tests, RBDs' discrepancy score ($M=.08$) was significantly higher than that of LBDs ($M=.005$) or NCs ($M=.006$). For the word discrimination task, again, there was a main effect of Group ($F(1,42) = 6.70$, $p < .025$). Tukey's test revealed that the discrepancy score was significantly higher for RBDs ($M=.10$) than for either LBDs ($M=.03$) or NCs ($M=.04$).

c. Summary

The results of the analyses for the perceptual tasks show that RBDs were more impaired in lexical emotional than in lexical nonemotional conditions. LBDs were impaired in both emotional and nonemotional conditions for the sentence identification task. These results support the hypothesis that the right hemisphere is dominant for perception of emotion through the lexical channel.

2. Tests of Secondary Hypothesis

The valence hypothesis predicted that there would be significant interactions between Group and Valence. RBDs would do worse on the negative than on the positive emotional tasks, while LBDs would do worse on the positive

than on the negative emotional tasks. It was predicted that NCs would do equally well on the positive and negative emotional tasks. To test this hypothesis, a two-way ANOVA was performed on the accuracy percentage scores for Group (LBD, RBD, NC) and Valence (positive, negative) for the emotional condition. Another two-way ANOVA was performed for Group and Valence (positive, negative, neutral) for the nonemotional condition, since the nonemotional condition was also construed to include positive and negative items.

a. Emotional Condition

i. Word Identification Task. There was a main effect of Group ($F(2,45) = 12.84$, $p < .001$). Tukey's test showed that RBDs (M=71.55) were significantly less accurate than NCs (M=94.34). When valence was examined, the effect was not statistically significant ($F(1,45) = 1.65$, $p > .05$). The interaction effect was not significant ($F(2,45) = .51$, $p > .05$).

ii. Sentence Identification Task. There was a main effect of Group ($F(2,45) = 13.84$, $p < .001$). Tukey's test showed that RBDs (M=75.36) and LBDs (M=77.80) were significantly more impaired than NCs (M=94.73). The Valence ($F(1,45)$=2.15, $p > .05$) and the Interaction ($F(2,45)$=.51, $p > .05$) effects were not statistically significant.

iii. Word Discrimination Task. There was a main effect of Group ($F(2,42) = 5.67$, $p < .05$). Tukey's post-hoc test revealed that RBDs ($M = 74.76$) were significantly less accurate in discrimination of emotional words than NCs (M=87.35). The Valence ($F(1,42) = .27$, $p > .05$) and the interaction ($F(2,42) = .59$, $p > .05$) effects were not statistically significant (Table 11).

b. Nonemotional Condition

i. Word Identification Task. There was a significant main effect of Group

Table 11

Group Means as a Function of Valence for the Emotional Part of the Perceptual Tasks

	valence		total
	negative	positive	
word identification			
RBD	73.08	70.03	71.55
LBD	83.11	83.06	83.08
NC	97.16	91.52	94.34
all Ss	84.45	81.54	82.99
sentence identification			
RBD	75.42	75.29	75.36
LBD	80.29	75.31	77.80
NC	97.50	91.96	94.73
all Ss	84.4	80.85	82.63
word discrimination			
RBD	74.07	75.45	74.76
LBD	81.84	80.24	81.04
NC	88.31	86.38	87.35
all Ss	81.41	80.69	81.05

Note. Each cell represents mean percent accuracy score.

($F(2,45) = 5.0$, $p < .05$),but using post-hoc tests, none of the pairwise group differences were statistically significant. There was also a significant effect of Valence ($F(2,90)=8.02$, $p < .001$). Again, Tukey's post-hoc comparison of means did not reveal any significant pairwise differences. As can be seen from Table 12, consistently higher scores in the neutral condition possibly had an effect on the overall results. The interaction effect was not significant ($F(4,90) = 1.92$, $p > .05$).

ii. Sentence Identification Task. Again, there was a main effect of Group ($F(2,45) = 7.09$, $p < .05$), but no significant pairwise differences. There was also a significant effect of Valence ($F(2,90) = 5.94$, $p < .05$). Post hoc comparisons again did not reveal any significant differences. The interaction ($F(4,90) = .94$, $p > .05$) effect was not statistically significant.

iii. Word Discrimination Task. The main effect of Group ($F(2,42) = 2.78$, $p > .05$) was not statistically significant. When Valence was examined, the effect was statistically significant ($F(2,90) = 10.98$, $p < .001$). Using post-hoc tests, the neutral condition ($M=94.01$) received significantly higher scores than the negative condition ($M=85.79$). A significant interaction ($F(4,90) = 4.99$, $p < .05$) between Group and Valence was observed on this task which can be seen on Figure 5. Tukey's post-hoc tests showed the following significant differences: for the negative words, both RBDs ($M=80.53$) and LBDs ($M=82.38$) performed significantly worse than NCs ($M=94.46$). For the positive words, only RBDs ($M=81.97$) performed significantly worse than NCs ($M=92.79$). For group comparisons, RBDs performed significantly better on neutral ($M=97.78$) than on negative ($M=80.53$) or positive ($M=81.97$) words (Table 12).

c. Summary

There were no significant interactions between Group and Valence for

Table 12

Group Means as a Function of Valence for the Nonemotional Part of the Perceptual Tasks

	valence			total
	negative	positive	neutral	
word identification				
RBD	83.99	87.59	93.75	88.45
LBD	86.29	78.88	95.84	87
NC	91.42	98.19	100	96.54
all Ss	87.23	88.22	96.53	90.66
sentence identification				
RBD	83.46	89.43	95	89.3
LBD	75.87	86.24	87.5	83.2
NC	94.86	95.78	97.5	96.05
all Ss	84.73	90.48	93.33	89.52
word discrimination				
RBD	80.53	81.97	97.78	86.76
LBD	82.38	87.36	90.5	86.75
NC	94.46	92.79	93.76	93.67
all Ss	85.79	87.37	94.01	89.06

Note. Each cell represents mean percent accuracy score.

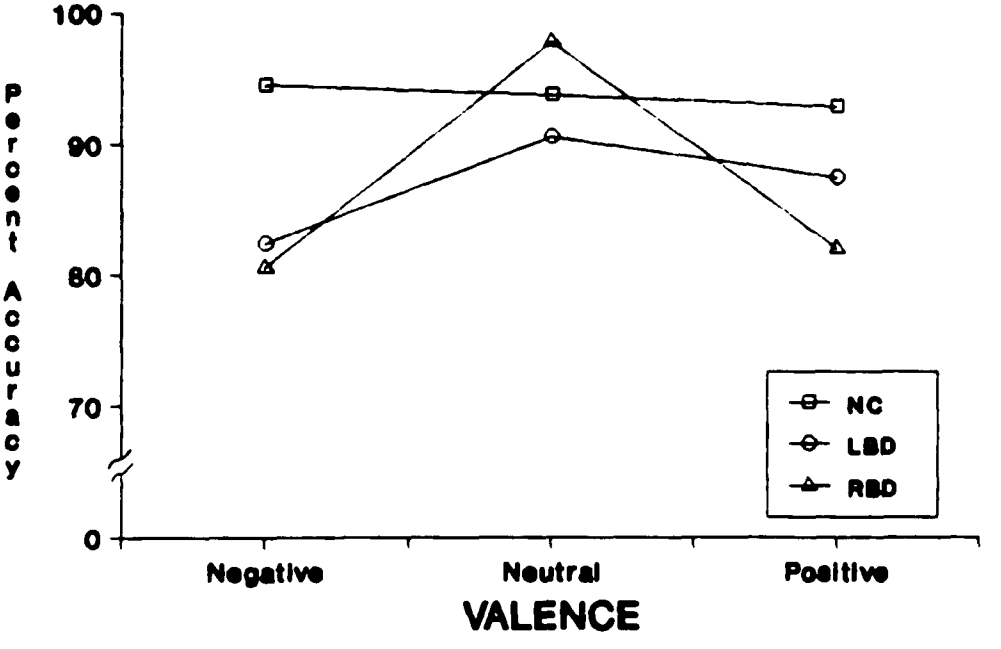

FIGURE 5 Interaction of Group and Valence for the Nonemotional Word Discrimination Task.

the emotional condition. Thus, the valence hypothesis of hemispheric specialization for emotion is not supported. The significant Group and Valence interaction in the word discrimination task of the nonemotional condition was mainly due to the neutral category (hair color). This category appeared to be too easy, compared to the other categories, possibly because it was too concrete. Results of the Valence analysis did not support the valence hypothesis of hemispheric specialization for emotion.

C. Expression Data

1. Tests of Primary Hypothesis

The right hemisphere dominance for emotion hypothesis predicted that there would be significant Group by Condition interactions. LBDs and NCs would be less affected than the RBDs by emotional versus the nonemotional conditions. A series of ANOVAs was performed on frequency, accuracy and intensity total scores for both expressive tasks: word fluency and recollected experiences task. Tukey's post-hoc method of multiple comparison was used to compare the group means.

a. Word Fluency Task

i. Frequency score. There was a significant main effect of Group ($F(2,45) = 16.84$, $p < .001$). Tukey's post hoc comparison of means showed that the verbal output of the NCs (M=4.94) was significantly higher than that of RBDs (M=2.81) or LBDs (M=2.53). The Condition ($F(1,45) = 2.31$, $p > .05$) and interaction ($F(2,45) = .14$, $p > .05$) effects were not statistically significant.

ii. Accuracy score. Statistical analysis was performed on two accuracy scores: "mean percent correct" and "correct total".

For the mean percent correct, the main effect of Group was not statistically significant ($F(2,45) = 1.25$, $p > .05$). There was a significant main effect

of Condition ($F(1,45) = 104.69$, $p < .001$). The nonemotional words ($M =$ 84.08) were produced with more accuracy than emotional words ($M =$ 61.74) by all subject groups. The interaction between Group and Condition was not statistically significant ($F(2,45) = .60$, $p > .05$).

For the correct total score, there was a significant main effect of Group ($F(2,45) = 19.97$), $p < .001$). The post hoc analysis showed that NCs (M = 358.62) produced significantly more words of higher accuracy than either LBDs (M = 189.77) or RBDs (M = 192.74). There was a significant effect for Condition ($F(1,45) = 58.24$, $p < .001$), such that there was a greater number of accurate nonemotional words (M=289.61) than of emotional words (M = 204.47). The interaction effect ($F(2,45) = .86$, $p > .05$) was not statistically significant.

iii. Discrepancy Score (N-E)/(N+E). One-way ANOVAs were performed on the frequency and the two accuracy scores. The main effects of Group for Frequency ($F(2,45) = 1.91$, $p > .05$), "mean percent correct" ($F(2,45)=.49$, $p > .05$), and "correct total" ($F(2,45)=2.64$, $p > .05$) were not statistically significant. The means for all three score types are reported in Table 13.

iv. Intensity Score. A one-way ANOVA on the intensity score was performed. The Group effect ($F(2,45)=.77$, $p > .05$) was not statistically significant (Table 13).

v. Summary. These results do not show significant group differences in the emotional versus the nonemotional condition for any analysis. Thus, the results of the word fluency task do not support the hypothesis of the right hemisphere dominance for lexical expression of emotion. They do, however, suggest that there may be a general effect of brain damage on verbal expression of emotion.

Table 13

Group Means as a Function of Condition in the Word Fluency Task

	total	condition		ratio score
		E	NE	
frequency score				
LBD	2.53	2.47	2.59	.02
RBD	2.81	2.72	2.91	.03
NC	4.94	4.97	4.92	-.01
all Ss		3.38	3.47	
mean percent correct				
LBD	73.92	61.34	86.49	.17
RBD	69.70	58.41	80.99	.16
NC	75.11	65.45	84.77	.13
all Ss		61.74	84.08	
correct total				
LBD	189.77	154.93	224.61	.18
RBD	192.74	152.23	233.24	.21
NC	358.62	306.25	410.98	.15
all Ss		204.47	289.61	
intensity				
LBD	4.42			
RBD	4.25			
NC	4.5			

Note. Ratio score refers to [(NE-E)/(NE+E)].

b. Recollected Experiences Task

Three two-way ANOVAs with Group (RBD, LBD, NC) as a between-subject factor and Condition (emotional, nonemotional) as a within-subject factor were performed on the frequency and the two accuracy scores. In addition, three one-way ANOVAs with Group (3) as the between-subject factor was performed on the discrepancy score.

i. Frequency Score. There was a main effect of Group ($F(2,45)=5.03$, $p < .025$). Using post hoc tests, none of the pairwise group differences reached statistical significance. The Condition ($F(1,45)=.36$, $p > .05$) and Interaction ($F(2,45)=.96$, $p > .05$) effects were not statistically significant.

ii. Accuracy Scores. For the mean percent correct, there was a significant main effect of Group ($F(2,45)=8.96$, $p < .001$). Post hoc tests revealed that LBDs ($M=.66$) produced significantly less accurate speech than NCs ($M=.79$). There was a significant effect of Condition ($F(1,45)=53.27$, $p < .001$). Nonemotional monologues ($M=.79$) were produced with higher accuracy than emotional monologues ($M=.64$). The Interaction effect ($F(2,45)=2.03$, $p > .05$) was not statistically significant.

For the correct total score, there was a main effect of Group ($F(2,45) = 16.63$, $p < .001$). Tukey's post hoc analysis showed that NCs ($M = 1.31$) produced significantly more speech of higher accuracy than LBDs ($M = .87$) or RBDs ($M = .95$). There was also a significant effect of Condition ($F(1,45) = 28.83$, $p < .001$) such that the nonemotional monologues ($M = 1.16$) were longer and more accurate than the emotional monologues ($M = .92$). The interaction between Group and Condition ($F(2,45)=.76$, $p > .05$) was not statistically significant.

iii. Discrepancy Score (N-E)/(N+E). The main effect of Group for the frequency score ($F(2,45) = .56$, $p > .05$) was not statistically significant. The

finding for the mean percent correct score ($F(2,45)=2.75$, $p < .10$) approached the .05 level of significance. Post hoc tests did not reveal any significant group differences. The main effect of Group for the correct total score ($F(2,45) = 1.73$, $p > .05$) was not statistically significant. (See Table 14).

iv. Summary. The results of the ANOVA's tests of the Condition effect do not lend support to the hypothesis that the right hemisphere is dominant for expression of emotion, as none of the interaction effects were significant. There was a tendency for the nonemotional monologues to be more accurate than the emotional monologues. The results suggest a detrimental effect of brain damage on the length and accuracy of speech output, since the normal controls produced significantly longer and more accurate speech than the brain-damaged subjects.

c. Recollected Emotional Experiences

Statistical analysis was performed within the emotional, and separately, within the nonemotional condition. This analysis was performed in search of possible effects of specific emotional and nonemotional categories. Four two-way ANOVAs were performed for Group (3) and Emotion Type (7) for the frequency, the two accuracy, and the intensity scores.

i. Frequency Score. The main effect of Group ($F(2,45)=2.77$, $p < .10$) approached the .05 level of significance. The post hoc tests, however, did not reveal any significant group differences. There was a significant effect of Emotion Type ($F(6,270)=2.58$, $p < .05$). Using Tukey's tests, however, none of the differences between Emotion Types reached statistical significance. The Interaction ($F(2,270)=1.49$, $p > .05$) was not statistically significant.

ii. Accuracy Scores. For the mean percent correct, there was a significant main effect for Group ($F(2,45) = 9.56$, $p < .001$). Using post hoc tests, NCs ($M=.75$) were significantly more accurate than LBDs ($M=.57$) and RBDs

Table 14

Group Means as a Function of Condition in the Recollected Experiences Task

	frequency		mean % correct		correct total	
group						
LBD	1.34		.66		.87	
RBD	1.42		.69		.95	
NC	1.70		.79		1.31	
condition	E	N	E	N	E	N
LBD	1.41	1.27	.57	.75	.77	.97
RBD	1.40	1.43	.60	.79	.79	1.10
NC	1.69	1.71	.75	.84	1.21	1.41
all Ss	1.50	1.47	.64	.79	.92	1.16
ratio score						
LBD	-.05		.14		.11	
RBD	.01		.14		.16	
NC	.01		.06		.08	

(.60). There was a significant main effect of Emotion Type ($F(6,270) = 14.88$, $p < .001$). Using post hoc tests, the Disgust category ($M=.35$) was expressed significantly less accurately than Happiness ($M=.8$), Anger ($M=.75$), or Fear ($M=.73$). None of the other comparisons were significant. The Group by Type interaction was not statistically significant ($F(12,270) = 1.51$, $p > .05$).

For the correct total score, there was a significant main effect of Group ($F(2,45) = 18.09$, $p < .001$). When post hoc tests were conducted, none of the group differences were statistically significant. There was a significant effect for Emotion Type ($F(6,270) = 7.47$, $p < .001$). Using post hoc tests, none of the pairwise differences between emotion types was statistically significant. The Interaction effect ($F(12,270)=1.20$, $p > .05$) was not statistically significant.

iii. Intensity. There was a significant effect of Group ($F(2,45) = 8.82$, $p < .001$). However, post hoc pairwise comparisons did not reveal any significant differences . There was a significant effect of Emotion Type ($F(6,270) = 15.93$, $p < .001$). Using post hoc tests, Interest monologues ($M=3.34$) were significantly less intense than Sadness ($M=4.60$), Anger ($M=4.36$), Disgust ($M=4.34$), or Fear ($M=4.38$). The Interaction effect was not statistically significant ($F(12,270) = 1.29$, $p > .05$) (Table 15).

iv. Summary. These results suggest that there is an effect of brain damage on verbal expression of emotion. Negative emotions tended to be expressed with higher intensity than some of the positive emotional categories (interest).

d. Recollected Nonemotional Experiences.

Three two-way ANOVAs for three subject groups and seven monologue types were performed on the frequency and two accuracy scores.

i. Frequency. There was a significant main effect of Group ($F(2,45)= 5.26$, $p < .05$). Post hoc pairwise comparison of means showed that NCs

Table 15

Group Means for Accuracy and Intensity in Recollected Emotional Experiences

	emotional categories	LBD	total RBD	NC	LBD	RBD	NC	mean for all Ss
Frequency		1.41	1.40	1.68				
	Happiness				1.25	1.31	1.31	1.29
	Pleasant Surprise				1.25	1.38	1.69	1.44
	Interest				1.56	1.69	1.75	1.67
	Sadness				1.38	1.25	1.94	1.52
	Anger				1.44	1.25	1.88	1.52
	Disgust				1.69	1.56	1.56	1.61
	Fear				1.31	1.38	1.63	1.44
Mean % Correct		.57	.60	.75				
	Happiness				.82	.69	.88	.80
	Pleasant Surprise				.59	.59	69	.63
	Interest				.41	.56	.69	.55
	Sadness				.61	.60	.81	.67
	Anger				.78	.72	.76	.75
	Disgust				.21	.28	.57	.35
	Fear				.55	.75	.88	.73
Correct Total		.77	.78	1.21				
	Happiness				.99	.86	1.14	1.00
	Pleasant Surprise				.68	.78	1.10	.85
	Interest				.55	.79	1.15	.83
	Sadness				.89	.71	1.50	1.03
	Anger				1.09	.90	1.33	1.11
	Disgust				.40	.42	.89	.57
	Fear				.75	.97	1.38	1.03
Intensity		3.90	3.94	4.48				
	Happiness				3.85	3.81	4.13	3.93
	Pleasant Surprise				3.70	3.69	4.06	3.80
	Interest				3.03	3.23	3.76	3.34
	Sadness				4.58	4.23	4.99	4.60
	Anger				4.33	4.23	4.52	4.36
	Disgust				3.76	4.16	5.11	4.34
	Fear				4.08	4.24	4.82	4.38

(M=1.71) produced longer monologues than LBDs (M = 1.26) or RBDs (M = 1.43). No significant effect for Monologue Type ($F(6,279) = .65$, $p > .05$) or the Interaction ($F(12,27) = 1.01$, $p > .05$) was observed.

ii. Accuracy. The effect of Group for the mean percent correct score ($F(2,45) = 2.93$, $p < .10$) approached the .05 level of significance. The post hoc tests, however, did not reveal any significant group differences. There was a significant effect for Monologue Type ($F(6,270) = 5.73$, $p < .05$) Using post hoc tests, however, none of the pairwise differences between the means reached statistical significance. The Interaction effect ($F(12,270)=.75$, $p > .05$) was not statistically significant.

For the correct total score, there was a significant main effect of Group ($F(2,45) = 8.24$, $p < .001$). Post hoc analysis of means, again, did not reveal any significant group differences. There was a significant effect for Monologue Type ($F(6,270) = 5.48$, $p < .05$). Using post hoc comparisons, none of the differences were statistically significant. No significant interaction was observed ($F(12,270) = .64$, $p > .05$) (Table 16).

iii. Summary. These results suggest that there is a general effect of brain damage on the amount and accuracy of verbal expression.

2. Tests of Secondary Hypothesis

The valence hypothesis predicted that there would be Group by Valence interactions. RBDs would do worse on the negative than on the positive emotional expression tasks, while LBDs would do worse on the positive than on the negative emotional expression tasks. NCs would do equally well on positive and negative emotional tasks. To test this hypothesis in emotional and nonemotional conditions separately, a series of two-way ANOVAs with Group (RBD, LBD, NC) as a between-subject factor and Valence (positive, negative) as a within-subject factor was performed on frequency, accuracy and inten-

Table 16

Accuracy Group Means in Recollected Nonemotional Experiences

	control categories	total LBD	total RBD	total NC	LBD	RBD	NC	mean for all Ss
Frequency		1.26	1.43	1.71				
	Beauty				1.13	1.47	1.75	1.45
	Strength				1.33	1.34	1.56	1.41
	Intelligence				1.33	1.41	1.63	1.46
	Hair Color				1.33	1.34	1.88	1.52
	Stupidity				1.27	1.36	1.56	1.40
	Weakness				1.13	1.60	1.75	1.49
	Fatness				1.34	1.47	1.81	1.54
Mean % Correct		.75	.79	.84				
	Beauty				.88	.85	.94	.89
	Strength				.77	.76	.82	.78
	Intelligence				.73	.81	.91	.82
	Hair color				.86	.89	.84	.87
	Stupidity				.61	.72	.83	.72
	Weakness				.59	.63	.74	.65
	Fatness				.84	.82	.83	.83
Correct Total		.96	1.10	1.41				
	Beauty				.98	1.22	1.63	1.28
	Strength				1.06	.99	1.29	1.11
	Intelligence				1.00	1.12	1.47	1.20
	Hair Color				1.13	1.19	1.61	1.31
	Stupidity				.78	.94	1.20	.97
	Weakness				.67	1.04	1.13	.95
	Fatness				1.10	1.23	1.51	1.28

sity scores for the two emotional expression tasks. Another series of two-way ANOVAs was performed on the frequency and accuracy scores for the two nonemotional expression tasks.

a. Emotional Word Fluency Task.

Four two-way ANOVAs for Group (3) and Valence (positive, negative) were performed on the frequency, two accuracy, and the intensity scores.

i. Frequency. There was a significant main effect of Group ($F(2,45) = 11.34$, $p < .001$). Tukey's post-hoc analysis showed that NCs ($M=5.02$) produced significantly more emotional words than either LBDs ($M=2.52$) or RBDs ($M=2.73$). There was a significant effect for Valence ($F(1,45) = 16.82$, $p < .001$). Overall, the word output was higher for positive ($M=3.76$) than for negative ($M=3.09$) emotions. There was no significant interaction between these two variables ($F(2,45) = 1.22$, $p > .05$).

ii. Accuracy. For the mean percent correct, no significant effects were found for Group ($F(2,45) = .60$, $p > .05$) and for Valence ($F(1,45) = .68$, $p > .05$). The Interaction ($F(2,45) = 2.66$, $p < .10$) approached the .05 level of statistical significance. Post hoc tests did not reveal any significant differences.

For the correct total score, there was a significant main effect of Group ($F(2,45) = 14.70$, $p < .001$). Using Tukey's tests, NCs ($M=309.48$) produced a significantly greater number of accurate words than LBDs ($M=159.05$) or RBDs ($M=157.76$). There was a significant effect for Valence ($F(1,45) = 9.47$, $p < .001$). All subject groups produced more accurate words of positive ($M=230.64$) than of negative ($M=186.88$) emotions. No significant interaction was observed ($F(2,45) = .04$, $p > .05$).

iii. Intensity. The main effect of Group ($F(2,45) = .73$, $p > .05$) was not statistically significant. However, there was a significant effect for

Valence ($F(1,45) = 82.45$, $p < .001$). The mean of intensity was higher for negative items ($M=4.81$) than for positive items ($M=3.89$) for all subjects. A significant interaction was found between Group and Valence ($F(2,45) = 6.94$, $p < .001$) which can be seen in Figure 6. As Tukey's tests showed, negative emotions were expressed with significantly higher intensity by LBDs ($M=5.16$) than by RBDs ($M=4.51$). In addition, within each group, negative emotions were expressed with significantly higher intensity than positive emotions (Table 17).

iv. Summary. These results show that there were more positive than negative words produced, particularly by the LBDs. However, negative words were expressed with higher intensity than positive words, particularly by the LBDs. A significant Group by Valence interaction for the intensity score suggests that valence hypothesis may be operative in part: LBDs produce negative emotional words more intensely than RBDs. However, full support for the valence hypothesis was not obtained, since the opposite trend was not found for the positive emotions.

b. Nonemotional Word Fluency Task

Three two-way ANOVAs for Group (3) and Valence (positive, negative, neutral) were performed on frequency and accuracy scores.

i. Frequency. There was a significant main effect for Group ($F(2,45) = 15.36$, $p < .001$). Tukey's post hoc pairwise analysis of means showed that NCs ($M=5.45$) produced a significantly greater number of words than LBDs ($M=3.08$). There was also a significant effect of Valence ($F(2,90) = 143.00$, $p < .001$). Tukey's test showed that there was a significantly greater number of neutral words ($M=6.04$) produced, than of positive ($M=3.33$) or negative ($M=2.76$) words. The interaction effect ($F(4,90) = .65$. $p > .05$) was not statistically significant.

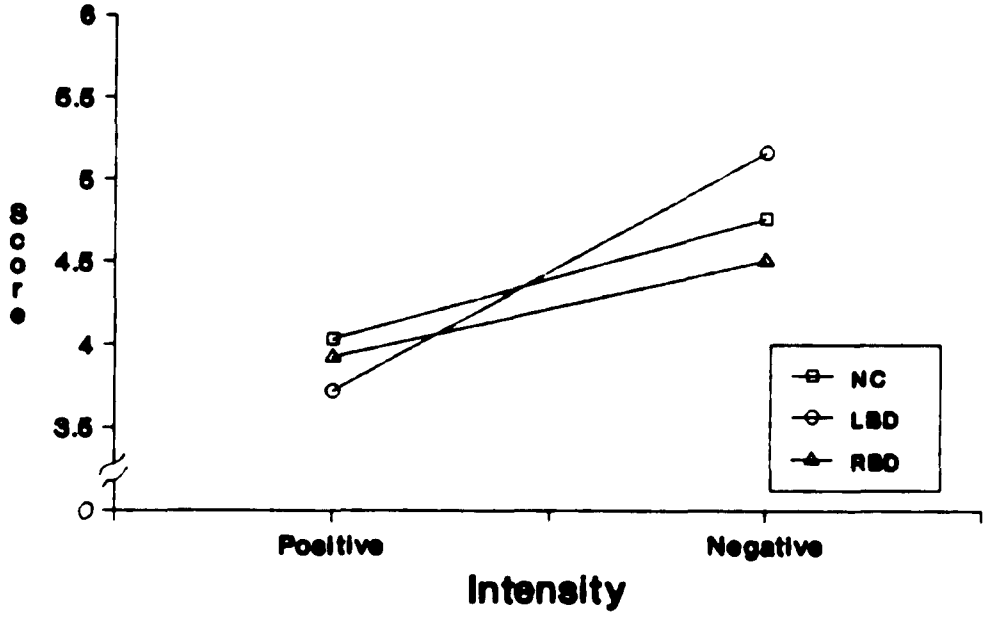

FIGURE 8 Interaction of Group and Valence for the Intensity Score in the Emotional Word Fluency Task.

Table 17

Group Means as a Function of Valence in the Emotional Word Fluency Task

	total	valence	
frequency		negative	positive
LBD	2.52	2.24	2.80
RBD	2.73	2.51	2.96
NC	5.02	4.50	5.54
all Ss		3.09	3.76
mean % correct			
LBD	62.61	56.54	68.67
RBD	59.18	57.91	60.45
NC	64.99	68.25	61.73
all Ss		60.90	63.62
correct total			
LBD	159.05	135.17	182.92
RBD	157.76	138.60	176.92
NC	309.48	286.88	332.08
all Ss		186.88	230.64
intensity			
LBD	4.42	5.16	3.72
RBD	4.25	4.51	3.92
NC	4.50	4.76	4.03
all Ss		4.81	3.89

ii. Accuracy. For the mean percent correct, the effect of Group ($F(2,45) = 1.57$, $p > .05$) was not statistically significant. There was a significant effect of Valence ($F(2,90) = 8.35$, $p < .001$). Using post hoc tests, none of the valence differences reached statistical significance. The Interaction effect ($F(4,90) = .51$, $p > .05$) was not statistically significant.

For the correct total score, there was a mean effect of Group ($F(2,45) = 15.23$, $p < .001$). Tukey's tests revealed that NCs (M=457.78) produced a significantly greater number of accurate words than LBDs (M = 270.96) or RBDs (294.28). There was also a significant Valence effect ($F(2,90) = 177.70$, $p < .001$). Tukey's tests showed that all subject groups performed better on the neutral category (M=528.91) than on the positive (M=276.25) or negative (M=217.85) categories. The interaction ($F(4.90) = 1.04$, $p > .05$) effect was not significant (Table 18).

iii. Summary. These results show that there is a generalized effect of brain damage on verbal expression. In addition, these results suggest that negative valence words were used more accurately than positive valence words. All subject groups were particularly fluent on neutral items.

c. Recollected Emotional Experiences Task

Four two-way ANOVAs were performed on the monologues in search of valence effects.

i. Frequency. There were no significant effects for Group ($F(2,45) = 2.52$, $p > .05$), for Valence ($F(1,45) = .70$, $p > .05$) nor for the Interaction ($F(2,45) = .27$, $p > .05$).

ii. Accuracy. For the mean percent correct, there was a significant main effect of Group ($F(2,45) = 8.06$, $p < .001$). Using post hoc tests, NCs (M=.75) produced significantly more accurate emotional speech than LBDs (M=.58). The effects for Valence ($F(1,45) = .66$, $p > .05$) or for the Interaction ($F(2,45)$

Table 18

Group Means as a Function of Valence in the Nonemotional Word Fluency Task

	total	valence		
frequency		negative	positive	neutral
LBD	3.08	1.81	2.40	5.04
RBD	3.59	2.06	2.94	5.76
NC	5.45	4.40	4.65	7.31
all Ss		2.76	3.33	6.04
mean % correct				
LBD	87.18	83.54	88.34	89.67
RBD	82.68	76.94	83.29	87.81
NC	85.29	79.82	88.93	87.13
all Ss		80.10	86.85	88.20
correct total				
LBD	270.96	153.15	200.00	459.72
RBD	294.28	150.73	226.67	505.44
NC	457.78	349.69	402.08	621.56
all Ss		217.86	276.25	528.91

= .27, $p > .05$) were not statistically significant.

For the correct total score, there was a main effect of Group ($F(2,45)$ = 17.06, $p < .001$). As the post hoc tests showed, NCs (M = 1.20) produced more speech of higher accuracy than LBDs (M = .77) or RBDs (M = .80). The effects for Valence ($F(1,45) = .56$, $p > .10$) or for the Interaction ($F(2,45)$ = 1.41, $p > .10$) were not statistically significant.

iii. Intensity. There was a significant effect for Group ($F(2,45) = 7.87$, $p < .001$). Tukey's post hoc test showed that NCs (M=4.42) produced speech that was more emotionally intense than that of LBDs (M = 3.87) or RBDs (M = 3.87). There was a significant Valence effect ($F(1,45) = 53.38$, $p < .001$). For all subject groups, negative emotional speech (M=4.43) was more intense than positive emotional speech (M=3.67). The interaction effect ($F(2,45)$ = .37, $p > .05$) was not statistically significant (Table 19).

iv. Summary. These results show that there is an effect of brain damage on the quantity and accuracy of emotional expression. Brain damage also lowers the emotional intensity of the verbal output. In addition, negative emotions were expressed with higher intensity than positive emotions by all subject groups. These results do not offer support to either of the hypotheses.

d. Recollected Nonemotional Experiences Task.

Three two-way ANOVAs were performed on nonemotional monologues in search of general valence effects.

i. Frequency. There was a significant main effect of Group ($F(2,45)$ = 4.85, $p < .025$). Tukey's post hoc comparison did not reveal any significant group differences. The Valence ($F(2,90) = .61$, $p > .05$) and the Interaction ($F(4,90) = 1.29$, $p > .05$) effects were not statistically significant.

ii. Accuracy. For the mean percent correct score, the effect of Group ($F(2,45) = 1.43$, $p > .05$) was not statistically significant. There was a signifi-

Table 19

Group Means as a Function of Valence in Recollected Emotional Experiences

	total	valence	
frequency		negative	positive
LBD	1.40	1.45	1.35
RBD	1.40	1.35	1.46
NC	1.67	1.75	1.58
all Ss		1.15	1.47
mean % correct			
LBD	.58	.55	.61
RBD	.60	.59	.61
NC	.75	.75	.76
all Ss		.63	.66
correct total			
LBD	.77	.79	.74
RBD	.80	.76	.83
NC	1.20	1.27	1.13
all Ss		.94	.90
intensity			
LBD	3.87	4.22	3.52
RBD	3.87	4.21	3.53
NC	4.42	4.86	3.98
all subjects		4.43	3.67

cant effect for Valence ($F(2,90) = 6.56, p < .001$). Using post hoc comparisons, none of the valence differences reached statistical significance. The Interaction effect ($F(4,90) = 1.02, p > .05$) was not statistically significant.

For the correct total score, there was a significant main effect of Group ($F(2,45) = 6.17, p < .001$). Post hoc analysis showed that none of the group differences were statistically significant. There was a significant main effect for Valence ($F(2,90) = 6.91, p < .001$). Post hoc analysis, however, did not reveal any significant differences. The Interaction effect ($F(4,90)=.48, p > .05$) was not statistically significant (Table 20).

iii. *Summary.* These results show that LBDs perform worse than the other subject groups on nonemotional speech. The results do not suggest any patterns of hemispheric specialization for emotional production according to valence.

Table 20

Group Means as a Function of Valence in Recollected Nonemotional Experiences

	total	valence		
frequency		negative	positive	neutral
LBD	1.29	1.24	1.29	1.33
RBD	1.40	1.45	1.41	1.33
NC	1.74	1.71	1.65	1.88
all Ss		1.47	1.45	1.51
mean % correct				
LBD	.78	.67	.80	.87
RBD	.82	.74	.81	.89
NC	.84	.80	.89	.84
all Ss		.73	.83	.87
correct total				
LBD	1.00	.83	1.03	1.13
RBD	1.12	1.06	1.11	1.19
NC	1.45	1.28	1.46	1.61
all Ss		1.06	1.20	1.31

IV. DISCUSSION

Results of the perceptual portion of this experiment offer support to the right hemisphere dominance for emotion hypothesis. The findings suggest that the right hemisphere is dominant for perception of lexically coded emotion. The results of the expressive portion of the test failed to support either the right hemisphere dominance for emotion hypothesis or the valence hypothesis. The different results for perception and expression of emotion are discussed in light of possible differences in processing modes. Lesion data that are available suggest a possible role for the right temporal area in lexical processing of emotion.

A. Right Hemisphere Dominance for Emotion Hypothesis

1. Perception

The support for the right hemisphere dominance for emotion hypothesis comes from the results of the perceptual portion of the study. Significant group by condition interactions observed in all perceptual subtests suggest that RBDs have an impairment in lexical perception of emotion. In all three perceptual tasks, the RBDs were significantly more impaired (less accurate) in emotional than in nonemotional conditions. Even though NCs and LBDs performed slightly better in nonemotional than emotional conditions, the difference did not reach statistical significance.

These results, taken together with the majority of experimental studies performed on perception of emotion via facial and intonational channels (e.g., Bradshaw and Nettleton, 1983; Safer and Leventhal, 1977) suggest that the right hemisphere plays a dominant role in perception of emotion. The results

of this experiment are also consistent with the study on perception of lexical emotion in normal controls (Graves, Landis, and Goodglass, 1981). In this tachistoscopic study, a left visual-field advantage (implicating the right hemisphere) was found for perception of single words. Our experiment demonstrated the importance of the right hemisphere in perception of emotion in larger linguistic units, such as sentences.

However, in the sentence identification task, the LBDs, too, were significantly more impaired than NCs in both emotional and nonemotional tasks. It is possible that syntactic processing demands in the sentence identification task may have interfered with their performance. The aphasic disorder that most of the LBDs had, may have made processing of sentences more difficult than processing of single words. On a post hoc basis, the performance of 11 aphasic and five nonaphasic LBDs was compared on perceptual tests. The following pattern emerged. For the word identification and the sentence identification tasks, the performance of nonaphasic LBDs was close to that of NCs, while performance of aphasic LBDs was severely impaired in both emotional and nonemotional conditions. Thus, the aphasic LBDs were equally impaired in both emotional and nonemotional conditions, while the RBDs were significantly impaired only in the emotional condition. The decreased, though not significantly different, performance of RBDs in nonemotional tasks can be explained as a general difficulty in lexical processing. This explanation is consistent with the literature on right hemisphere language capacities (e.g., Searleman, 1977) which suggests that after right hemisphere damage there may be subtle deficits in word recognition. Gainotti et. al. (1981) found that comprehension deficits in right-hemisphere damaged patients are not due to phoneme discrimination in auditory and reading tasks, but to impaired lexical-semantic processing of words. This impairment in lexical-semantic processing can include the use of

abstract concepts, naming, extraction of meaning from stories, appreciation of humor and some deficit in emotional processing. The results of the perceptual portion of our experiment showed that RBDs were relatively more impaired in lexical/emotional perception than in general lexical perception.

In the word discrimination task, there were no substantial differences between emotional and nonemotional conditions for aphasic versus the nonaphasic LBDs. No further breakdown of performance according to aphasic subtypes could be made because no formal criteria for aphasia type were included in this experiment.

It was observed throughout all perceptual and expressive subtests, that most subjects performed better in nonemotional than in emotional conditions. There are several possible reasons for this performance. The words of emotion may be more abstract and less imageable than the words of other categories pertaining to humans, even though in this experiment the level of abstractness was balanced for emotional and most of the nonemotional stimuli. One exception to this was the use of the neutral (hair color) category, which was more concrete than the other characteristics of people. A ceiling effect was obtained on the perceptual tasks for this category and it should be substituted for a more abstract category in future studies. Interestingly, no ceiling effect was observed on the neutral category in the expressive tasks, especially in the monologue tasks. Possibly, the reduced abstractness level of this category was masked by a larger linguistic context in the expressive tasks – verbal paragraphs.

However, this difference, since it was a constant affecting all subject groups, was not crucial for the purpose of this experiment. It was the relative difference between the two conditions and three subject groups that was of interest. Thus, for the perceptual tasks, only RBDs performed significantly

less accurately in emotional than in nonemotional conditions. Taken together with the majority of studies performed on perception of emotion via facial and intonational channels of communication, this study suggests an important role for the right hemisphere in perception of emotion.

2. Expression

The results of the expressive portion of the test did not support the right hemisphere hypothesis of hemispheric specialization of emotion. There were no significant group by condition interactions for either of the expressive tasks. All subject groups performed better in nonemotional than emotional conditions.

These results are in marked contrast to the perceptual results of this experiment. However, it should be noted that no clear relationship between perceptual and expressive modes of processing of emotion has been demonstrated. In fact, Borod, Koff, Perlman, Lorch, and Nicholas (1986) found no correlation between expression and perception of facial emotion in brain-damaged subjects. It may be the case that these two processing modes employ different cerebral mechanisms. Another explanation of an absence of significant results for expression may be the purely statistical approach employed in this study, which failed to capture subtle linguistic differences in expressive tasks. One crucial difference between the perceptual and expressive data was that the perceptual stimuli were controlled for length and linguistic complexity. The expressive data, on the other hand, were open-ended and therefore may require a qualitative psychological and linguistic analysis.

Another explanation of the similarity of performance between LBDs and RBDs in expressive tasks, may be equal participation of both hemispheres in lexical tasks of emotional expression. This conclusion would be in partial agreement with the Hager and Ekman (1985) study presented in the Introduction section, in which asymmetry of contraction of facial musculature was

found only in posed but not in spontaneous emotional expression conditions. The authors conclude that only deliberate emotional facial movements are lateralized. The spontaneous emotional expressions reveal bilateral engagement. However, in our study, no group differences were found for either posed or spontaneous tasks.

On the other hand, it may be the case that the nonemotional expressions, which were open-ended, received some emotional loading by the subjects in the experiment, therefore masking the differences between emotional and nonemotional conditions. For example, subjects' attitudes towards human intelligence or stupidity may have some emotional undertones, which may be reflected in their verbal descriptions. In this case, the ratings that these expressions would receive would not differ substantially from the ratings of emotional expressions. The failure to demonstrate differences on the expressive tasks may, therefore, reflect an experimental artifact.

It was observed during the administration of the expressive tasks that some of the RBDs' speech lacked proper intonation and was not completely appropriate. On a post hoc basis, lesion data that were available were informally examined. The performance of three patients, one of whom had a fronto-temporal lesion and the other two had temporoparietal lesions, was compared on perceptual and expressive tasks. On the perceptual tasks, the performance of these patients did not differ from that of the whole RBD group. On the expressive tasks, however, their performance differed markedly from the others in the RBD group. Two of these patients performed the word fluency task. The third patient (fronto-temporal lesion) was unable to perform this task. All three patients performed the monologues task. For the word fluency task, the difference of the accuracy score between the emotional and the nonemotional conditions was greater for these two patients (36.8) than

for the other patients in the RBD group (20.29). The accuracy score was always higher in the nonemotional condition. For the monologue task, too, the difference of the accuracy score between the emotional and the nonemotional conditions was greater for the three patients (28.0) than for the other patients in the RBD group (17.0). Unfortunately, there was no parallel LBD group available for comparison, neither were there additional lesion data. Therefore, no conclusions could be made based on these data only. However, these data are consistent with Williams's (1969) review of the temporal lobe functions. He suggests that temporal lobes, and particularly the right temporal lobe, together with the cingulate cortex are responsible for subserving emotions.

These data are also consistent with Tompkins and Mateer's (1985) findings with temporal lobe seizure patients. In their experiment, appreciation of attitudes conveyed through prosodic cues and lexical content of a paragraph was studied. The patients' task was to judge the consistency of verbal and intonational meaning of sentences. The authors found that errors in judgements of consistency of verbal and prosodic stimuli were frequent only in patients with right temporal lobe seizures. They found that errors of judgement were strongly associated with the extent of right temporal involvement.

As mentioned, no significant Group by Condition interactions were found for expressive tasks. However, in some cases where the p value was less than .10 but greater than .05, post hoc tests were undertaken on an exploratory basis. The Discrepancy Score ANOVA for the correct total score of the word fluency task ($F(2,45)=2.64$, $p < .10$) approached .05 level of significance. Tukey's post hoc analysis revealed that the discrepancy score of NCs (.14) was significantly lower than that of LBDs (.22) and RBDs (.27). This finding indicated that the difference in base performance of emotional and nonemotional tasks was significantly smaller for NCs than for LBDs and RBDs. However, LBDs

and RBDs, too, performed better on nonemotional than the emotional tasks, that is, in the nonemotional condition more words were produced with higher accuracy than in emotional condition.

A similar tendency was observed for the correct total discrepancy score for the monologues ($F(2,45)=2.75$, $p < .10$). Tukey's post hoc analysis again revealed that the difference in base performance between the two conditions was significantly smaller for NCs (.07) than for LBDs (.12) or RBDs (.16). Although the difference for RBDs is higher, there were no statistically significant differences between RBDs and LBDs. Both of these findings suggest that when the amount of lexical output and its accuracy are taken into account, NCs perform almost similarly in emotional and nonemotional conditions.

The Group effect for the Frequency score of the emotional monologues ($F(2,45) = 2.77$, $p < .10$) approached .05 level of significance. Post hoc Tukey's tests showed that NCs (.75) produced significantly longer emotional monologues than LBDs (.57) or RBDs (.60), suggesting a general effect of brain damage on the length of verbal emotional output. For the nonemotional monologues, the Group finding for the accuracy mean percent correct score ($F(2,45)=2.93$, $p < .10$) approached .05 level of significance. Post hoc tests did not reveal any significant group differences. These analyses, together with the other significant results of the expressive tasks, suggest that there may be a generalized effect of brain damage on the length and accuracy of verbal output, emotional and nonemotional. They do not offer support to the right hemisphere hypothesis for expression of emotion.

Lexical expression of both RBDs and LBDs was significantly less accurate than that of NCs, especially emotional lexical expression. These results suggested the possibility of a generalized brain damage effect on lexical expression. To examine this hypothesis, performance of aphasic and nonaphasic

LBDs was informally compared on the total scores in all expressive tasks. As in the perceptual tasks, the performance of the LBDs was not uniform. For both expressive tasks, performance of aphasic patients was closer to that of RBDs, while performance of nonaphasic patients was similar to that of NCs. Thus, brain damage by itself cannot explain impaired lexical performance. Rather, lesion data and presence or absence of aphasia seem to be important variables.

In addition, emotional facilitation of aphasic speech was not observed in this experiment. Again, a qualitative linguistic and speech contents analysis of patients' speech may reveal differences that our quantitative approach failed to capture. Thus, one of the directions for future research would be analysis of emotional and nonemotional speech in patients with temporal lesions and/or different aphasia subtypes.

B. Valence Hypothesis

1. Perception

Results of the perceptual portion of this experiment did not support the valence hypothesis of hemispheric specialization for emotion, as there were no significant group by valence interactions in the emotional condition. A significant interaction between group and valence observed in the nonemotional word discrimination task was due to the effect of the neutral category on RBDs. A valence analysis of the nonemotional condition was performed in search of possible general hemispheric differences for valence, not just to document a main effect for emotional valence. It was thought that if the valence hypothesis were correct, there might be a general underlying information processing principle, extending beyond emotional processing. However, the results of valence analyses did not support the contention that the right hemisphere is responsible for perception of negative valence, while the left hemisphere is responsible for per-

ception of positive valence. These findings are in accordance with Hirshman and Safer's results (1982), which also failed to support the valence hypothesis for the perception of facial emotion.

2. Expression

Results of the expressive portion of the test did not support the valence hypothesis of hemispheric specialization for emotion, as there were no group by valence interactions. In cases where the interaction p value was less than .10 but greater than .05, post hoc Tukey's analysis was applied on an exploratory basis. The accuracy mean percent correct score in the emotional word fluency task ($F(2,45)=2.66$, $p < .10$) approached .05 level of significance. Tukey's analysis of means revealed two significant differences. LBDs expressed negative emotions ($M=56.54$) significantly less accurately than positive emotions ($M=68.67$). In addition, expression of negative emotions of LBDs was significantly less accurate than that of NCs ($M=68.25$) (See Table 17). This finding is strengthened by a significant interaction effect for the intensity score ($F(1,45)=82.45$, $p < .001$) (see Figure 6). Post hoc pairwise comparisons revealed that negative emotions were expressed with significantly higher intensity by LBDs ($M=5.16$) than by RBDs ($M=4.51$). Within each group, negative emotions were expressed with significantly higher intensity than positive emotions. See Table 17.

It has been proposed in the literature that LBDs are prone to dysphoric mood and may dwell on negative emotions (e.g., Ruckdeschel-Hibbard, Gordon, and Diller, 1986). In their review article, the authors report a study where patients, following inactivation of the left cerebral hemisphere, exhibited a dysphoric mood. In another study, patients with left temporal lobe seizures showed an exaggeration of a depressive state, while patients with right temporal seizures showed minimization of emotional feelings. They report on yet

another study in which RBDs, too, showed symptoms of depression. After an extensive review of the literature on depression in brain-damaged patients, the authors conclude that there is no consistent evidence for lateralized affect after brain damage. In our experiment LBDs expressed negative emotions with high intensity. Of course, a deficit in communication of emotion does not imply a deficit in affect state. It may be the case that depressive attitudes in RBDs and LBDs are expressed differently, or by the use of different defense mechanisms.

There was a significant valence effect observed for the monologues too, namely, negative monologues were expressed consistently with higher intensity than positive monologues by all subject groups. This finding raised the question of linguistic complexity of positive versus negative emotional expression. Are negative emotions more elaborately expressed than positive emotions? If this is the case, is grammatical complexity correlated with intensity of emotional expression? There have been no studies on lexical expression of emotion in brain-damaged subjects. However, there are some studies on lexical expression performed with normal subjects (Collier, Kuiken, and Enzle, 1982; Rintell, unpublished manuscript). Rintell found that descriptions of negative emotions included more embedded sentences, a greater number of transformations and other linguistic measures of complexity than descriptions of positive emotions in native English speakers and speakers of English as a second language. Collier et. al., who studied lexical expression of positive and negative emotions in normal subjects, also found expressions of negative emotions to be more grammatically complex that expressions of positive emotions. The authors' explanation for these differences in grammatical complexity is that they are a function of circumstances that cause reluctance to express negative feelings. The individual is therefore motivated to subtly qualify and carefully delimit the negative emotional content. It seems that a qualitative linguistic

and speech content analysis of the monologues along the valence dimension may offer more insight on hemispheric specialization for emotion hypotheses.

C. Conclusion

In summary, this study was a systematic investigation of lexical perception and expression of positive and negative emotion in stroke patients with unilateral lesions and in normal controls. As there were many studies on the perception and expression of emotion via facial and intonational channels of communication, the lexical channel remained largely unexplored. The information obtained from investigation of the lexical channel can be therefore viewed as complementary to the data obtained from exploration of emotional communication through the other channels. One theoretical implication of this study was that it offered support to the right hemisphere dominance for perception of emotion hypothesis.

Results of the expressive portion of the test were inconclusive. Different results for perception and expression were discussed in light of possible differences in processing modes. It is possible, that only perception of emotion is lateralized. On the the other hand, results of the expressive part of the experiment may reflect insufficient control over the emotionality factor of the control condition. One major contribution of this study was development of lexical control tasks to control for cognitive and linguistic factors. Ways of improvement of these tasks were suggested. This study offered several avenues for future research, for example, employment of a qualitative linguistic and psychological approach to the set of expressive data and administration of this instrument to patients with temporal lobe lesions. One practical implication of this study would be development of a comprehensive battery for lexically-based assessment of emotional deficits following brain damage.

Appendix 1

Characteristics of the LBDs

ID No	Sex	Age	Years of education	Occupational scale	lesion description	MPO	Hemiplegia	Visual field defect
1.	M	58	16	8	cerebral infarction	14	right	unknown
2.	F	74	12	2	parietal stroke	18	none	unknown
3.	F	55	12	2	occipital-parietal infarction	12	none	unknown
4.	M	78	16	8	middle carotid artery stroke	12	none	none
5.	M	64	16	8	CVA	20	right	unknown
6.	F	69	20	9	cerebral hematoma	12	right	unknown
7.	M	76	16	7	occipital infarction	4	none	unknown
8.	M	71	20	9	middle cerebral artery infarct	18	none	unknown
9.	M	39	16	8	deep cortical infarct	9	right	none
10.	M	61	14	6	parietal infarct	12	none	present
11.	M	67	12	3	embolic stroke	12	none	unknown
12.	M	72	16	8	internal capsule infarct	4	right	none
13.	F	40	12	2	posterior communicating artery occlusion	9	right	present
14.	M	78	12	2	CVA	4	right	unknown
15.	M	54	12	4	CVA	7	none	unknown
16.	F	74	18	7	CVA	30	right	unknown

Note. CVA = cerebrovascular accident; MPO = months post onset; Occupational Scale = Nine-point scale, used by Hollingshead (1977) (9 = higher executives and major professionals, 5 = clerical and sales workers, or small business owners, 2 = unskilled workers, 1 = farm laborers and menial service workers).

Appendix 2

Characteristics of the RBDs

ID No	Sex	Age	Years of education	Occupational scale	Lesion description	MPO	Hemiplegia	Visual field defect
1.	M	66	16	7	middle cerebral artery infarct	14	left	unknown
2.	F	75	12	5	middle carotid artery infarct	18	left	unknown
3.	F	78	12	2	CVA	12	left	unknown
4.	M	72	12	3	fronto-temporal infarct	30	left	unknown
5.	M	60	18	7	parieto-occipital hematoma	14	left	unknown
6.	M	52	16	8	parietal hematoma	12	none	none
7.	M	62	12	3	temporo-parietal lesion	24	left	unknown
8.	M	76	12	3	CVA	24	none	unknown
9.	F	80	12	2	internal proximal infarct	18	left	unknown
10.	F	69	12	2	CVA	7	left	present
11.	F	74	12	5	temporo-parietal infarct	12	none	present
12.	F	47	12	2	deep infarct	6	left	unknown
13.	F	79	12	2	lacunar infarct	4	left	unknown
14.	M	69	14	7	CVA	14	left	unknown
15.	M	79	12	4	vertebral basilar ischemia	4	left	unknown
16.	M	64	14	5	CVA	9	left	unknown

Note. CVA = cerebrovascular accident; MPO = months post onset; Occupational scale = nine-point scale used by Hollingshead (1977) (9 - higher executives and major professionals, 5 - clerical and sales workers and small business owners, 2 - unskilled workers, 1 - farm laborers and menial service workers.)

Appendix 3

Informed Consent Form

Morristown Memorial Hospital
100 Madison avenue
Morristown, New Jersey 07960

You are being asked to volunteer to be a subject in a research study. This form is designed to provide you with information about this study which you should know and to answer any questions.

Project Director: Joan C. Borod, Ph.D.
Department: Neurology, Mount Sinai Hospital, New York City
Title of Research Study: Perception of Emotions in Stroke Patients
Participation Time: Approximately two hours

This research study includes procedures which may not give you immediate benefits. It is hoped that the knowledge gained will be of benefit to others in the future.

Purpose of the Research: to learn how a person's understanding and expression of emotions can be affected by a stroke.

Procedures: You will have to read some words and sentences printed on a card. You will be asked to judge which emotion they represent. The seven emotions that we study will be printed on a separate card. You will also be asked to speak for a few minutes about these emotions. What you say will be tape-recorded for later analysis. Some of the words and sentences refer to the non-emotional characteristics of people, such as beauty and intelligence. You will be asked to identify these categories and speak about them, as well.

Potential risks and discomforts: there are no physical or psychological risks in performing these tasks.

Participation in research is voluntary: you can discontinue your participation at any time. Your participation will not alter the care you receive for your illness.

Confidentiality: should you consent to participate in this research your identity will be kept confidential. All data will be kept in locked files. The interview protocol will be given a number and your name will be nowhere mentioned. If you would like to discuss your participation with an institutional representative who is not part of this study, call: 540-5460, Pharmacist on duty.

Agreement to participate

I have read the above description of the research study (or it was read to me by .....).

Everything I did not understand was explained to me by

..... .

In consideration of this understanding, I voluntarily agree to participate in this research.

Name of subject: .....

Signature of participant: .....

Signature of witness: .....

Signature of investigator: .....

Date: .....

(Mrs. F. Andelman 201-789-3410)

Appendix 4

Rating Form Used in Development of the Sentence Identification Task

For each sentence,

1. Identify the most appropriate emotion.
2. Under that column check how strongly this emotion is reflected in the sentence.

   1 - least representative; 5 - most representative.

EVERYTHING IS GOING JUST RIGHT FOR HIM.

happiness	pleasant surprise	interest	sadness	anger	disgust	fear
12345	12345	12345	12345	12345	12345	12345

JOHN WAS PLEASED TO WIN THE AWARD.

happiness	pleasant surprise	interest	sadness	anger	disgust	fear
12345	12345	12345	12345	12345	12345	12345

THIS WAS A REPULSIVE LOOKING PAINTING

happiness	pleasant surprise	interest	sadness	anger	disgust	fear
12345	12345	12345	12345	1234	12345	12345

HE FELT AN IMPULSE TO HIT SOMEONE.

happiness	pleasant surprise	interest	sadness	anger	disgust	fear
12345	12345	12345	12345	12345	12345	12345

Appendix 5

Sample Stimulus for the Emotional Sentence Identification Task

Appendix 6

Emotional Categories

SAD

HAPPY

PLEASANT SURPRISE

DISGUST

INTEREST

FEAR

ANGER

Appendix 7

Rating Form Used in Development of the Word Identification Task

For each word:

1 Identify the most appropriate emotion.

2 Under that column check how strongly this emotion is reflected in the word.

1 - least representative; 5 - most representative.

stimulation

happiness	pleasant surprise	interest	sadness	anger	disgust	fear
12345	12345	12345	12345	12345	12345	12345

anguished

happiness	pleasant surprise	interest	sadness	anger	disgust	fear
12345	12345	12345	12345	12345	12345	12345

astound

happiness	pleasant surprise	interest	sadness	anger	disgust	fear
12345	12345	12345	12345	12345	12345	12345

stench

happiness	pleasant surprise	interest	sadness	anger	disgust	fear
12345	12345	12345	12345	12345	12345	12345

Appendix 8

Sample Stimulus for the Emotional Word Identification Task

anguished

rejected

nostalgia

Appendix 9

Sample Stimulus for the Emotional Word Discrimination Task

party

stimulation

Appendix 10

Emotional Category Label

PLEASANT SURPRISE

Appendix 11

Examples of Responses in Emotional Word Fluency Task

Happiness - successful, satisfied, health, swell.

Pleasant surprise - unexpected, astonished, surprise party, visitor.

Interest - book, movie, theater, literature, sports.

Sadness - unhappy, illness, sorrow, tears, loss.

Anger - insult, discourteous, mad, rage.

Disgust - vomit, mess, revulsion, dirty.

Fear - apprehensive, accident, death, dread, terror.

Appendix 12

Examples of Recollected Emotional Experiences

HAPPINESS

"Recently I had my birthday, and when I got flowers it was the feeling that made me happy because I felt very special. It was unexpected. And as a result I felt as if I was the most important person in the world; and I felt very excited and that I was that important. That what made me happy." (NC 5)

PLEASANT SURPRISE

"Well, that was my 25th anniversary , that was a surprise. My daughter and the grands, I couldn't stand up for about 10 minutes because I was in such a shock." (LBD 3)

INTEREST

"Interest to me are mainly the talkshows on TV and on radio. You know, the radio shows, but they are mostly talkshows; and the news, I like to listen to them. They are all of interest to me now." (RBD 3)

SADNESS

"Recently a relative has visited us, and I learned that this person, who is still a young person, is very gravely ill. And it's an illness that currently there is no cure for. And she will become worse and worse as time goes on."

"We can only hope that it's a slow process and she will enjoy the time that she has left, which is an undetermined amount of time. And she has a daughter. I feel sad about the whole situation and about her. And we, my wife and I, have pledged to help the daughter in case some bigger problem develops." (NC 8)

ANGER

"I remember anger and being angry when you are pressed beyond endurance and you are being made to do something, or being approached to do something that you don't really want to do."

"As a result, I mean, a child can easily frustrate and anger you and it has happened to me when no matter what, no matter what an answer or suggestion I give my child, it has

gotten me to the point where I have been so angry that I would strike out and don't have words anymore." (NC 5)

DISGUST

"I was thinking of this restaurant. And we were waiting; we had a flat tire. We were waiting for the guy to come and fix it. And people came in and sandwiches and hotdogs. They threw their papers on the ground. My sister-in-law and my brother-in-law were absolutely disgusted."

"And we couldn't figure out what's the matter with the people." (LBD 8)

FEAR

"I am always in fear of having another stroke. I have to watch what I eat. I am still overweight. And I am real particular about my nose, because I am left home alone." (RBD 7)

Note. Each paragraph represents a 15-second interval.

Appendix 13

Sample Stimulus for the Nonemotional Sentence Identification Task

She had much force in her arms.

Appendix 14

Nonemotional Categories

INTELLIGENCE

BEAUTY

STUPIDITY

STRENGTH

FAT

WEAKNESS

HAIR COLOR

Appendix 15

Sample Stimulus for the Nonemotional Word Identification Task

dumb

uninformed

dull-witted

Appendix 16

Sample Stimulus for the Nonemotional Word Discrimination Task

powerful

senseless

Appendix 17

Nonemotional Category Label

HAIR COLOR

Appendix 18

Examples of Responses in Nonemotional Word Fluency Task

Beauty - pretty, gorgeous, handsome, elegant.

Strength - athletic, muscular, weight-lifter, boxer, heavy-weight.

Intelligence - high I. Q., professor, knowledgeable, calculating.

Hair color - brown, blond, dark, black, brunette.

Weakness - frail, weak will, epileptics, sloppy, clumsy.

Fatness - overweight, unsightly, bosomly, pig, enormous.

Stupidity - debilitated, retarded, failure, illogical.

Appendix 19

Examples of Recollected Nonemotional Experiences

BEAUTY

"The sunset was so beautiful because the sky was filled with such a variety of colors and contrasting lights. Against the western sky there were clouds that were black and they had brilliantly lit rims, sometimes white like silver and sometimes gold."

"And against most of the sky was dark overcast and the sun was peeping in and around the rim and that gave, made the buildings of, in, towards the east, set them up in sharp and brilliant detail like a spotlight."

"The air from the thunderstorm was perfectly crystal and clear and it was exhilarating to see the world in such stark and colorful variety." (NC 7)

INTELLIGENCE

"Q.E.D. - quantum electrodynamics by Richard Feynman. And I think he is one of the most intelligent men I have ever read. I don't know him personally but I have listened to him on the radio when he was on the commission. And I think he is about the most intelligent person I have ever known." (LBD 8)

HAIR COLOR

"Good many men prefer red hair. Others look at blonds. And one thing, a little tint of grey tends to make yourself, one, older and the old one more colorful. Hair is a nice object you prefer by color." (RBD 8)

STRENGTH

"We went down to Florida. There were a number of incidents there where there was a lot of strength needed. We had a situation where a number of boys that were wondering around our complex, and while I wasn't the strongest man in the world, and with a stick, in fact, in my hand and threatened them."

"While there was no strength in my body at the time, I thought, by taking a stick I would be able to scare them. And apparently they thought there was a lot of strength either in my body or in the stick and so they dispersed." (NC 12)

FATNESS

"Extra flesh rippled from the chin. Great blobs hung from her shoulders and her upper arms and her massive breasts and stomach made a great mass hanging in front of her frame." (NC 7)

WEAKNESS

"They are weak physically because of medical problems. Either they may be born with some physical defect which stays with them, or as they go along in years they develop some ailment, particularly associated with aging. But I think people have to do what they can, within their own limitations, capabilities, to try to overcome physical weakness. They also, I think, need to try to overcome emotional weakness, but sometimes they can't do that all by themselves. And they may need professional assistance." (NC 10)

STUPIDITY

"I read an article where it says that the difference between genius and stupid is that genius has some limitations. And I think that's sort of true. Stupidity runs. It amazes me that certain people are so ignorant, stupid about things, that there is one dimension to it."

"I just feel compassion for stupid, I mean really, truly stupid people. I can accept stupid incidences or stupid things, but when people are really grossly stupid, it is a shame because they miss so much. They are so limited." (RBD 5)

Note. Each paragraph represents a 15-second interval.

Appendix 20

Word Fluency Task, Order of Words by Subject

Subject 1:

1. swell
2. happy
3. event
4. story
5. unhappy
6. rage
7. filthy
8. stench
9. apprehensive

Subject 2:

10. glad
11. party
12. winning
13. meeting
14. money
15. what we do
16. death
17. illness
18. punch
19. knock out

etc.

n=800 words of emotion excluding repeated words

n=549 nonemotional words excluding repeated words

Appendix 21

Examples of Emotional Words Randomized by Computer

777 need
163 ignoring
417 raise
107 fascination
701 blowing off steam
21 aiding
382 line
763 unresponsiveness
256 visitor
617 alone
553 relieved
705 petrified
242 frustration
499 unlucky
663 new book
537 desire
375 ired
771 enrich
178 insult
etc.

Appendix 22

Emotional Word Fluency Task, Instructions for Accuracy Ratings

"For each word check the emotion that the word best represents"

category

Happiness Pleasant Sadness Disgust Interest Fear Anger Surprise

word

glad
awful
pretty
birthday
death
smell
present
horror
book
movie
mad
afraid
etc.

n=800 words

Appendix 23

Nonemotional Word Fluency Task, Instructions for Accuracy Rating

"For each word check the category that the word best represents"

Category

	Beauty	Fatness	Intelligence	Weakness	Hair Color	Stupidity	Strength
word							
pretty							
enormous							
frail							
smart							
black							
retarded							
athlete							
gorgeous							
bright							
heavy							
thin							
red							
brown							
IQ							
winner							
old							
etc.							

n=549 words

Appendix 24

Emotional Word Fluency, Instructions for Intensity Rating

"For each word, indicate on a scale of 1 to 7 how intensely the emotion is expressed in each word"

	1	2	3	4	5	6	7
	not at all intense	slightly intense	mildly intense	moderately intense	quite intense	very intense	extremely intense
word							
glad							
pretty							
awful							
happy							
death							
books							
rage							
gay							
filthy							
ugly							
smelling							
gleeful							
cheerful							
scared							
uneasy							
etc.							

n=800 words

Appendix 25

Recollected Emotional Experiences, Instructions for Accuracy Rating

"For each paragraph check the emotion that the paragraph best represents"

Category

Happiness Pleasant Anger Fear Disgust Interest Sadness Surprise

15-second intervals:

"Sometimes me and my brother; we get an argument; we get - an argument can get very heightened."

"The train was going slowly and it took hours to get home."

n=636 paragraphs.

Appendix 26

Recollected Nonemotional Experiences, Instructions for Accuracy Rating

"For each paragraph check the category that the paragraph best represents"

Category

	Hair Color	Strength	Fat	Beauty	Stupidity	Intelligence	Weakness
15-second intervals:							
"And he feels that this will be the thing that will show how brave he is."							
"Associated with the academia. Necessary for fast schooling"							

n=583 paragraphs.

Appendix 27

Recollected Emotional Experiences, Instructions for Intensity Rating

"For each paragraph, indicate on a scale of 1 to 7 how intensely the emotion is expressed in each paragraph"

1	2	3	4	5	6	7
not at all intense	slightly intense	mildly intense	moderately intense	quite intense	very intense	extremely intense

15-second intervals:

"Sometimes me and my brother, we get an argument, we get fearful; an argument can get very heightened."

"The train was going slowly and it took hours to get home."

n=636 paragraphs.

Appendix 28

Emotional Word Fluency, a Sample of Rating Results in a Randomized Order

Raters	1	2	3	4	5	Target	% Score
word No.							
775	I	H	I	I	I	I	80 %
162	A	A	A	A	A	A	100 %
416	H	R	H	R	H	H	60 %
107	I	H	I	I	I	I	80 %
699	A	A	A	A	A	A	100 %
21	A	H	I	I	I	I	60 %
381	F	F	F	F	S	F	80 %
761	S	S	I	S	I	S	60 %
256	R	R	R	R	S	R	80 %
616	S	F	S	S	S	S	80 %
552	H	H	H	H	H	H	100 %
703	F	F	F	F	F	F	100 %
241	I	H	I	I	I	I	80 %
498	F	F	F	F	F	F	80 %
661	I	I	I	I	I	I	100 %
536	I	H	I	I	H	I	60 %
374	A	F	A	A	A	A	80 %
769	H	H	H	I	H	H	80 %
etc.							

Note. Each number corresponds to a word and carries with it the results of the ratings.

Appendix 29

Emotional Word Fluency, a Sample of Rating Results in a Derandomized Order

Raters:	1	2	3	4	5
Subject 5					
30 pleasant	H	H	H	H	H
31 smile	H	H	H	H	H
32 awards	R	H	H	H	H
33 health	H	H	H	H	H
34 hobby	I	I	I	I	I
35 pain	F	S	S	S	F
36 stroke	S	S	F	F	F
37 holocaust	F	D	F	S	F
38 politics	D	A	I	I	I
39 vomit	D	D	D	D	D
40 personal harm	F	F	F	A	S
41 accident	F	F	F	F	A
Subject 6					
42 grandson	H	H	H	H	H
43 whales	S	I	I	I	H
44 sewing	I	I	I	I	I
45 rage	A	A	A	A	A
etc.					

Note. The number before each word indicates that word's chronological order.

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