7

THE EFFECTS OF LINGUISTIC CONTEXT ON THE PROCESSING OF AFFECTIVE INTONATION

by

FELICIA R. GIRONDA

A dissertation submitted to the Graduate Faculty in Speech and Hearing Sciences in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

2000

UMI Number: 9986331

UMI

Bell & Howell Information and Learning Company
300 North Zeeb Road
P.O. Box 1346
Ann Arbor, MI 48106-1346

This manuscript has been read and accepted by the Graduate Faculty in Speech and Hearing Sciences in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

9/7/00
Date

Lawrence Raphael
LAWRENCE RAPHAEL, Ph.D.
Chair of Examining Committee

9/7/00
Date

Robert Goldfarb
ROBERT GOLDFARB, Ph.D.
Executive Officer

KATHERINE S. HARRIS, Ph.D.

VIVIEN TARTTER, Ph.D.

Supervisory Committee

CAROLE E. GELFER, Ph.D.
External Examiner

THE CITY UNIVERSITY OF NEW YORK

ABSTRACT

THE EFFECTS OF LINGUISTIC CONTEXT
ON THE PROCESSING OF AFFECTIVE INTONATION

by

Felicia R. Gironda

Advisor: Lawrence Raphael, Ph.D.

The expression of emotion via the speech signal is thought to be bound to the communicative situation, the use of certain words which describe the stated feeling, and specific intonation patterns associated with the emotion ("tone of voice"). The purpose of this study was to explore how stimulus context and brain damage differentially affect the processing of affective intonation.

A group of twenty-four adult subjects (eight aphasic left-hemisphere damaged, eight right-hemisphere damaged and eight normal controls) listened binaurally to a series of stimuli in which affective information (happy, sad, angry, and neutral) was conveyed in three different linguistic contexts (narrative, phrase, and intonation contour).

There was a significant difference between the accuracy scores of the normal controls as compared to both left and right hemisphere-damaged groups. All three groups performed better in the narrative condition than in the phrase and contour conditions. While both left and right hemisphere-damaged groups performed significantly worse than the normal controls

in all three linguistic conditions, the right hemisphere-damaged group performed (non-significantly) better than the left hemisphere-damaged group in the narrative condition, and, the left hemisphere-damaged group performed (non-significantly) better than the right hemisphere-damaged group in the phrase condition and the contour condition. The results are consistent with parallel processing and task demand theories as applied to the identification of affective intonation contours.

ACKNOWLEDGMENTS

I am deeply indebted to Dr. Lawrence Raphael, Dr. Katherine Harris, and Dr. Vivien Tartter for their steadfast guidance and support, and for graciously continuing their supervision and attentiveness over the past three years. I would also like to thank Dr. Carole Gelfer for serving as the fourth reader and Dr. Robert Goldfarb, Ms. Loretta Walker and Mr. Gary Chant for their cordial assistance.

Others whose care and concern helped make this task possible include Dr. Enzo Bard and Dr. Lucille Horn at Kings County Hospital; my dearest spouse Chana Benjamin; and the many wonderful colleagues, friends, relatives and patients who kindly served as subjects.

I dedicate this manuscript in loving memory of my departed parents, Vincent and Marie Gironda, and my departed siblings, Vincent Jr., Philip, and Marie Joy Nelson. I also wish to honor the memory of Dr. Irving Hochberg, for his wisdom and encouragement throughout my doctoral education.

I further devotedly salute my Mentor and Guru, Bhagavan Sri Sathya Sai Baba, at whose Lotus Feet I have placed this manuscript.

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

4

CHAPTER ONE

INTRODUCTION AND PURPOSE

The intonation contour of an utterance can be defined as the combined pattern of pitch, intensity and duration changes that occur in connected speech. Affective intonation broadly refers to those same patterns in connected speech that help to convey an emotion. The processing of affective intonation has been generally described in terms of the expected cerebral lateralization of the utterance components. These utterance components would include those considered segmental, and thereby assigned for processing to the left/dominant hemisphere, and those considered suprasegmental, and thereby assigned for processing to the right/non-dominant hemisphere (Zurif, 1974). Descriptions of the processing of affective intonation contours have been complicated by theories regarding the biological substrates for the comprehension of emotion (Kent & Rosenbek, 1982).

The research literature has tended to fragment the process of prosodic cue integration by localizing the processing of utterance components to different cerebral areas; for instance, pitch and melodic patterns to the right hemisphere; sequential phonetic, syllabic and syntactic units to the left hemisphere; emotion and emotional words to the right hemisphere and/or the hypothalamus; and non-emotional words to the left hemisphere.

Because both hemispheres are implicated, it is clear that an investigation into the effects of linguistic context on the comprehension of affective intonation involves an examination of different information-processing strategies. Information in this case refers to cues to meaning derived from the acoustic features that compose the intonation contour as well as cues derived from the segmental, semantic, and syntactic features of the utterance. Another factor that has to be considered with regard to the brain-damaged population is the availability of residual mental resources with which to extract and decode part or all of such information.

The present study was designed to explore a "whole-brain" approach to the following research questions: 1) To what degree is the processing of affective intonation contours dependent on linguistic context? 2) Does the processing of affective intonation contours differ between brain-damaged subjects and normal controls? 3) What is the nature of the difference? The answers to these research questions were then used to evaluate two theories that describe speech information decoding: parallel processing and task demand information processing. Generally speaking, the parallel processing theory suggests that both hemispheres are engaged in the simultaneous processing of speech components for which each hemisphere is specialized (Shipley-Brown, Dingwall, Berlin, Yeni-Komshian, & Gordon-Salant,1988). The task demand information processing theory broadly refers to automatic and effortful cognitive strategies used to access memory and derive meaning from emotional texts (Tompkins and Mateer,1985).

CHAPTER TWO

LITERATURE REVIEW

Discussions of the main issues pertaining to affective intonation processing in normal and brain-damaged subjects can be found in the literatures of speech perception and auditory processing, aphasiology and right hemisphere impairment, linguistics, and neuropsychology/information processing. For the most part there has been a tendency for each discipline to focus on one particular aspect of an emotionally-intoned utterance. For example, speech scientists have addressed the specific intonation patterns associated with an emotion; aphasiologists and linguists, the use of certain words that describe the stated feeling; and neuropsychologists, the emotional situation being communicated. Most authors, however, conclude that the matter of which cues are most useful is certainly a complex one.

2.1 Speech Perception and Auditory Processing

In this body of literature, the intonation contour of an utterance has been considered a cluster of suprasegmental features that co-occur with sequences of words and that can denote, among many other things, the speaker's emotional state (Cruttenden, 1995; McRoberts, Studdert-Kennedy & Shankweiler, 1995). Comprehension of the intonation contour in normal subjects has been generally defined by this literature in terms of the expected lateralization of utterance components.

In a series of dichotic studies, Kimura (1967) broadly apportioned speech (spoken digits) processing to the left hemisphere and non-speech (woodwind melodic patterns) to the right hemisphere. Other research narrowed the lateralized perceptual features of duration and pitch to the left and right hemispheres respectively, using comparisons of synthetic steady-state vowels and consonant-vowel syllables (Shankweiler & Studdert-Kennedy, 1967) and voiced and voiceless stop consonants (Molfese, 1980). Still another hypothesis attributed a sequential syllable and word strategy to the left hemisphere and a gestalt of the entire intonation contour to the right hemisphere (Emmorey, 1987). Overall though, the most prevalent description has been that the segmental components of experimental stimuli are processed in the left (dominant) hemisphere. Studdert-Kennedy & Shankweiler (1970) established significant right ear advantages (REAs) for the accurate identification of initial and final stop consonants in consonant-vowel-consonant (CVC) dichotic pairs differing in only one phoneme. They concluded that "while the general auditory system common to both hemispheres is equipped to extract the auditory parameters of the speech signal, the dominant hemisphere may be specialized for the extraction of linguistic [phonetic] features from those parameters." (p. 307).

Various other studies with normal populations have also confirmed the parallel but unequal participation of both hemispheres in the processing of intonation contours, depending on the complex interaction of syntactic, semantic, prosodic and segmental features. In a dichotic listening experiment, Blumstein & Cooper (1974) pursued the question of whether the "perception of intonation contours in a medium which retains the phonetic character of natural speech produces a REA." They obtained a significant left ear advantage (LEA) in the accurate identification of declarative, interrogative, imperative and conditional contours consisting of CV nonsense syllables. Zurif (1974) explained the dual hemisphere involvement phenomenon by suggesting that while intonation itself was probably processed in the right hemisphere, it "enhances the left hemisphere's ability to carry out linguistic decisions." According to Zurif, these left-hemisphere linguistic decisions arise from the fundamental frequency and amplitude of the intonation contour as an intrinsic part of a message, superimposed on the sequential segmental sound patterns, word meanings, and the syntactic organization of the utterance.

2.2 Aphasiology and Right Hemisphere Impairment

This body of literature has traditionally assumed that the linguistic and emotional components of an affectively intoned utterance are processed in the left and right hemispheres, respectively attributing selective deficits in prosodic comprehension were attributed to the hemisphere of lesion (Brownell, Gardner, Prather, & Martino ,1994). Although conclusions drawn from earlier research with right- hemisphere damaged (RHD) and left-hemisphere damaged (LHD) subjects pointed towards right hemisphere dominance for the comprehension of prosody based on poorer performance by the RHD groups (Heilman, Bowers, Speedie, & Coslett, 1984), some early studies also theorized that the lower RHD scores might be attributable to deficits in acoustic processing (Tucker, Watson & Heilman, 1977). Furthermore, the results of later studies in which both RHD and LHD subjects performed more poorly than normal controls on prosodic comprehension tasks pointed to breakdowns within the decoding and integration of various cues, across multiple neurological systems (Van Lancker & Sidtis,1992).

Ross (1981) described case histories of ten RHD patients, offering the following clinical observations: patients with right anterior frontoparietal lesions displayed or reported good prosodic/affective comprehension, while those patients with right posterior frontoparietal, right middle cerebral artery, and right temporal lesions all reported or displayed poor prosodic/affective comprehension.

In a non-prosodic auditory language comprehension task matching spoken words to pictures, Gainotti, Caltagirone, Miceli, & Masulo (1981) found that more semantic-lexical errors were made by their RHD subjects relative to normal controls when the RHD subjects' long-term lexicon was accessed through the auditory modality, indicative of a generalized auditory processing disorder.

Tucker, Watson & Heilman (1977) tested eleven RHD subjects with parietal lesions matched to seven LHD subjects with conduction aphasia for the abilities both to recognize and to discriminate four seven-word, neutrally worded sentences spoken by a male speaker in angry, happy, sad, and indifferent tones of voice. During the recognition task, subjects were asked to listen to the sentences and to judge the mood of the speaker by how he said it; the recognition task score was derived from the number of correct responses out of 16 recorded presentations. During the discrimination task, subjects were asked to listen to pairs of sentences and to indicate if the mood was the same or different; the discrimination task score was derived from the number of correct responses out of 32 recorded presentations. In both tasks the RHD subjects performed significantly worse than the LHD subjects. Because their RHD subjects could neither name the target emotions in the recognition tasks, nor discriminate sentences with different emotions, the authors concluded that the failure to discriminate pointed to decreased discrimination of pitch at an early stage of auditory perception .

Heilman, Bowers, Speedie, & Coslett (1984) presented 30 six- and seven-word recorded sentences spoken by a male speaker to eight RHD, five non-fluent aphasic LHD, four fluent aphasic LHD, and fifteen normal subjects. The phonetic, semantic, and syntactic components of the stimuli were eliminated by filtering, leaving only recorded prosodic contours intended to convey happiness, anger, or sadness. The dependent variable was the mean percentage number of correctly identified contours. They found that the RHD subjects (all also with parietal lesions) had significantly decreased comprehension of emotional prosody relative to the non-fluent and fluent aphasic LHD subjects, and the normal controls. Both the RHD and the LHD groups performed significantly worse than the normal controls The authors postulated that the successful comprehension of emotional prosody required an appropriate "cognitive set" to interpret affective information which may have been deficient in their RHD subjects.

Van Lancker & Sidtis (1992), however, using 16 seven-syllable recorded sentences, spoken by a professional actress, that were intended to convey happiness, anger, sadness or surprise, found equally poor recognition scores by both non-fluent (18) and fluent (6) aphasic LHD, and (13) RHD subjects, relative to (37) normal controls. Both LHD and RHD subjects were described as diagnosed with "a unilateral focal lesion in the distribution of the middle cerebral artery."(Van Lancker & Sidtis,1993). The researchers measured the number of correct affective judgments made on the 16 test items, and concluded that "receptive dysprosody can be accounted for at the level of perceptual deficit without invoking additional deficits in affective or cognitive processing" since the extraction of pitch information might wholly determine the accuracy of affective identification.

2.3 Linguistics

Linguists generally view any cerebral lesion as a cause of some difficulty in decoding emotional intonation, especially when verbal information is considered. For instance, if the acoustic features of frequency, intensity and duration , which compose the intonation contour, provide some basic cues intrinsic to signaling affective meaning, in addition to semantic meaning (Johnson-Weiner, 1984; Miller & Docherty, 1995), both hemispheres are implicitly involved by such a description.

Brownell, Gardner, Prather, & Martino (1994), and, Joanette, Goulet, & Hannequin (1990), reviewed recent articles pertaining to the hemispheric processing of prosody. The consensus leaned toward bilateral representation because different experimental results could not establish clear acoustic differences between affective and linguistic prosody; they found strong evidence for prosodic disorders that could be differentiated diagnostically from mood disorders; and, the intonational contour was defined as translating the "modality" of the whole sentence, either by proposition such as declarative, interrogative, or imperative intent (left hemisphere domain) and/or by reflection of the speaker's emotional state (right hemisphere domain).

2.4 Neuropsychology / Information Processing

The evidence for bilateral representation of affective information expanded the field of explanations that incorporated the hemispheric processing of acoustic, lexical, semantic, and/or emotional inputs.

Borod, Andelman, Obler, Tweedy & Welkowitz (1992) found a significant selective RHD deficit in visually-processed printed lexical-emotional stimuli, relative to normal controls and aphasic LHD subjects, (16 subjects in each group), in 21 emotional word cluster identification and 42 emotional word-pair discrimination tasks; and, a significant selective RHD deficit in visually-processed printed lexical-emotional stimuli, relative to RHD accuracy scores for visually-processed printed, analogous lexical non-emotional tasks. (For example, in the emotional word cluster identification condition, subjects were asked to select, from a multiple-choice list of seven emotions, the emotion they thought was best represented by a cluster of three printed emotion words; in the control non-emotional word cluster identification condition, subjects were asked to select from a multiple-choice list of seven non-emotional "characteristics of people," the characteristic they thought was best represented by a cluster of three printed non-emotional words.) These findings were in contrast to those of Strauss (1983), who presented 12 printed emotional and 12 printed non-emotional four-letter words to 20 normal adults and obtained a right visual field (left hemisphere) superiority for emotionally positive and negative words, and, for emotional and non-emotional words.

Using recorded auditory stimuli, Bowers, Coslett, Bauer, Speedie & Heilman (1987) presented 32, six-word affectively intoned declarative sentences intended to convey happiness, sadness, anger or no emotion, to eight RHD, nine LHD, and fifteen normal control subjects, in semantically congruent and semantically incongruent conditions. The RHD subjects did significantly worse than the LHD subjects and the normal controls depending on the degree of discrepancy between the semantic and prosodic information. In the semantically congruent condition, the RHD subjects scored significantly lower than both the normal controls and the LHD subjects (who scored equally well). In the semantically incongruent condition, the RHD subjects scored lower than the LHD subjects, and both hemisphere-damaged groups scored significantly lower than the normal controls. The poorer performance by the RHD subjects in both conditions pointed to a strong right hemisphere contribution to the comprehension of emotional prosody. The authors explained the LHD subjects' deficit as a distraction effect, i.e., "that the left hemisphere also has the capacity to process emotional prosody, but it is distracted by and only attends to the semantic message, rather than attending to the prosodic message."

Pell (1998) also pursued the influence of linguistic/emotional (functional) and acoustic (structural) attributes of prosodic contours on recognition following unilateral brain lesion, with nine RHD, eleven aphasic LHD, and ten normal controls. He devised a common set of five, six-syllable, semantically neutral sentences which were spoken by a female speaker and recorded as happy, sad, angry, neutral, declarative or interrogative, in 24 combinations for a total of 120 tokens. He measured the recognition of prosody type by the number of items correctly identified when all the potential acoustic features noted as within his baseline duration and fundamental frequency parameters (but no semantic features) signaled the target response. Relative to the normal controls, both RHD and LHD subjects were impaired in interpreting the emotional meaning of the prosodic contours. The author concluded that although his results supported bilateral prosodic processing, it was "not inferred that emotional processing deficits stem from a common underlying mechanism in RHD and LHD subjects."

What may be common to the normal, RHD, and LHD populations is some degree of access to a variety of cognitive strategies elicited during the processing of emotional intonation. Two explanations under consideration here are the parallel processing hypothesis and the task-demand information processing theory.

2.5 The Parallel Processing Hypothesis

The parallel processing hypothesis proposes that both hemispheres participate simultaneously in the processing of speech components for which each one is specialized. For example, in an emotionally spoken question, the normal, non-dominant right hemisphere would process the mood conveyed, and at the same time the normal, dominant left hemisphere would process the interrogative form of the sentence. In a dichotic listening experiment, Shipley-Brown et al., (1988) presented 32 normals with four six-word, semantically neutral sentences which were read by a male speaker as happy, sad, angry, declarative, interrogative or as a "continuation." A continuation intonation indicated that more was to follow. Subjects listened through earphones to 96 trials of recorded sentences spoken with two different affective intonations, one in each ear, and were asked to identify them, and

96 trials of recorded sentences spoken with two different linguistic intonations, one in each ear, and were asked to identify them as well. The experimenters obtained a highly significant ($p < .0001$) left ear advantage (LEA) for both the affective condition (identifying happy, sad and angry), and a less robust but significant LEA ($p < .03$) for the linguistic condition (identifying declarative, interrogative and continuation). The authors postulated that in their study, pitch cues (fo) elicited a stronger right-hemisphere laterality/LEA during the affective prosody task because of the right hemisphere's role in mediating affect, and a significant LEA of lesser degree during the linguistic prosody task because the pitch cues were also simultaneously "drawn" to the left hemisphere for language processing purposes.

In another dichotic experiment (Ley & Bryden,1982), 32 normals heard, via headphones, 128 trials of four six-word sentences intended to convey happiness, sadness, anger, or no emotion, as recorded by two speakers, one female and one male. The subjects were instructed that although they would hear two competing sentences, they were to attend to the designated ear and ignore the material heard in the other ear, in both the emotional tone identification task and the sentence content identification task. Judgments of both emotion and content were made on every trial. The sentence content identification condition required subjects to choose the correct target subject (noun), verb, or object (noun) from a series of competing foils. The results revealed a LEA for recognition of emotional intonation, and a simultaneous right ear advantage (REA) for recognition of semantic/verbal content. The researchers suggested that a composite emotional and verbal stimulus gives rise to independent parallel processing in the two hemispheres and predicts that the right hemisphere will attend to emotional intonation cues (hence the LEA) while the left hemisphere will attend to linguistic content (hence the REA).

2.6 The Task-Demand Information Processing Hypothesis

The task-demand information processing hypothesis was put forth by Tompkins (1990, 1991a) who reported two interdependent, sequential strategies employed by normal subjects, RHD subjects and LHD subjects in the processing of emotional intonation. Tompkins distinguished between automatic and effortful processing. Automatic processing quickly activates basic conceptual knowledge about emotional situations, similar to a reflex, and taps into the organization of emotionally related items in a semantic network. Effortful processing builds on automatic activation to access more internal representations of emotional knowledge stored in long-term memory (increasing task demands), and is a slower mechanism that allocates limited attentional resources for performing further cue processing.

Tompkins (1991a) had tested 24 RHD, 24 LHD (including 14 aphasic LHD), and 24 normal controls. Subjects listened over headphones to stimuli previously recorded by three female speech-language pathologists. Subjects were asked to identify the emotion described in a series of 120 three-sentence stories ("priming contexts") that were followed by either emotionally congruent or incongruent neutrally-worded target phrases in which intonation varied to convey happiness, anger, fear, or no emotion. Subjects were also instructed to select the target phrase mood as quickly as possible, as both accuracy and response time were recorded by the examiners. In the automatic condition, subjects were told that sometimes the story was a distraction, to be ignored when judging the emotion of the target phrase. In the automatic condition, Tompkins found that there were no differences between the three groups in the accuracy of identifying the target phrase emotion, although the normals responded significantly faster than the RHD and LHD subjects, who did not differ in response time. In the effortful condition, subjects were told that most of the time the story would help them. In the effortful condition, again there were no differences between the three groups in the accuracy of identifying the target phrase emotion, although the RHD subjects responded significantly slower than the normal and LHD subjects, when judging target emotions preceded by emotionally incongruent story primes. The finding of no significant group differences in the accuracy of identifying emotional intonation, coupled with Tompkins' subsequent study (1991b) in which increased semantic redundancy improved the interpretation of affect, suggests that access to the working memory of emotional concepts and the higher level cognitive ability to draw correct inferences are also factors involved in identifying emotions. This task-demand model is therefore not hemisphere dependent, as cognitive resources such as attentional capacities, activation of emotional memory nodes and the ability to associate emotional meanings with specific contexts are not believed to be localized cerebrally, but are presumed to be distributed cortically and sub-cortically (Heilman & Gilmore, 1998; Adolphs & Tranel, 1999).

2.7 General Implications and Aims of the Current Study

What is known about the effects of linguistic context on the processing of affective intonation can be summarized simply as inconclusive, mainly because not much context has been provided. Table 2.7.1 compares the aforementioned research studies in terms of the helpfulness of the linguistic content of the experimental stimuli.

The present study was designed to determine the linguistic context conditions under which the processing of affective intonation is most accurate for the normal and the brain-damaged groups and the conditions under which hemisphere of damage is a significant variable.

Wells, Peppe, and Vance (1995), pointed out that the affective role of intonation patterns is not easy to specify because of the variety of nuances associated with over 300 affective labels, and the difficulties associated with attempting to separate the expression of these emotional/attitudinal states from their semantic, grammatical and pragmatic contexts. Researchers have devised a variety of binaural listening tasks with happy, sad and angry stimuli, for RHD, LHD and normal subjects, which have differed markedly in linguistic complexity. Tompkins and Mateer (1985) outlined the prerequisite task processing skills that they believe must be at least partially intact to interpret narrative mood in paragraphs: comprehension of the verbal message; comprehension of the attitude implied by the verbal message; ability to extract intonational information from the message; and the ability to assign affective meaning to the intonation.

Table 2.7.1

Helpfulness of Linguistic Context

Study Author	Year	Subject Groups	Mode of Presentation	Type & Helpfulness of Linguistic Context
Tucker et al.	1977	LHD, RHD	Sound field	Neutrally-worded sentences; No
Heilman et al.	1984	LHD, RHD, NC	Binaural, via headphones	Filtered emotional contours; No
Van Lancker & Sidtis	1992	LHD, RHD, NC	Sound field	Neutrally-worded sentences; No
Bowers et al.	1987	LHD, RHD, NC	Sound field	Emotionally-worded sentences; Yes
Pell	1998	LHD, RHD, NC	Sound field	Neutrally-worded sentences; No
Shipley-Brown et al.	1988	Normals	Dichotic via headphones	Neutrally-worded sentences; No
Ley & Bryden	1982	Normals	Dichotic via headphones	Neutrally-worded sentences; No
Tompkins	1991a	LHD, RHD, NC	Binaural, via headphones	Emotionally-worded stories; Yes

Note. LHD = Left Hemisphere Damage; RHD = Right Hemisphere Damage; NC = Normal Controls

The rationale underlying the present study was to systematically subtract linguistic material from each successive affective information identification task presented to the three subject groups, under three conditions:

1. The narrative condition: Short narratives relating one of four explicitly stated and intoned intended moods (happy, sad, angry , or neutral), ending in a neutrally-worded target phrase which is congruently intoned.

2. The phrase condition: A different production of the same neutrally-worded target phrase as condition one, intoned with one of four affective contours (happy, sad, angry, or neutral).

3. The contour condition: A different production of the same neutrally-worded target phrase as in condition one and two, with all useful segmental cues filtered, leaving only the four affective intonation contours (happy, sad, angry , or neutral) available for processing.

The narratives (ten to twelve words long) and the target phrase (three words) were made shorter than those in all the research referenced above, in order to reduce the load on hemisphere-damaged subjects' short term memory and to accommodate their residual hemispheric functions. They were still long enough to provide a plausible linguistic context and to yield sufficient acoustic cues to signal specific affective intonation contours (happy, angry, sad and neutral) that were almost 100% identifiable by normals.

What was different about this study and what did it add? The design of this study was unique in that there were three interrelated linguistic conditions (narrative, phrase, and contour), four emotions conveyed (happy, sad, angry and neutral), and three groups tested (LHD, RHD and normal controls). This study thereby contributed a substantially broader response matrix (three by three by four) than previous studies by which to evaluate affective intonation processing outcomes.

What did this study predict? If the parallel processing hypothesis were true, normal subjects should perform better than the hemisphere-damaged groups in all three conditions; LHD subjects might rely upon pitch change information and segment-independent cues, and perform better than the RHD subjects in the phrase and contour conditions; RHD subjects might rely upon duration cues and linguistic redundancy and perform better than the LHD subjects in the narrative condition (Joanette et al., 1990; Tompkins, 1991b; Van Lancker & Sidtis, 1992).

If the task-demand information processing hypothesis were true, normal subjects should perform best of all the groups (but not necessarily perfectly) in each condition; and if all the conditions lend themselves to automatic processing, there should be no differences between the performance of the RHD and LHD groups across conditions. The more effortful the processing per condition, the more likely hemisphere-of-lesion group differences may emerge, especially as RHD subjects have more difficulty interpreting complex affective materials presented orally (Tompkins, 1991a;1991b).

CHAPTER THREE

METHODS

3.1 Subjects

The hemisphere-damaged subject group consisted of 16 adult patients, between 41 and 81 years old, who were recruited from Kings County Hospital Center. Eight had left cerebrovascular accidents (CVAs) and eight had right CVAs. The study also included eight normal controls, between 42 and 79 years old, for a total of 24 subjects (Tables 3.1.1 and 3.1.2.). The normal subjects were recruited from among the principal investigator's associates at Kings County Hospital Center and the surrounding community. Informed consent was obtained from each subject (Appendix A). Using a questionnaire (Appendix B), the normal subjects reported that they were monolingual English speakers with at least a high-school education, that they were right-hand dominant, and that they had no history of psychiatric illness, substance abuse, neurological damage or uncorrected hearing impairment.

Each hemisphere-damaged subject had a unilateral CVA confirmed by computerized tomographic (CT) scan and neurological examination and was between 1 and 55 months post-onset of the CVA. All hemisphere-damaged subjects presented with upper and/or lower extremity hemiparesis contralateral to the diagnosed hemisphere of lesion. Restricted access to the hemisphere-damaged subjects' medical records limited data to general descriptions of size (small to moderate) and locus of lesion. As with the normal controls, all hemisphere-damaged subjects' prior medical histories were negative for uncorrected hearing impairment, previous neurological insult, psychiatric illness, dementia or substance abuse. All hemisphere-damaged subjects were evaluated by a speech-language pathologist, using the Boston Diagnostic Aphasia Examination (BDAE), (Goodglass & Kaplan, 1983). Severity of the LHD subjects' speech and language impairments was rated (Table 3.1.2) using the BDAE Aphasia Severity Rating Scale (Goodglass & Kaplan, 1983) as follows: Moderately severe (2)- "Conversation about familiar subjects is possible with help from the listener. There are frequent failures to convey the idea, but patient shares the burden of communication with the examiner." Mild to moderate (3)- "The patient can discuss most everyday problems with little or no assistance. Reduction of speech and/or comprehension, however, makes conversation about certain material difficult or impossible." Mild (4)- "Some obvious loss of fluency in speech or facility of comprehension, without significant limitation on ideas expressed or form of expression."

The group ranges, means and standard deviations for the subject characteristic variables are listed in Table 3.1.1. One-way ANOVAs were performed and no significant differences in age, months post-onset of CVA or education level were found among the subject groups ($p > .05$) (Table 3.1.3).

Table 3.1.1

Subject Characteristics by Group

Characteristic	LHD (n=8)	RHD (n=8)	NC (n=8)	All (n=24)
Gender				
Male	4	4	4	12
Female	4	4	4	12
Age				
Range	41-81	43-73	42-79	41-81
Mean (years)	60.88	60.00	56.50	56.13
SD	13.65	10.73	12.28	11.89
Months post onset				
Range	1-55	1-6	NA	1-55
Mean	8.50	2.13	NA	5.31
SD	18.80	1.73	NA	13.31
Education level				
Range	8-12	8-12	12-18	8-18
Mean (years)	11.50	11.50	13.00	12.00
SD	1.41	1.41	2.14	1.77
Locus of lesion				
	2 Frontal	2 Frontal/Parietal	NA	
	4 Left MCA	2 Right MCA	NA	
	2 Basal Ganglia	4 Basal Ganglia	NA	

Note. LHD = Left Hemisphere Damage; RHD = Right Hemisphere Damage; NC = Normal Controls; NA = Not Applicable; MCA = Middle Cerebral Artery

Table 3.1.2

Subject Characteristics by Subject

Subj No.	Gender	Group	Onset months	Age yrs	Educ. yrs	Locus	Aphasia	Severity BDAE
1	Male	LHD	3	57	12	Frontal	Broca's	4
2	Male	LHD	1	61	12	MCA	Broca's	2
3	Male	LHD	55	63	12	MCA	Broca's	3
4	Male	LHD	2	76	12	MCA	Broca's	2
5	Female	LHD	2	41	12	MCA	Broca's	3
6	Female	LHD	2	45	8	Frontal	Anomic	3
7	Female	LHD	2	63	12	B.G.	Broca's	2
8	Female	LHD	1	81	12	B.G.	Anomic	4
9	Male	RHD	6	43	12	B.G.	NA	NA
10	Male	RHD	1	51	12	F/P	NA	NA
11	Male	RHD	2	57	12	MCA	NA	NA
12	Male	RHD	2	73	12	MCA	NA	NA
13	Female	RHD	1	55	12	F/P	NA	NA
14	Female	RHD	1	60	8	B.G.	NA	NA
15	Female	RHD	1	68	12	B.G.	NA	NA
16	Female	RHD	3	73	12	B.G.	NA	NA

Table 3.1.2 (continued)

Subject Characteristics by Subject

Subj No.	Gender	Group	Onset months	Age yrs	Educ. yrs	Locus	Aphasia	Severity BDAE
17	Male	NC	NA	48	12	NA	NA	NA
18	Male	NC	NA	52	12	NA	NA	NA
19	Male	NC	NA	54	12	NA	NA	NA
20	Male	NC	NA	79	12	NA	NA	NA
21	Female	NC	NA	42	14	NA	NA	NA
22	Female	NC	NA	48	18	NA	NA	NA
23	Female	NC	NA	60	12	NA	NA	NA
24	Female	NC	NA	69	12	NA	NA	NA

Note. LHD = Left Hemisphere Damage; RHD = Right Hemisphere Damage
NC = Normal Controls; MCA = Middle Cerebral Artery;
B.G. = Basal Ganglia; F/P = Frontoparietal; NA = Not Applicable
BDAE Impairment Severity Rating Scale:
(2) = Moderately severe; (3) = Mild to moderate; (4) = Mild

Table 3.1.3

ANOVA Results for Group Differences

Effect	N	df	F	p-level
Age	24	(2,21)	.28	.76
Months Post-Onset	16	(1,14)	.91	.36
Education Level	24	(2,21)	2.10	.15

3.2 Materials

Six sets of four target sentences were initially developed. Each sentence in each set was presented in three linguistic conditions (narrative, phrase and contour) and was spoken to convey four different emotions (happy, sad, angry , or neutral). These sentences were formulated in consideration of at least "average" imagery, concreteness, meaningfulness, number of attributes, and frequency of occurrence in English (Paivio, Yuille, & Madigan, 1968; Toglia & Battig, 1978); simply phrased, active tense grammatical structure (Collier, Kuiken, & Enzle, 1982); and appropriateness for use with RHD and LHD subjects (Wechsler, 1973; Schlanger, Schlanger & Gerstman, 1976; Semenza, Pasini, Zettin, Tonin, & Portolan, 1986; Ostrove, Simpson & Gardner, 1990). Appendix C contains a detailed analysis of the imagery, concreteness, number of attributes, and frequency of occurrence ratings in English of the 24 target sentences.

For the purposes of validation, a preliminary tape recording of 24 emotionally-worded short narratives, 24 emotionally-intoned neutrally-worded phrases, and 24 affective contours, was made by a 45-year-old female speaker, spoken in standard American English at a normal volume and rate of speech. The affective contours were generated by the same adult female speaker appropriately intoning/humming the target phrase with the target emotion (Lalande, Braun, Charlebois & Whitaker, 1992). Each set consisted of randomized affective material representing the verbal expression of happiness, sadness, anger, or no emotion/neutral, for a total of seventy-two stimulus items. The inter-stimulus and inter-task intervals were both five seconds.

Validation judgments of the identifiability of the different emotions under the different linguistic conditions, recognizability of the target phrases as plausible examples of happy, sad, angry and neutral intonation patterns, and, the salience of the narratives' semantic features, were obtained first from five normal adults listening in sound field at a comfortable level. The three target sentence sets which yielded 90% or better correct affective intonation identification scores from this validation process were chosen for presentation in this study. Set one was predominantly cluster six, above average in familiarity, concreteness and imagery; set two was cluster four, relatively familiar, below average in concreteness and imagery; and set three was predominantly cluster two, highly abstract but also highly familiar. Thus the semantic dimensions of the narrative and phrase conditions reflected a range of standardized attributes (Appendix C) .

For the study, a separate tape recording of the three validated target sentence sets (each consisting of four emotionally-worded short narratives, four emotionally-intoned neutrally-worded sentences, and four affective contours), spoken three times each at a normal volume and rate of speech, was made by the same adult female speaker. Contours with obscured speech intelligibility were phonated emotionally by the same adult female humming each syllable of each target phrase with a closed mouth (Lalande et al., 1992). The completed tape contained three different tokens of the same stimulus recorded in randomized order, for a total of 108 sentences, and was re-validated by two of the five normal adults who had previously served as validators, with affective intonation identification scores averaging 94% correct. The order of presentation is listed in Appendix D. There was an inter-stimulus and an inter-condition interval of seven seconds.

In addition, the 108 recorded sentences were acoustically analyzed to obtain their relative average intensity (in decibels), average fundamental frequency (fo, in Hertz), and average duration (in seconds) for comparison purposes, using the Kay Elemetrics Computerized Speech Lab (Appendices E1, E2 and E3). The means of these relative acoustic measurements appear in Table 3.2.1. Two one-way MANOVAs were also performed, one using emotion (happy, sad, angry and neutral) as the independent variable and mean acoustic measures as the dependent variable, and another using linguistic condition (narrative, phrase and contour) as the independent variable and mean acoustic measures as the dependent variable ($p < .05$) (Table 3.2.2). The emotion MANOVA revealed no significant differences in intensity, fo, or duration. The linguistic condition MANOVA and subsequent Scheffé post-hoc tests revealed significant differences in intensity and duration (Table 3.2.3). The contour condition was significantly greater in amplitude than both the narrative and phrase conditions, and the narrative condition was significantly longer in duration than both the phrase and contour conditions.

Table 3.2.1

Means of Acoustic Parameters of Stimuli by Emotion and Linguistic Condition

Emotion	Linguistic Condition	Average Intensity in Decibels	Average fo in Hertz	Average Duration in Seconds
Happy	Narrative	63.23	206.27	3.45
	Phrase	65.65	217.49	.98
	Contour	69.71	226.33	.97
Sad	Narrative	59.39	180.64	3.65
	Phrase	64.32	208.47	1.09
	Contour	72.60	204.44	1.35
Angry	Narrative	64.39	191.93	3.39
	Phrase	65.02	207.67	1.01
	Contour	74.67	196.82	1.00
Neutral	Narrative	59.19	188.70	2.79
	Phrase	62.46	210.20	.86
	Contour	71.10	213.73	1.06

Table 3.2.2

MANOVA Results for Acoustic Parameter Differences

Effect	Wilks' Lambda	Rao's R	df 1	df 2	p-level
Emotion	.23	1.34	9	14	.29
Condition	.007	24.68	6	14	.000001 *

Table 3.2.3

Scheffé Results for Main Effect of Linguistic Condition MANOVA

Variable	Narrative	Phrase	Contour
Intensity	.23	.23	.002 *
Pitch	.07	.07	.99
Duration	.000001 *	.82	.82

3.3 Procedures

Individual subjects were tested binaurally at a comfortable listening level, in sound field, in a single experimental session that lasted approximately 30 minutes, in a room free of auditory distractions. Each subject was asked to listen carefully to several practice items and then to the target stimuli and to report orally to the examiner the emotion she/he thought was expressed by what she/he had just heard: "happy," "angry," "sad," or "no emotion." Subjects were also instructed to guess if they were unsure. The order of presentation for each subject was: study sets one, two, and three, narratives, phrases, and contours (Appendix D). Each subject was reminded of the instructions between sets. Subjects (especially LHD subjects with effortful speech) were also given the option of pointing to an 8.5" x 11" cue card which was placed in view of all the subjects with the words "happy," "angry," "sad," or "no emotion," printed vertically, to remind them of possible choices of emotions conveyed during each of the conditions. The examiner marked each of the subject's responses next to the printed text of the stimuli on a score sheet concealed from the subject.

Immediately before any listening tasks commenced, and again immediately after the listening tasks ended, all subjects were asked to rate their current state of mind by choosing one of three labeled black-and-white line drawings: one depicting a happy facial expression, one depicting a sad facial expression, or one depicting a neutral facial expression. This mood screening device was chosen to aid in detecting biased responses, especially among RHD subjects, who often “exhibit affective abnormalities” (Brownell et al., 1994) or “appear indifferent” (Tucker et al., 1977).

CHAPTER FOUR

RESULTS

Data were tallied from the score sheets of all 24 subjects and analyzed utilizing the CSS Statistica basic statistics and ANOVA/MANOVA programs (STATISTICA, 1995) . An alpha level of .05 was used for all statistical tests.

A three-way analysis of variance was performed using group (left CVA, right CVA and normal) as the independent (between-groups) variable and number scored correct as the dependent (repeated measures) variable. Linguistic condition (narrative, phrase and contour), and, emotion (happy, sad, angry and neutral) were the within-group variables (Table 4.1.1).

4.1 Effect of Group

The three-way ANOVA revealed a significant main effect for group [$F(2, 21) = 19.51$; $p < .000016$]. An inspection of the group means and standard deviations shows that the normal controls performed better than both CVA groups across all three linguistic conditions (Tables 4.1.2 and 4.1.3). For the main effect of group, Scheffé post hoc tests revealed that the normal subjects' mean score was significantly higher than both the left CVA subjects' ($p < .000064$) and the right CVA subjects' ($p < .000183$).

The difference between the left CVA and the right CVA subjects' mean scores was not significant (Table 4.1.4 and Figure 4.1.1).

Table 4.1.1

Summary of All Effects, Three-Way Group ANOVA N=24

Effect	df	F	p-level
Group	(2, 21)	19.51	.000016 *
Linguistic Condition	(2, 42)	39.08	.000000 *
Emotion	(3, 63)	5.41	.002253 *
Group x Linguistic Condition	(4, 42)	2.41	.063775
Group x Emotion	(6, 63)	5.43	.000142 *
Linguistic Condition x Emotion	(6, 126)	2.91	.010937 *
Group x Linguistic Condition x Emotion	(12, 126)	2.63	.003660 *

Table 4.1.2

Group Score Means. Mean number correct on the nine item tasks.

Condition	Left CVA N = 8	Right CVA N = 8	Normal N = 8	All Groups N = 24
Narrative Happy	3.50	8.00	8.63	6.71
Narrative Sad	1.88	6.38	8.00	5.42
Narrative Angry	6.00	7.63	8.75	7.46
Narrative Neutral	6.38	1.13	6.75	4.75
Phrase Happy	2.25	1.75	5.00	3.00
Phrase Sad	2.75	3.13	6.13	4.00
Phrase Angry	2.50	4.13	8.00	4.88
Phrase Neutral	5.25	2.50	6.50	4.75
Contour Happy	1.50	1.25	5.88	2.88
Contour Sad	2.63	3.25	3.50	3.13
Contour Angry	2.75	4.75	8.75	5.42
Contour Neutral	5.25	1.75	3.25	3.42

Table 4.1.3

Group Score Standard Deviations.

Condition	Left CVA N = 8	Right CVA N = 8	Normal N = 8	All Groups N = 24
Narrative Happy	4.57	1.31	0.74	3.53
Narrative Sad	3.09	2.97	1.77	3.68
Narrative Angry	3.63	3.11	0.71	2.90
Narrative Neutral	3.02	1.25	3.62	3.76
Phrase Happy	2.19	2.31	2.98	2.81
Phrase Sad	2.82	2.30	3.14	3.06
Phrase Angry	2.78	2.36	1.60	3.22
Phrase Neutral	2.92	1.93	3.78	3.31
Contour Happy	2.14	2.05	3.64	3.38
Contour Sad	3.02	2.25	2.27	2.46
Contour Angry	2.12	2.96	0.71	3.27
Contour Neutral	3.41	2.43	3.11	3.23

Table 4.1.4

Scheffé Results: Main Effect of Group

Group	Left CVA 3.55	Right CVA 3.80	Normal 6.59
Left CVA		.899064	.000064 *
Right CVA	.899064		.000183 *
Normal	.000064 *	.000183 *	

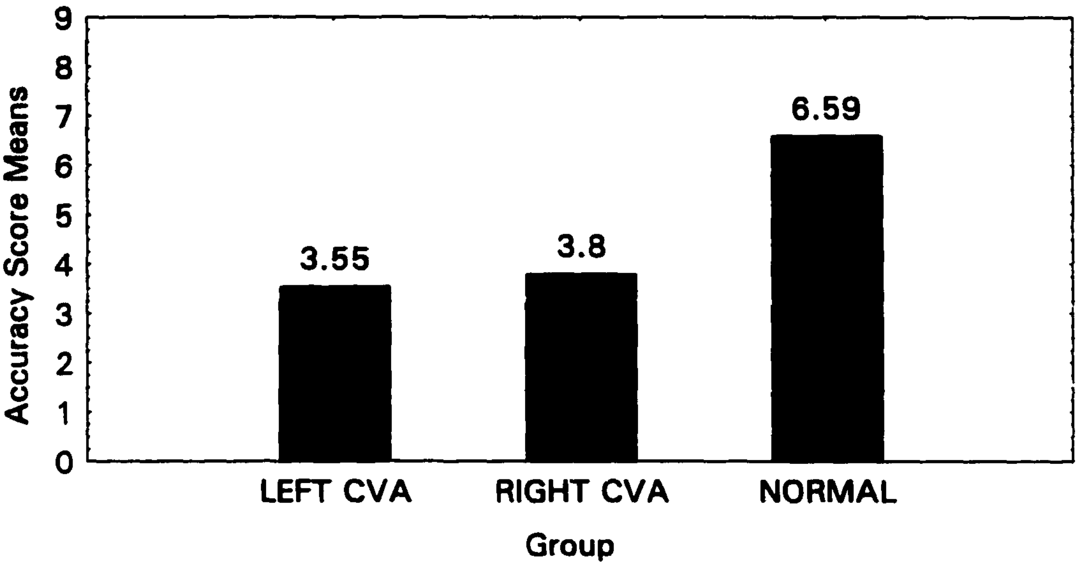

Figure 4.1.1 Plot of Means, Main Effect of Group

4.2 Effect of Linguistic Condition

The three-way ANOVA revealed a significant main effect for linguistic condition [$F(2, 42) = 39.08$; $p < .000000$]. Specific effects tests confirmed the univariate significant results for linguistic condition at $p < .00001$ (Table 4.2.1). Scheffé post hoc tests revealed that for the main effect of linguistic condition, the narrative mean score was significantly higher than the phrase or contour mean scores (both $p < .000000$); the difference between the phrase and contour condition mean scores was not significant (Table 4.2.2 and Figure 4.2.1).

Table 4.2.1

Specific Effects Testing: Main Effect of Linguistic Condition

Test	Value	p-level
Wilks' Lambda	.24578	
Rao R Form 2 (2, 20)	30.68716	.000001 *
Pillai-Bartlett Trace	.75422	
V (2, 20)	30.68716	.000001 *

Table 4.2.2

Scheffé Results: Main Effect of Linguistic Condition

Linguistic Condition	Narrative 6.08	Phrase 4.16	Contour 3.71
Narrative		.000000 *	.000000 *
Phrase	.000000 *		.302335
Contour	.000000 *	.302335	

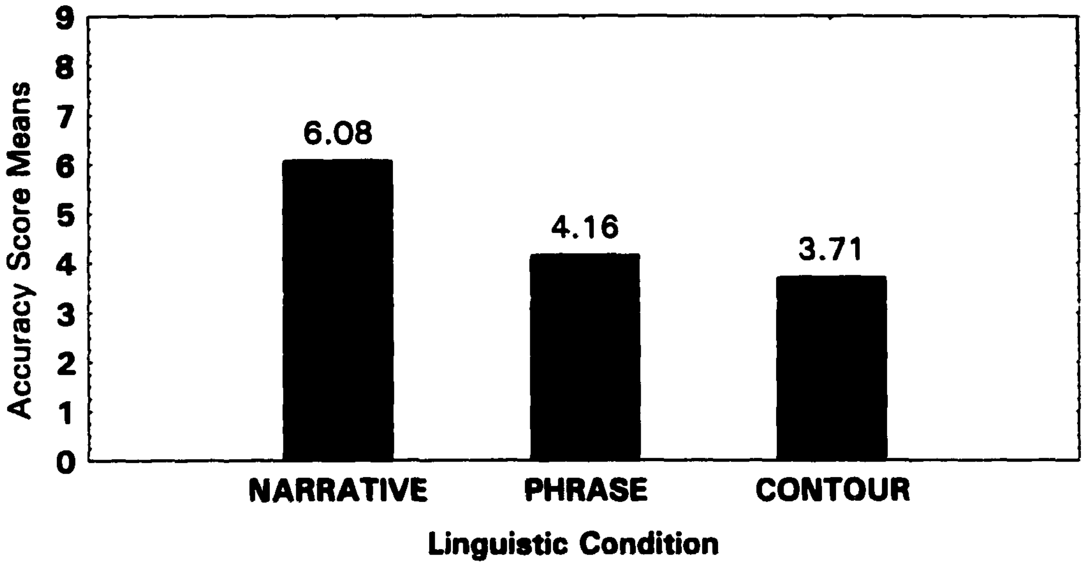

Figure 4.2.1 Plot of Means, Main Effect of Linguistic Condition

4.3 Effect of Emotion Conveyed

The three-way ANOVA revealed a significant main effect for emotion [$F(3, 63) = 5.41$; $p < .002253$]. Specific effects tests confirmed the univariate significant results for emotion at $p < .0013$ (Table 4.3.1). Scheffé post hoc tests revealed that for the main effect of emotion, the mean score for "angry" was significantly higher than those for "happy" ($p < .0157$), "sad" ($p < .0146$) and "neutral" ($p < .0272$) (Tables 4.3.2 and Figure 4.3.1). Across conditions, the emotion of anger was identified significantly more accurately than those of happiness, sadness and neutrality, and there were no other significant differences between happiness and sadness, happiness and neutral, or sadness and neutral.

Table 4.3.1

Specific Effects Testing: Main Effect of Emotion

Test	Value	p-level
Wilks' Lambda	.445127	
Rao R Form 2 (3, 19)	7.894819	.001277 *
Pillai-Bartlett Trace	.554873	
V (3, 19)	7.894819	.001277 *

Table 4.3.2

Scheffé Results: Main Effect of Emotion

Emotion	Happy 4.19	Sad 4.18	Angry 5.92	Neutral 4.31
Happy		.999995	.015652 *	.997337
Sad	.999995		.014578 *	.996224
Angry	.015652 *	.014578 *		.027161 *
Neutral	.997337	.996224	.027161 *	

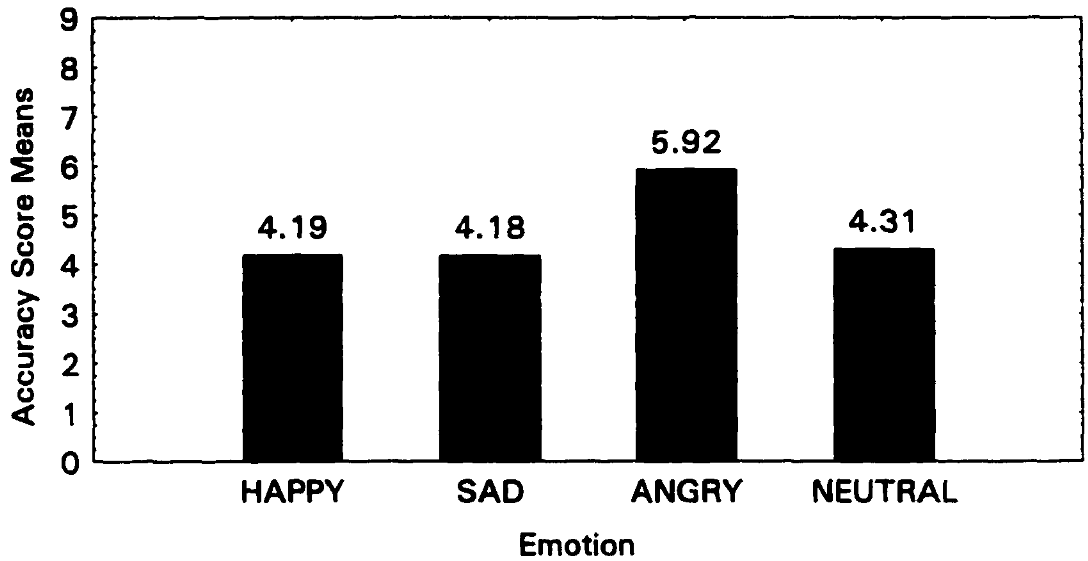

Figure 4.3.1 Plot of Means, Main Effect of Emotion

4.4 Effect of Mood of Subject

A separate three-way analysis of variance was performed using mood (reported by each subject before testing as being happy or neutral) as the independent (between-groups) variable and number scored correct as the dependent (repeated measures) variable. Linguistic condition (narrative, phrase and contour), and, emotion (happy, sad, angry and neutral) were the within-group variables. (Table 4.4.1). The ANOVA results revealed significant main effects for linguistic condition, [$F(2, 44) = 32.60$; $p < .000000$] and emotion [$F(3, 66) = 4.63$; $p < .005332$]. Scheffé post hoc tests revealed that for the main effect of emotion, the mean score for "angry" was significantly higher than those for "happy" ($p < .0226$), and "sad" ($p < .0122$) but not for "neutral" ($p <. 1145$), for both the happy-feeling and the neutral-feeling subjects (Table 4.4.4). Across mood of subject, the emotion of anger was identified significantly more accurately than those of happiness and sadness, and there were no other significant differences between happiness and sadness, happiness and neutral, sadness and neutral, or anger and neutral. However, an inspection of the group means and standard deviations shows that the subjects who reported being in a happy mood performed non-significantly better than the subjects who reported being in a neutral mood on the happy stimuli;

similarly, the subjects who reported being in a neutral mood performed non-significantly better than the subjects who reported being in a happy mood on the neutral stimuli (Tables 4.4.2 and 4.4.3).

Table 4.4.1

Summary of All Effects, Three-Way Mood ANOVA N=24

Effect	df	F	p-level
Mood	(1, 22)	.71	.408827
Linguistic Condition	(2, 44)	32.60	.000000 *
Emotion	(3, 66)	4.63	.005332 *
Mood x Linguistic Condition	(2, 44)	.72	.492892
Mood x Emotion	(3, 66)	2.98	.037406 *
Linguistic Condition x Emotion	(6, 132)	1.99	.070181
Mood x Linguistic Condition x Emotion	(6, 132)	.53	.785920

Table 4.4.2

Mood Score Means. Mean number correct on the nine item tasks.

Condition	Happy Mood N = 15	Neutral Mood N = 9	All Groups N = 24
Narrative Happy	7.33	5.67	6.71
Narrative Sad	6.40	3.78	5.42
Narrative Angry	7.27	7.78	7.46
Narrative Neutral	4.07	5.89	4.75
Phrase Happy	3.33	2.44	3.00
Phrase Sad	5.13	2.11	4.00
Phrase Angry	5.00	4.67	4.88
Phrase Neutral	4.73	4.78	4.75
Contour Happy	3.33	2.11	2.88
Contour Sad	3.53	2.44	3.13
Contour Angry	5.67	5.00	5.42
Contour Neutral	2.80	4.44	3.42

Table 4.4.3

Mood Score Standard Deviations.

Condition	Happy Mood N = 15	Neutral Mood N = 9	All Groups N = 24
Narrative Happy	2.97	4.30	3.53
Narrative Sad	3.33	3.83	3.68
Narrative Angry	2.94	2.99	2.90
Narrative Neutral	3.51	4.08	3.76
Phrase Happy	3.27	1.88	2.81
Phrase Sad	2.95	2.32	3.06
Phrase Angry	3.72	2.35	3.22
Phrase Neutral	3.53	3.11	3.31
Contour Happy	3.62	2.98	3.38
Contour Sad	2.42	2.51	2.46
Contour Angry	3.22	3.50	3.27
Contour Neutral	3.41	2.79	3.23

Table 4.4.4

Scheffé Results: Main Effect of Emotion for the Mood ANOVA

Emotion	Happy 4.04	Sad 3.90	Angry 5.89	Neutral 4.45
Happy		.996542	.022572 *	.916561
Sad	.996542		.012159 *	.825188
Angry	.022572 *	.012159 *		.114518
Neutral	.916561	.825188	.114518	

4.5 Interactions

The three-way group ANOVA revealed significant two-way interactions for group x emotion [$F(6, 63) = 5.43$; $p < .000142$] and linguistic condition x emotion [$F(6,126) = 2.91$; $p < .010937$]; and a significant three-way interaction for group x linguistic condition x emotion [$F(12, 126) = 2.63$; $p < .003660$]. The interaction for group x linguistic condition was not significant [$F(4, 42) = 2.41$; $p < .0638$] (Table 4.1.1).

Specific effects tests confirmed the univariate significant results for the interaction of linguistic condition x emotion at $p < .009$, (Table 4.5.1) and the interaction of group x linguistic condition x emotion at $p < .002$ (Table 4.5.2).

Scheffé post hoc tests revealed that for the non-significant interaction of group x linguistic condition, the mean score for the normal controls narrative was significantly higher than all the other group condition means except that for normal control phrase (Table 4.5.3).

Scheffé post hoc tests also revealed that for the significant interaction of linguistic condition x emotion, the mean score for the happy narrative was significantly higher than the happy phrase, and the happy, sad, and neutral contour means (Column 1, Table 4.5.4 and Figure 4.5.2) also, the mean score for the angry narrative was significantly higher than the happy phrase, the sad phrase, and the happy, sad, and neutral contour means (Column 3, Table 4.5.4 and Figure 4.5.2)

Figure 4.5.1, the plot of means for the interaction of group x emotion, shows that for the neutral stimuli, the normal controls and the left CVA group performed significantly better that the right CVA group. For the happy, sad, and angry stimuli however the right CVA group performed more like the normal controls.

Figures 4.5.3 a, b and c, the plot of means for the interactions of group x linguistic condition x emotion, show that all three groups varied within group as to their mean accuracy scores across linguistic conditions and emotions. For example, the left CVA group scored higher in the neutral phrase and contour conditions than in the happy and sad narratives (Figure 4.5.3a); the right CVA group scored higher in the angry phrase and contour conditions than in the neutral narratives (Figure 4.5.3b); and the normal controls scored highest in the angry narrative and contour conditions (Figure 4.5.3c).

Figure 4.5.4, the plot of means for the interaction of group x linguistic condition shows that although both left and right hemisphere-damaged groups performed significantly worse than the normal controls in all three linguistic conditions, the right hemisphere-damaged group performed (non-significantly) better than the left hemisphere-damaged group in the narrative condition, and, the left hemisphere-damaged group performed (non-significantly) better than the right hemisphere-damaged group in the phrase condition and the contour condition.

The separate three-way mood ANOVA revealed a significant two-way interaction for mood x emotion [$F(3, 66) = 2.98$; $p < .037406$] and a non-significant two-way interaction for linguistic condition x emotion [$F(6, 132) = 1.99$; $p < .070181$]. (Table 4.4.1). Figure 4.5.5, the plot of means for the interaction of subject's mood x emotion, shows that across mood of subject, the angry stimuli accuracy score mean (5.89) was significantly higher than those for the happy (4.04) and sad (3.90) stimuli, and non-significantly higher than the neutral stimuli mean (4.45).

Table 4.5.1

Specific Effects Testing: Linguistic Condition x Emotion

Test	Value	p-level
Wilks' Lambda	.384481	
Rao R Form 2 (6, 16)	4.269083	.009342 *
Pillai-Bartlett Trace	.615519	
V (6, 16)	4.269083	.009342 *

Table 4.5.2

Specific Effects Testing: Group x Linguistic Condition x Emotion

Test	Value	p-level
Wilks' Lambda	.194662	
Rao R Form 3 (12, 32)	3.377389	.002922 *
Pillai-Bartlett Trace	1.100036	
V (12, 34)	3.463212	.002143 *

Table 4.5.3

Scheffé Results: Interaction of Group x Linguistic Condition.

Group Condition	Narrative 4.44	Left CVA Phrase 3.19	Contour 3.03
Left CVA Narrative		.61	.44
Left CVA Phrase	.61		1.00
Left CVA Contour	.44	1.00	
Right CVA Narrative	.51	.004 *	.002 *
Right CVA Phrase	.30	.99	1.00
Right CVA Contour	.20	.99	.99
Normal Narrative	.000 *	.000 *	.000 *
Normal Phrase	.07	.000 *	.000 *
Normal Contour	.90	.033 *	.016 *

Table 4.5.3 (continued)

Group Condition	Right CVA Narrative 5.78	Right CVA Phrase 2.88	Right CVA Contour 2.75
Left CVA Narrative	.51	.30	.20
Left CVA Phrase	.004 *	.99	.99
Left CVA Contour	.002 *	1.00	.99
Right CVA Narrative		.001 *	.000 *
Right CVA Phrase	.001 *		1.00
Right CVA Contour	.000 *	1.00	
Normal Narrative	.021 *	.000 *	.000 *
Normal Phrase	.99	.000 *	.000 *
Normal Contour	.99	.007 *	.004 *

Group Condition	Normal Narrative 8.03	Normal Phrase 6.41	Normal Contour 5.34
Left CVA Narrative	.000 *	.07	.90
Left CVA Phrase	.000 *	.000 *	.032 *
Left CVA Contour	.000 *	.000 *	.016 *
Right CVA Narrative	.021 *	.99	.99
Right CVA Phrase	.000 *	.000 *	.007 *
Right CVA Contour	.000 *	.000 *	.004 *
Normal Narrative		.25	.002 *
Normal Phrase	.25		.79
Normal Contour	.002 *	.79	

Table 4.5.4

Scheffé Results: Interaction of Linguistic Condition x Emotion.

Condition Emotion	Narrative Happy 6.71	 Sad 5.42	 Angry 7.46	 Neutral 4.75
Narrative Happy		.98	.99	.73
Narrative Sad	.98		.67	.99
Narrative Angry	.99	.67		.21
Narrative Neutral	.73	.99	.21	
Phrase Happy	.007 *	.39	.000 *	.86
Phrase Sad	.21	.97	.019 *	.99
Phrase Angry	.81	.99	.28	1.00
Phrase Neutral	.73	.99	.21	1.00
Contour Happy	.004 *	.30	.000 *	.79
Contour Sad	.011 *	.48	.000 *	.91
Contour Angry	.98	1.00	.67	.99
Contour Neutral	.035 *	.70	.001 *	.98

Table 4.5.4 (continued)

Condition Emotion	Phrase Happy 3.00	Sad 4.00	Angry 4.88	Neutral 4.75
Narrative Happy	.007 *	.21	.81	.73
Narrative Sad	.39	.97	.99	.99
Narrative Angry	.000 *	.019 *	.28	.21
Narrative Neutral	.86	.99	1.00	1.00
Phrase Happy		.99	.79	.86
Phrase Sad	.99		.99	.99
Phrase Angry	.79	.99		1.00
Phrase Neutral	.86	.99	1.00	
Contour Happy	1.00	.99	.70	.79
Contour Sad	1.00	.99	.86	.91
Contour Angry	.39	.97	.99	.99
Contour Neutral	1.00	.99	.96	.98

Table 4.5.4 (continued)

Condition Emotion	Contour Happy 2.88	Sad 3.13	Angry 5.42	Neutral 3.42
Narrative Happy	.004 *	.011 *	.98	.035 *
Narrative Sad	.30	.48	1.00	.70
Narrative Angry	.000 *	.000 *	.67	.001 *
Narrative Neutral	.79	.91	.99	.98
Phrase Happy	1.00	1.00	.39	1.00
Phrase Sad	.99	.99	.97	.99
Phrase Angry	.70	.86	.99	.96
Phrase Neutral	.79	.91	.99	.98
Contour Happy		1.00	.30	.99
Contour Sad	1.00		.48	1.00
Contour Angry	.30	.48		.70
Contour Neutral	.99	1.00	.70	

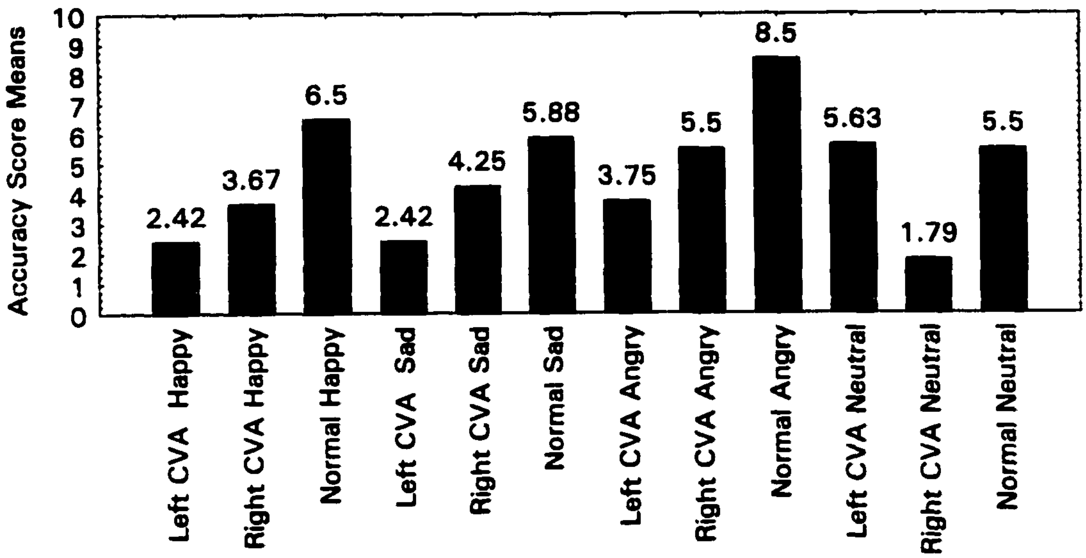

Figure 4.5.1 Plot of Means, Interaction of Group x Emotion

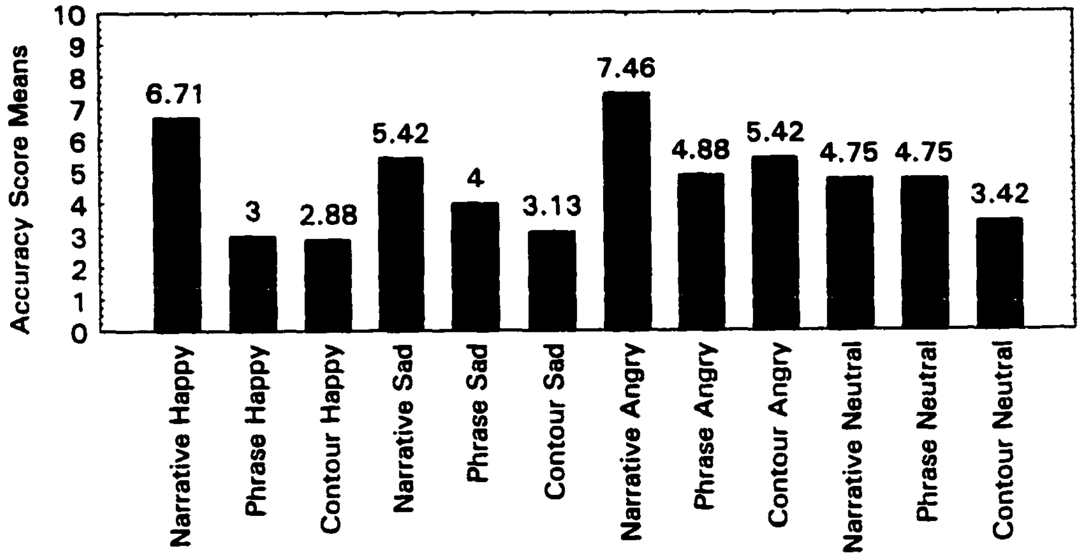

Figure 4.5.2 Plot of Means, Interaction of Linguistic Condition x Emotion

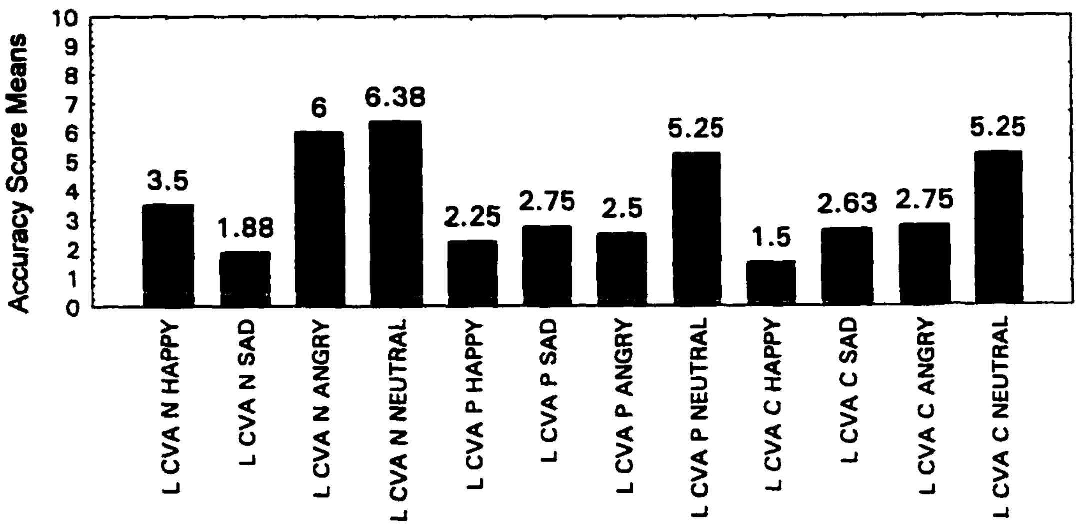

Figure 4.5.3.a Interaction of Group x Linguistic Condition x Emotion

Legend: L = Left, R = Right, NC = Normal, N = Narrative, P = Phrase, C = Contour

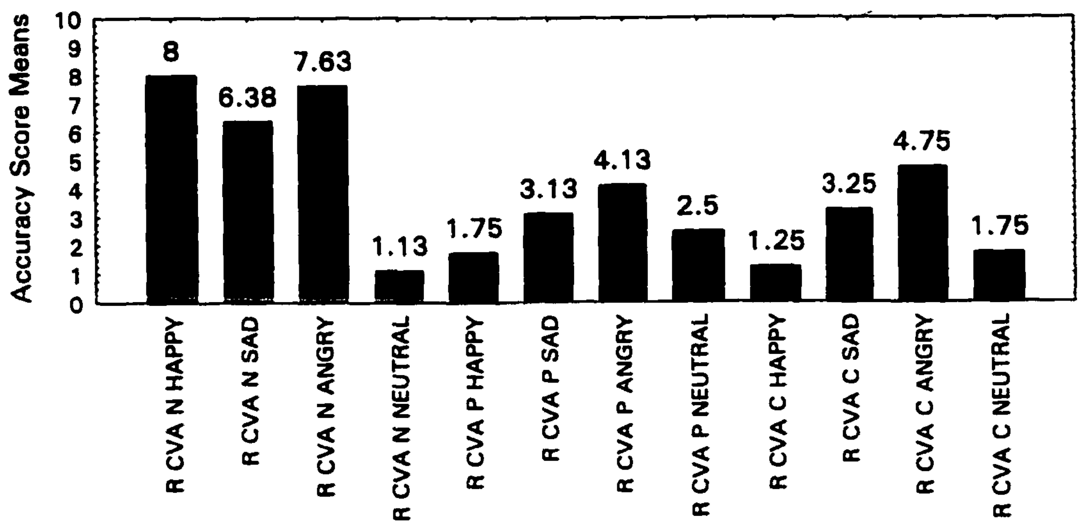

Figure 4.5.3.b Interaction of Group x Linguistic Condition x Emotion

Legend: L=Left, R=Right, NC=Normal, N=Narrative, P=Phrase, C=Contour

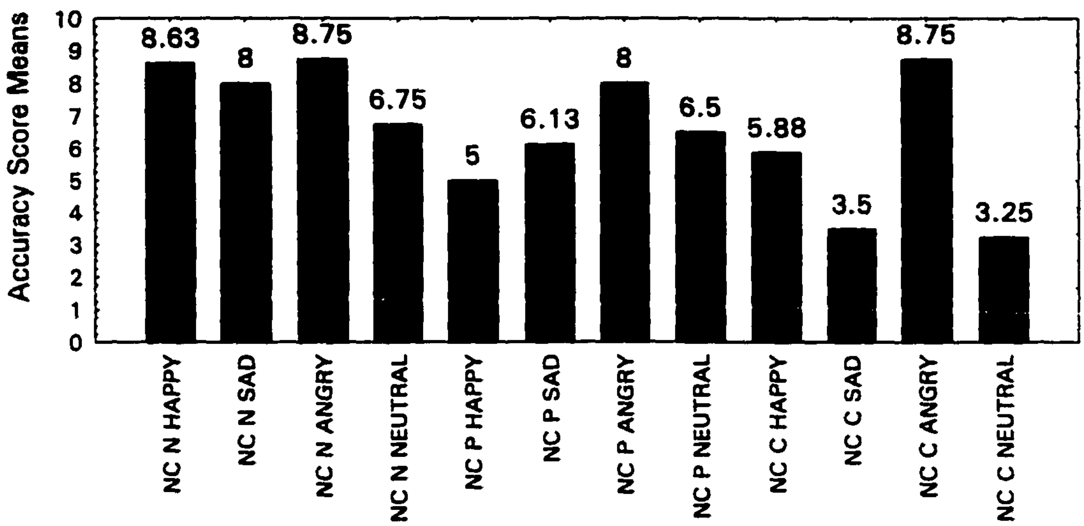

Figure 4.5.3.c. Interaction of Group x Linguistic Condition x Emotion
Legend: L=Left, R=Right, NC=Normal, N=Narrative, P=Phrase, C=Contour

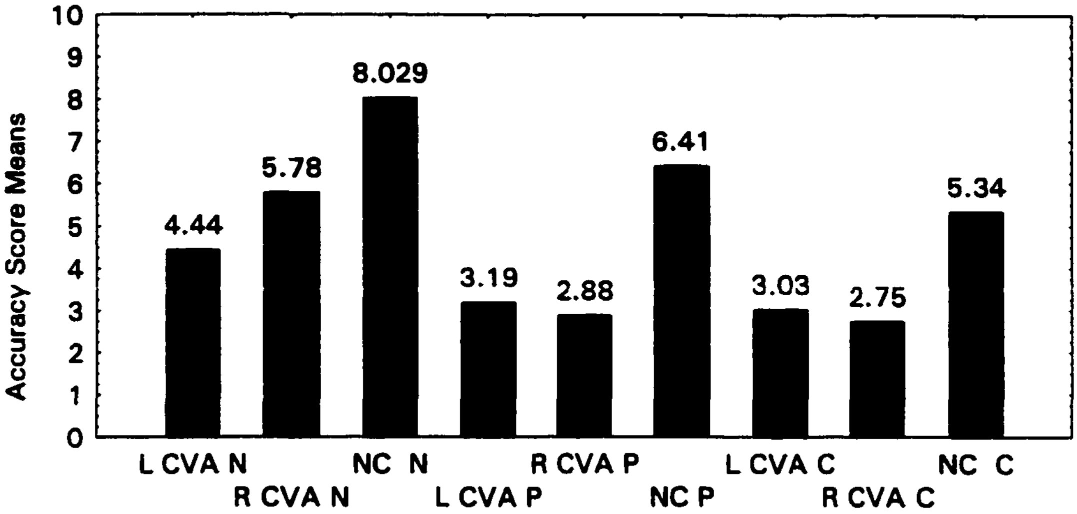

Figure 4.5.4 Plot of Means, Interaction of Group x Linguistic Condition

Legend: L=Left, R=Right, NC= Normal, N=Narrative, P= Phrase, C= Contour

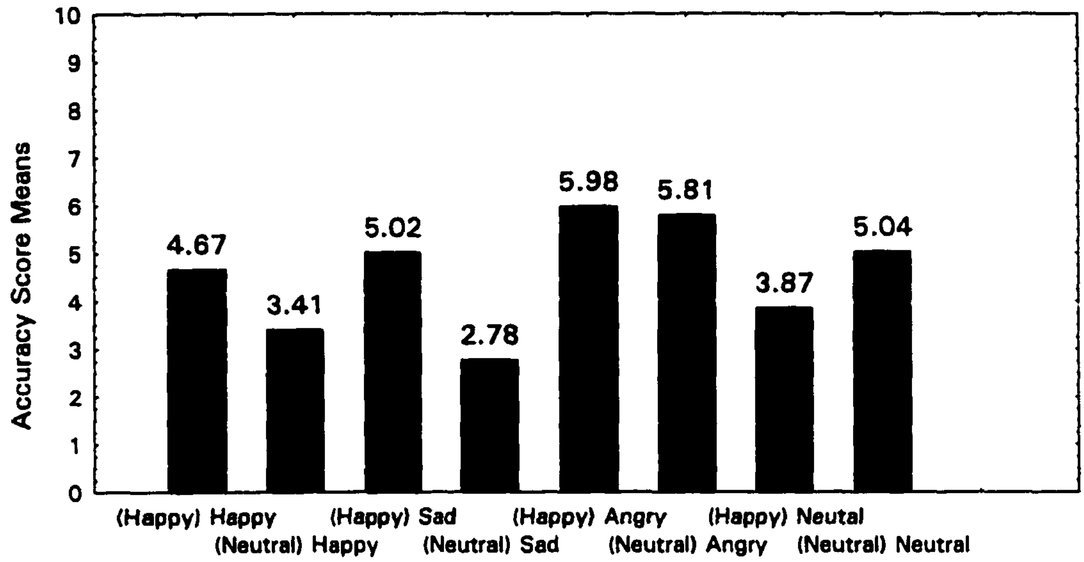

Figure 4.5.5 Plot of Means, Interaction of (Subjects' Mood) x Emotion

CHAPTER FIVE

DISCUSSION

5.1 General Observations

The present study was designed to explore the degree to which the processing of affective intonation is dependent on linguistic context, and how it differs among LHD subjects, RHD subjects and normal controls. Both the parallel processing and task demand information processing theories were put forth as potential predictors of group results. The parallel processing theory suggests that both hemispheres simultaneously process linguistic and acoustic speech components for which each hemisphere is specialized; task demand information processing refers to staged stimulus cue demands on cognitive resources and suggests the retrieval of memory of emotional events plays a part in affective intonation processing. Some of the cognitive skills thought to be necessary for accurate affective identification include at least the partially intact abilities to comprehend the verbal message, to comprehend the attitude implied by the verbal message, to extract intonational information from the message, and to assign affective meaning to the intonation (Tompkins and Mateer ,1985).

What was different about this study and what did it add? The design of this study was unique in that there were three interrelated linguistic conditions (narrative, phrase, and contour), four emotions conveyed (happy, sad, angry and neutral), and three groups tested (LHD, RHD and normal controls). Previous studies have focused instead on only one linguistic or prosodic condition, fewer emotional categories, and only two subject groups, thereby neglecting possible interactions among these variables.

The rationale underlying this study was to subtract linguistic material systematically from each successive affective information identification task presented to LHD, RHD and normal control subject groups. The narratives (ten to twelve words long) and the target phrases (three words) were designed to reduce the load on subjects' short term memory and to accommodate their residual hemispheric functions. They were still long enough to provide a plausible linguistic context and yield sufficient acoustic cues to signal a specific affective intent (happy, angry, sad or neutral). An examination of Table 2.7.1 highlights the helpfulness of emotionally-worded sentences and stories in affective intonation identification.

What did this study predict? If the parallel processing hypothesis were true, normal subjects should have performed better than the hemisphere damaged groups in all three conditions, which they did; LHD subjects may have relied upon pitch change information and segment-independent cues, and performed better than the RHD subjects in the phrase and contour conditions, which they did, non-significantly; and RHD subjects may have relied upon duration/timing cues and linguistic redundancy and performed better than the LHD subjects in the narrative condition, which they did, non-significantly (Joanette et al., 1990; Tompkins, 1991b; Van Lancker & Sidtis, 1992).

If the task-demand information processing hypothesis were true, normal subjects should perform best of all the groups (but not necessarily perfectly) in each condition, which they did; and if all the conditions lend themselves to automatic processing, there should be no differences between the performance of the RHD and LHD groups across the conditions. There were, however, non-significant differences in this study, hinting that the more effortful the processing per condition, the more likely hemisphere-of-lesion group differences would emerge, especially as RHD subjects have more difficulty interpreting complex affective materials presented orally (Tompkins, 1991a;1991b). The discrepancy, however, between the RHD and LHD narrative mean scores is more likely attributable to the LHD subjects' aphasia. It appears that the explanation of the experimental outcome as framed earlier in the parallel processing versus task demand processing paradigm is neither mutually exclusive or exhaustive.

Conclusions must also be tentative considering that this study examined the performance of only 24 subjects, only eight subjects in group. While matching efforts yielded no differences in age, education level, or months post-onset (Table 3.1.3), certain additional subject selection criteria (e.g., handedness, hearing ability) were obtained by report. Each hemisphere-damaged group was heterogeneous with respect to size, type, and locus of lesion (Table 3.1.1). Furthermore, the LHD group was heterogeneous with respect to aphasia severity ratings (Table 3.1.2). In this study, stimuli were designed in order to balance the semantic dimensions of frequency, imagery, and concreteness, within simple syntactic structures, through modest piloting and validation processes involving a small number of listeners. Three tokens of each of three sets, three linguistic conditions and four emotions were provided to each subject for a total of only 108 presentations. On the basis of these disclosures, it is understood that population and measurement generalizations may be limited.

5.2 Specific Findings

Figure 4.1.1 shows the main effect of group: The better performance of the normal controls in comparison to both the left- and right- hemisphere damaged groups, who appear to have equally depressed scores (RHD only slightly better than the LHD). This result supports dual hemisphere involvement (parallel processing) in affective intonation recognition because it has been suggested that emotional prosody, while most likely processed in the right hemisphere, can also enhance the left hemisphere's ability to carry out linguistic decisions (Zurif, 1974). If both hemispheres participate in affective intonation processing, residual hemispheric function deficits after CVA may preclude access to the working and long term memory resources referenced by the task demand theory.

Figure 4.2.1, the plot of means for the main effect of linguistic condition, demonstrates that all three subject groups were best able to identify the affective information in the context of the most numerous segmental and suprasegmental cues in the narrative condition, and that the decrease in segmental information in the phrase and the contour conditions interfered with the accurate identification of the target affect. The contribution of acoustic characteristics to accurate identification appears to be negligible and cannot explain the better narrative scores. For example, Tables 3.2.1 and 3.2.3 show that: narratives and phrases had less amplitude than contours; there were no significant differences in mean fo among the three linguistic conditions, although the narrative did have a lower average fo than the phrases and contours; and the significant difference in duration between the narrative (10 to 12 words) and the phrase and contour conditions (3 words) is explained by stimulus length. This result is also consistent with the parallel processing hypothesis in that the fewer segments for prosodic features to bind to, the more one hemisphere may have to process by itself, with subsequent errors especially for those with hemispheric impairment. This result does not necessarily preclude the possibility that both automatic and effortful processing were also occurring.

Figure 4.3.1 shows that the emotion most accurately identified, across all three conditions, was anger. Again, the acoustic data cannot account for this result. The means of the acoustic parameters of all 108 stimuli listed in Table 3.2.1, and the MANOVA summarized in Table 3.2.2 indicate that the angry stimuli are not significantly louder, higher or lower in Fo , or longer, on average than the other three emotions represented. No clear acoustic reason for the subjects' better identification scores is immediately obvious. Wells, Peppe, and Vance (1995) have suggested that affective intonation patterns are not easy to specify because of the great variety of nuances associated with over 300 affective labels, and the difficulties associated with attempting to separate the expression of these emotional/attitudinal states from their semantic, grammatical and pragmatic contexts. For instance, Pell & Baum (1997b) reported that they were unable to establish a specific basis for their subjects' scores by isolating and analyzing the acoustic properties of the happy, sad, and angry stimuli presented because of the "considerable variability in the way discrete emotions can be expressed vocally." One possible explanation might be that the efficient expression and recognition of anger, rage and fear, associated with the amygdala and extra-amygdalar structures (areas which may have been spared in all of the subjects in this study) are crucial to the survival of humans and other animals (Heilman & Gilmore, 1998; Adolphs & Tranel, 1999).

The significant interaction between group and emotion (Figure 4.5.1) revealed that the LHD subjects and the normals were significantly more accurate in identifying the neutral stimuli (mean scores 5.63 and 5.50 respectively) than the RHD subjects (mean score 1.79). Yet except for the neutral stimuli, RHD subjects performed better than LHD subjects across the other emotions. RHD subjects have been reported to be incorrect and variable when making inferences about emotion (Tompkins & Mateer, 1985; Van Lancker & Sidtis, 1992), and so may have mistakenly assigned an emotion (happy, sad or angry) where none was intended in the neutral stimuli. Conversely, the LHD subjects may have been using the neutral category as an exclusionary one (not happy, sad, or angry) and may have been distracted by and have attended more to the semantic message (Bowers et al., 1987). Since semantic processing is predictably more difficult for LHD aphasic subjects, they may have chosen neutral more often and more correctly than the RHD subjects and the normal controls, by default. For example, a simple error analysis of LHD subjects' accuracy scores for narratives by emotion shows that while the LHD group obtained 71% correctly identified as neutral, the LHD also incorrectly attributed neutrality to 19% of the angry, 36% of the happy, and 58% of the sad narratives

The significant interaction among group, condition and emotion (Figure 4.5.3) reinforces the salience of the main effects of group (normals significantly better than LHD and RHD subjects); linguistic condition (narrative scores higher than phrase and contour); and emotion (angry scores higher than happy, sad and neutral for normals). The non-significant interaction between group and linguistic condition (Figure 4.5.4) reflects a trend in results that is predicted by the parallel processing theory. If both hemispheres contribute, in different ways, to accurate affective intonation processing, then both hemisphere-damaged groups could be impaired, in different ways , in recognizing affective information (Pell, 1998; Pell & Baum, 1997a, 1997b; Van Lancker & Sidtis, 1992). The RHD subjects did non-significantly better than the LHD subjects in the most linguistically loaded condition, the narrative. Depressed LHD subjects' scores in the narrative condition were predictable from the increased demand of syntactic and semantic cues (Pell & Baum, 1997a; Borod et al., 1992), as were the LHD subjects' non-significant better scores than the RHD subjects in the phrase and contour conditions, which contained progressively reduced semantic cues (Zurif, 1974; Ross, Thompson & Yenkosky, 1997). Again these results seem to be more dependent on hemispheric processing than on activating increasingly broader memory references to emotional concepts and events (task demand processing).

The final significant interaction under consideration is that between mood of the subject and emotion correctly identified. Although there was no main effect of mood (Table 4.4.1), and the main effect of emotion was in the higher anger score means (Table 4.4.4), Figure 4.5.5 indicates that the subjects who reported a happy mood during the experiment (n= 15) scored higher on the happy and the sad stimuli than the subjects who reported a neutral mood during the experiment (n=9). Conversely, those in a neutral mood scored higher on the neutral stimuli than those in a happy mood. Although mood of the subject was not a controlled variable in this study, Tompkins, Baumgaertner, Lehman and Fassbinder, (2000) have taken into account subjects' personality factors in the comprehension of complex verbal material in terms of frame of mind and suggestibility especially as they apply to RHD comprehension deficits.

5.3 Clinical Implications and Future Research

The present study was designed to determine the linguistic context conditions under which the processing of affective intonation is most accurate for the normal and the brain-damaged groups and the conditions under which hemisphere of damage is a significant variable.

In this study it has been demonstrated that both hemisphere-damaged groups are impaired relative to normals in the identification of affective information, and that all groups perform best when the semantic and supra-segmental information is maximized. An important clinical implication is that if communicative intent and emotional meaning can be conveyed by both appropriate word selection and congruent affective prosody, CVA patients may be trainable in affective intonation identification tasks towards the development of a useful pragmatic skill: learning how to listen for clues on how others are feeling, and getting an idea when there is a communication breakdown and how to repair it.

One research application might be to immerse hemisphere-damaged patients in highly context-bound materials such as video tapes or role-playing exercises, which would provide the maximum visual, auditory, verbal, prosodic and situational cues to the speakers' intended emotion. The patients could then self-evaluate and report which parts of the presentation were most helpful to them. Future research might also include devising highly context-bound materials to determine which elements of the exercise are best suited to training the individual patient in functional affective information recognition.

As for the higher recognition scores of the angry stimuli across linguistic conditions in this study, another area for future research might be a study of voice quality differences, specifically a detailed analysis of jitter and shimmer as those acoustic values relate to affective intonation identification.

5.4 Conclusions

The present study was designed to explore to the degree to which the processing of affective intonation contours depends on linguistic context , and, how it differs between brain-damaged subjects and normal controls. A more comprehensive combination of subject groups, linguistic conditions and emotions conveyed was employed in this experimental design than in previous studies. The results of this study support a "whole-brain processing" model of affective intonation processing. Each hemisphere's contribution is equally necessary in order for a listener to perceive , extract and interpret segmental and suprasegmental sound patterns (Studdert-Kennedy & Shankweller, 1970; Zurif, 1974; Bowers,et al., 1987). Although there is very strong evidence for right hemisphere dominance for facial, prosodic and lexical emotional perception derived from neuropsychological (Borod et al., 1998), neuroradiological (George et al., 1996; Starkstein, Federoff, Price, Leiguarda, & Robinson, 1994) and psycho-physiological (Spence, Shapiro & Zaidel, 1996) investigations, LHD subjects have also shown significant impairments in identifying affective-prosodic stimuli (Pell, 1998; Van Lancker & Sidtis, 1992; Van Lancker & Sidtis, 1993; Heilman et al., 1984), as they did in this study.

The central paradigm common to all these studies involves the parsing of segmental and suprasegmental information, presumably routing the phonetic, syllabic, and sequential components to the dominant (left) hemisphere, and the intonation cues spread over those components to the right hemisphere. Both hemispheres have been assumed to be engaged at the same time, performing parallel tasks: the left, analytic and linear (Van Lancker & Sidtis, 1992); the right, holistic and integrative (Borod et al., 1992).

It appears that the explanation of the experimental outcome as framed earlier in the parallel processing versus task-demand processing paradigm was neither mutually exclusive or exhaustive. The results of this study were consistent with the parallel processing theory of affective intonation recognition, as well as with the possibility that some degree of both automatic and effortful cognitive strategies might have been used to derive the emotional meaning from the different stimuli, if only the hemispheric damage hadn't gotten in the way. Sequential sound patterns, word meanings, syntax, fundamental frequency, amplitude and duration information can be processed as a gestalt as well as by unitary feature (Emmorey, 1987; Zurif, 1974), depending on individual cognitive styles in the case of normals, and residual hemispheric function in the CVA subjects. This study found that affective information processing was more accurate in a richer linguistic context containing strong semantic cues (the narrative condition), and, that as semantic cues and stimulus decreased (in the phrase and contour conditions), so did the accuracy, particularly of the hemisphere-damaged groups, who were less able than the normals to rely only on shorter, suprasegmental cues.

Appendix A
Informed Consent Form

THE EFFECTS OF CORTICAL AND SUBCORTICAL BRAIN DAMAGE ON THE PROCESSING OF INTONATION IN PATIENTS WHO HAD A STROKE

You are being asked to volunteer in a clinical research study. In order to decide whether or not you wish to participate in this research study, you should understand the design of the study, its benefits and its risks so that you will be able to make an informed decision whether to participate or not. The investigator will answer any questions you might have about this form and the study.

You will be asked to listen to a tape recording of 100 short sentences and indicate what you have heard. Your responses will be studied to determine how the stroke may have affected your understanding of what you hear.

There will be one testing session, lasting less than an hour. The testing will be done at Kings County Hospital at a time convenient to you.

There are no known risks of listening to a taped list of sentences recorded at average loudness. In the event of any injury resulting from research in which you participate, only emergency medical care will be provided; no other compensation is available. Although there are no direct benefits of participating in this study, increased knowledge of your functioning may contribute to the future of therapy for others.

Your responses will be studied in a way that protects your identity. In this study, notations will be made of your age, gender, and other facts about you. These details may be seen only by the investigators and members of the Institutional Review Board. You will not be identified personally in any reports from this study and every effort will be made to keep your identity and medical information confidential.

By signing below, you understand that all procedures are investigational for the purpose of research. You understand that you may withdraw your consent and discontinue participation in this study at any time for any reason without affecting your medical care in any way. You will be given a copy of this signed consent form.

For additional information and answers to any questions you may contact Felicia Gironda, Principal Investigator, at (718) 245-5140 (Speech Pathology Dep't.) and Dr. Lawrence Raphael, Doctoral Faculty Advisor, at (516) 877- 4784.

If you have any questions concerning your rights as a participant in this study you may contact Ms Hilry Fisher , Director of the Office of Sponsored Research, GSUC/CUNY at (212) 642-2059, or the Executive Director of Kings County Hospital at (718) 245-3900.

Subject's Signature: ______________________ Date: ___/___/___.

Principal Investigator's Signature: ______________ Date: ___/___/___.

THE GRADUATE SCHOOL AND UNIVERSITY CENTER, C.U.N.Y., PH.D PROGRAM IN SPEECH AND HEARING SCIENCES, 33 West 42nd St., NY, NY

APPENDIX B

Subject Questionnaire

Subject # :______

1. Age: 1A. Education:

2. What hand do you write with? Right Left

3. Is English the only language you speak fluently?

4. Do you have any history of :

	Yes	No
a) psychiatric illness		
b) substance abuse		
c) hearing impairment		
d) neurological damage		

5. Have you ever participated in a listening experiment before?

Your responses will be studied in a way that protects your identity. In this study, notations will be made of your age, gender, and other facts about you. These details may be seen only by the investigators and members of the Institutional Review Board. You will not be identified personally in any reports from this study and every effort will be made to keep your identity and medical information confidential. Thank you for filling out this questionnaire.

KINGS COUNTY HOSPITAL CENTER, 451 Clarkson Ave., Brooklyn, NY
and
THE GRADUATE SCHOOL AND UNIVERSITY CENTER, C.U.N.Y., PH.D PROGRAM IN SPEECH AND HEARING SCIENCES, 33 West 42nd St., NY, NY

Appendix C

Semantic Analysis of Stimuli

The imagery, concreteness, number of attributes, and frequency of occurrence (familiarity) ratings in English for the words contained in the 6 preliminary target phrases and the 24 preliminary short narratives are listed, using the cluster analysis method of Toglia & Battig (1978). In their study, subjects rated over 2,000 words on a seven-point scale of low to high attribution, on seven basic semantic characteristics, including: Imagery (IMG) -the word's capacity to arouse mental images of things or events; Concreteness (CON)- the extent to which the word referred to concrete objects, persons, places or things that could be experienced by human senses; Number of Attributes (NOA)-the number of features, attributes, and/or properties that were associated with the word; and Familiarity (FAM)- how commonly or frequently the word had been experienced. Words were assigned into eight clusters based on a statistical cluster analysis of the mean ratings for all words on all dimensions. Words in cluster one were low in all dimensions; words in cluster two were low in all dimensions except for frequency, i.e., highly abstract but also highly familiar; cluster three words were below average on all dimensions; cluster four words were relatively familiar, below average in concreteness and imagery; words in cluster five were higher than cluster four in familiarity and number of attributes; words in cluster six were above average on all dimensions; cluster seven contained words high in concreteness and imagery , slightly below average in number of attributes and average in frequency; and words in cluster eight had the highest ratings on all the semantic dimensions concerned (IMG, CON, NOA and FAM). The criterion for acceptance of a preliminary set for inclusion in this study was an average accurate affective identification score of at least 90%.

SET ONE TARGET PHRASE: He was late .

6 2 4

I'm mad I missed my train because He was late . (Spoken angrily)

6/2 4 6 5 2 8 2 6 2 4

I'm glad I had time for coffee because He was late . (Spoken happily)

6/2 5 6 2 5 2 8 2 6 2 4

I'm thinking I should ride to school because He was late.

(Spoken neutrally)

6/2 5 6 2 6 2 8 2 6 2 4

I'm disappointed I missed my uncle because He was late . (Spoken sadly)

6/2 4 6 5 2 8 2 6 2 4

The validators' mean percentage correct for this set was 95%. Therefore this set was included in the study. This set is predominantly cluster six. Words in cluster six are above average on all dimensions: imagery, concreteness, number of attributes and familiarity.

SET TWO TARGET PHRASE: I was next .

6 2 2

I was mad about being cut off on line. I was next . (Spoken angrily)

6 2 4 2 2 4 2 2 6 6 2 2

I was glad they were giving out free gifts. I was next ! (Spoken happily)

6 2 5 2 2 5 2 5 8 6 2 2

I was waiting just a short time. I was next . (Spoken neutrally)

6 2 2 2 2 4 5 6 2 2

I was in despair over the trial. I was next . (Spoken sadly)

6 2 2 4 5 2 6 6 2 2

The validators' mean percentage correct for this set was also 95%. Therefore this set was also included in the study. This set is predominantly cluster two. Words in cluster two are low in all dimensions except for frequency, i.e., highly abstract but also highly familiar.

SET THREE TARGET PHRASE: They were here.

2 2 2

I'm very mad I lost the letters . They were here. (Spoken angrily)

6/2 2 4 6 4 2 8 2 2 2

I'm so glad I found the contracts. They were here. (Spoken happily)

6/2 2 5 6 5 2 6 2 2 2

I'm looking for my books. They were here. (Spoken neutrally)

6/2 5 2 2 8 2 2 2

I'm disappointed my friends left. They were here. (Spoken sadly)

6/2 4 2 8 2 2 2 2

The validators' mean percentage correct for this set was 90%. Therefore this set was also included in the study. This set is predominantly cluster two. Words in cluster two are low in all dimensions except for frequency, i.e., highly abstract but also highly familiar.

SET FOUR TARGET PHRASE: Our meeting is soon.

2 5 2 7

I'm mad I needed a lawyer. Our meeting is soon. (Spoken angrily)

6/2 4 6 5 2 8 2 5 2 7

I'm glad I'll see him for lunch. Our meeting is soon. (Spoken happily)

6/2 5 6/2 5 5 2 8 2 5 2 7

I'm thinking I should talk to the teacher. Our meeting is soon.

(Spoken neutrally)

6/2 5 6 2 6 2 2 8 2 5 2 7

I'm in despair because I need a doctor. Our meeting is soon.

(Spoken sadly)

. 6/2 2 4 2 6 5 2 8 2 5 2 7

The validators' mean percentage correct for this set was 88%. Therefore this set was not included in the study. This set is predominantly cluster six. Words in cluster six are above average on imagery, concreteness, number of attributes and familiarity.

SET FIVE TARGET PHRASE: My team won.
2 8 5

I'm mad the referee called us out. My team won. (Spoken angrily)
6/2 4 2 7 5 5 2 2 8 5

I'm glad I played baseball. My team won! (Spoken happily)
6/2 5 6 5 8 2 8 5

I'm thinking of playing football. My team won . (Spoken neutrally)
6/2 5 2 5 8 2 8 5

I'm disappointed I missed the game. My team won. (Spoken sadly)
6/2 4 6 5 2 8 2 8 5

The validators' mean percentage correct for this set was 82%. Therefore this set was not included in the study. This set is predominantly cluster five. Words in cluster five are below average in concreteness and imagery; and above average in familiarity and number of attributes.

SET SIX TARGET PHRASE: It didn't stop.
2 2/2 4

I was mad the music was so very loud. It didn't stop. (Spoken angrily)
6 2 4 2 8 2 2 2 6 2 2/2 4

I was glad I made so much money. It didn't stop. (Spoken happily)
6 2 5 6 2 2 2 8 2 2/2 4

I was watching the rain come down. It didn't stop. (Spoken neutrally)
6 2 6 2 8 5 4 2 2/2 4

I was in despair when the fire flared up. It didn't stop. (Spoken sadly)
6 2 2 4 2 2 8 6 5 2 2/2 4

The validators' mean percentage correct for this set was 83%. Therefore this set was not included in the study. This set is predominantly cluster two. Words in cluster two are low in all dimensions except for frequency, i.e., highly abstract but also highly familiar.

Appendix D

Affective Information Identification Tasks

SET ONE

Narrative Condition

I'm glad I had time for coffee because He was late. (Spoken happily)

I'm mad I missed my train because He was late . (Spoken angrily)

I'm disappointed I missed my uncle because He was late . (Spoken sadly)

I'm thinking I should ride to school because He was late.
(Spoken neutrally)

I'm disappointed I missed my uncle because He was late . (Spoken sadly)

I'm mad I missed my train because He was late . (Spoken angrily)

I'm thinking I should ride to school because He was late.
(Spoken neutrally)

I'm disappointed I missed my uncle because He was late . (Spoken sadly)

I'm mad I missed my train because He was late . (Spoken angrily)

I'm thinking I should ride to school because He was late.
(Spoken neutrally)

I'm glad I had time for coffee because He was late . (Spoken happily)

I'm glad I had time for coffee because He was late . (Spoken happily)

Phrase Condition

He was late. (Spoken neutrally)

He was late. (Spoken angrily)

He was late. (Spoken sadly)

He was late. (Spoken angrily)

He was late. (Spoken neutrally)

He was late. (Spoken happily)

He was late. (Spoken angrily)

He was late. (Spoken happily)

He was late. (Spoken sadly)

He was late. (Spoken happily)

He was late. (Spoken sadly)

He was late. (Spoken neutrally)

Contour Condition

He was late. (Hummed sadly)

He was late. (Hummed happily)

He was late. (Hummed sadly)

He was late. (Hummed neutrally)

He was late. (Hummed happily)

He was late. (Hummed sadly)

He was late. (Hummed neutrally)

He was late. (Hummed happily)

He was late. (Hummed neutrally)

He was late. (Hummed angrily)

He was late. (Hummed angrily)

He was late. (Hummed angrily)

SET TWO

Narrative Condition

I was glad they were giving out free gifts. I was next ! (Spoken happily)

I was glad they were giving out free gifts. I was next ! (Spoken happily)

I was waiting just a short time. I was next . (Spoken neutrally)

I was waiting just a short time. I was next . (Spoken neutrally)

I was in despair over the trial. I was next . (Spoken sadly)

I was mad about being cut off on line. I was next . (Spoken angrily)

I was glad they were giving out free gifts. I was next ! (Spoken happily)

I was in despair over the trial. I was next . (Spoken sadly)

I was mad about being cut off on line. I was next . (Spoken angrily)

I was in despair over the trial. I was next . (Spoken sadly)

I was mad about being cut off on line. I was next . (Spoken angrily)

I was waiting just a short time. I was next . (Spoken neutrally)

Phrase Condition

I was next. (Spoken neutrally)

I was next. (Spoken neutrally)

I was next. (Spoken sadly)

I was next. (Spoken angrily)

I was next. (Spoken angrily)

I was next. (Spoken neutrally)

I was next. (Spoken happily)

I was next. (Spoken happily)

I was next. (Spoken angrily)

I was next. (Spoken happily)

I was next. (Spoken sadly)

I was next. (Spoken sadly)

Contour Condition

I was next. (Hummed sadly)

I was next. (Hummed happily)

I was next. (Hummed happily)

I was next. (Hummed happily)

I was next. (Hummed sadly)

I was next. (Hummed neutrally)

I was next. (Hummed neutrally)

I was next. (Hummed angrily)

I was next. (Hummed neutrally)

I was next. (Hummed angrily)

I was next. (Hummed sadly)

I was next. (Hummed angrily)

SET THREE

Narrative Condition

I'm so glad I found the contracts.	They were here.	(Spoken happily)
I'm very mad I lost the letters .	They were here.	(Spoken angrily)
I'm very mad I lost the letters .	They were here.	(Spoken angrily)
I'm disappointed my friends left.	They were here.	(Spoken sadly)
I'm disappointed my friends left.	They were here.	(Spoken sadly)
I'm so glad I found the contracts.	They were here.	(Spoken happily)
I'm looking for my books.	They were here.	(Spoken neutrally)
I'm so glad I found the contracts.	They were here.	(Spoken happily)
I'm very mad I lost the letters .	They were here.	(Spoken angrily)
I'm looking for my books.	They were here.	(Spoken neutrally)
I'm disappointed my friends left.	They were here.	(Spoken sadly)
I'm looking for my books.	They were here.	(Spoken neutrally)

Phrase Condition

They were here. (Spoken sadly)

They were here. (Spoken happily)

They were here. (Spoken angrily)

They were here. (Spoken angrily)

They were here. (Spoken sadly)

They were here. (Spoken neutrally)

They were here. (Spoken angrily)

They were here. (Spoken sadly)

They were here. (Spoken neutrally)

They were here. (Spoken happily)

They were here. (Spoken happily)

They were here. (Spoken neutrally)

Contour Condition

They were here. (Hummed neutrally)

They were here. (Hummed neutrally)

They were here. (Hummed happily)

They were here. (Hummed neutrally)

They were here. (Hummed sadly)

They were here. (Hummed happily)

They were here. (Hummed angrily)

They were here. (Hummed sadly)

They were here. (Hummed angrily)

They were here. (Hummed sadly)

They were here. (Hummed angrily)

They were here. (Hummed happily)

Appendix E 1

Average Intensity by Emotion, Set and Condition

EMOTION	SET	CONDITION	dB	Hz	Sec.
Angry	III	Contour	72.09	189.97	1.01
Angry	I	Contour	73.46	216.94	0.85
Angry	II	Contour	73.50	179.85	1.09
Angry	I	Contour	74.34	191.33	0.86
Angry	I	Contour	74.39	206.53	0.95
Angry	II	Contour	75.41	196.43	0.95
Angry	III	Contour	75.84	209.56	1.09
Angry	III	Contour	76.07	159.14	1.13
Angry	II	Contour	76.90	221.63	1.05
Angry	II	Narrative	61.83	190.02	3.93
Angry	II	Narrative	62.17	183.35	3.97
Angry	I	Narrative	62.57	183.77	3.15
Angry	II	Narrative	63.06	190.73	3.68
Angry	I	Narrative	63.21	180.24	3.20
Angry	I	Narrative	64.13	183.96	2.80
Angry	III	Narrative	65.72	195.35	3.20
Angry	III	Narrative	68.10	206.12	3.27
Angry	III	Narrative	68.74	213.87	3.27
Angry	II	Phrase	43.89	195.89	1.00

Angry	II	Phrase	60.77	187.22	1.10
Angry	I	Phrase	63.97	208.70	1.02
Angry	II	Phrase	64.07	199.04	0.91
Angry	I	Phrase	67.05	225.77	1.11
Angry	I	Phrase	67.58	203.09	0.99
Angry	III	Phrase	70.25	216.59	0.96
Angry	III	Phrase	73.75	213.26	0.98
Angry	III	Phrase	73.84	219.44	0.99
Happy	I	Contour	66.84	211.53	1.04
Happy	III	Contour	69.32	210.24	0.83
Happy	I	Contour	69.53	237.94	1.04
Happy	II	Contour	69.58	226.20	0.96
Happy	III	Contour	69.85	239.55	0.89
Happy	III	Contour	70.35	220.49	1.04
Happy	II	Contour	70.50	222.65	0.91
Happy	II	Contour	70.69	237.63	1.02
Happy	I	Contour	70.75	230.73	0.98
Happy	I	Narrative	56.36	210.31	3.14
Happy	II	Narrative	59.07	198.93	3.82
Happy	II	Narrative	62.35	205.82	4.00
Happy	II	Narrative	62.59	200.87	4.86
Happy	I	Narrative	64.76	204.65	2.84
Happy	III	Narrative	64.85	217.01	3.18

Happy	III	Narrative	65.92	205.64	2.95
Happy	I	Narrative	66.43	203.52	3.23
Happy	III	Narrative	66.73	209.67	2.98
Happy	II	Phrase	55.37	224.75	1.08
Happy	II	Phrase	58.98	202.27	0.83
Happy	II	Phrase	62.77	221.61	1.57
Happy	III	Phrase	66.93	219.02	0.71
Happy	I	Phrase	68.99	229.57	0.87
Happy	III	Phrase	69.11	214.25	0.82
Happy	I	Phrase	69.34	214.05	0.85
Happy	III	Phrase	69.58	218.63	0.72
Happy	I	Phrase	69.82	213.26	1.37
Neutral	I	Contour	68.34	196.70	1.19
Neutral	III	Contour	70.30	160.94	0.86
Neutral	I	Contour	70.68	216.91	1.24
Neutral	II	Contour	70.78	202.26	1.04
Neutral	II	Contour	71.05	226.30	0.99
Neutral	I	Contour	71.33	236.49	1.19
Neutral	III	Contour	71.94	218.97	0.99
Neutral	II	Contour	72.06	219.32	1.04
Neutral	III	Contour	73.44	245.99	0.91
Neutral	II	Narrative	54.64	208.26	3.57
Neutral	II	Narrative	55.26	187.53	3.51

Neutral	II	Narrative	56.30	182.37	3.52
Neutral	I	Narrative	59.17	190.16	2.73
Neutral	III	Narrative	59.73	175.31	2.18
Neutral	III	Narrative	60.67	178.63	2.13
Neutral	I	Narrative	61.12	181.77	2.73
Neutral	III	Narrative	62.84	203.01	2.07
Neutral	I	Narrative	63.00	191.26	2.61
Neutral	II	Phrase	53.82	227.35	1.02
Neutral	II	Phrase	57.99	217.85	0.96
Neutral	II	Phrase	60.22	238.17	0.81
Neutral	I	Phrase	64.01	201.54	0.73
Neutral	III	Phrase	64.02	208.12	0.68
Neutral	I	Phrase	64.04	226.81	0.94
Neutral	I	Phrase	64.29	182.10	1.04
Neutral	III	Phrase	65.66	176.65	0.78
Neutral	III	Phrase	68.07	213.22	0.72
Sad	II	Contour	69.23	179.86	1.22
Sad	II	Contour	70.84	193.56	1.61
Sad	I	Contour	70.87	208.68	1.41
Sad	I	Contour	71.05	148.40	1.47
Sad	III	Contour	71.63	205.52	1.29
Sad	III	Contour	73.30	230.26	1.25
Sad	II	Contour	73.73	204.18	1.34

Sad	I	Contour	74.22	222.78	1.29
Sad	III	Contour	78.53	246.71	1.25
Sad	II	Narrative	53.91	149.65	3.97
Sad	II	Narrative	55.00	167.44	4.67
Sad	II	Narrative	56.83	167.88	4.21
Sad	III	Narrative	58.03	179.14	3.28
Sad	I	Narrative	60.96	197.29	3.12
Sad	III	Narrative	61.94	186.24	3.33
Sad	I	Narrative	62.35	185.07	3.33
Sad	I	Narrative	62.69	196.29	3.42
Sad	III	Narrative	62.87	198.60	3.46
Sad	II	Phrase	56.49	168.77	1.52
Sad	II	Phrase	58.86	164.13	1.26
Sad	II	Phrase	59.58	170.66	1.23
Sad	I	Phrase	64.64	207.34	1.06
Sad	I	Phrase	65.19	209.16	0.91
Sad	I	Phrase	65.48	244.59	0.86
Sad	III	Phrase	68.18	262.03	0.93
Sad	III	Phrase	69.86	228.02	0.93
Sad	III	Phrase	70.58	221.49	1.06

Appendix E 2

Average fo by Emotion, Set and Condition

EMOTION	SET	CONDITION	dB	Hz	Sec.
Angry	III	Contour	76.07	159.14	1.13
Angry	II	Contour	73.50	179.85	1.09
Angry	III	Contour	72.09	189.97	1.01
Angry	I	Contour	74.34	191.33	0.86
Angry	II	Contour	75.41	196.43	0.95
Angry	I	Contour	74.39	206.53	0.95
Angry	III	Contour	75.84	209.56	1.09
Angry	I	Contour	73.46	216.94	0.85
Angry	II	Contour	76.90	221.63	1.05
Angry	I	Narrative	63.21	180.24	3.20
Angry	II	Narrative	62.17	183.35	3.97
Angry	I	Narrative	62.57	183.77	3.15
Angry	I	Narrative	64.13	183.96	2.80
Angry	II	Narrative	61.83	190.02	3.93
Angry	II	Narrative	63.06	190.73	3.68
Angry	III	Narrative	65.72	195.35	3.20
Angry	III	Narrative	68.10	206.12	3.27
Angry	III	Narrative	68.74	213.87	3.27
Angry	II	Phrase	60.77	187.22	1.10
Angry	II	Phrase	43.89	195.89	1.00

Angry	II	Phrase	64.07	199.04	0.91
Angry	I	Phrase	67.58	203.09	0.99
Angry	I	Phrase	63.97	208.70	1.02
Angry	III	Phrase	73.75	213.26	0.98
Angry	III	Phrase	70.25	216.59	0.96
Angry	III	Phrase	73.84	219.44	0.99
Angry	I	Phrase	67.05	225.77	1.11
Happy	III	Contour	69.32	210.24	0.83
Happy	I	Contour	66.84	211.53	1.04
Happy	III	Contour	70.35	220.49	1.04
Happy	II	Contour	70.50	222.65	0.90
Happy	II	Contour	69.58	226.20	0.96
Happy	I	Contour	70.75	230.73	0.98
Happy	II	Contour	70.69	237.63	1.02
Happy	I	Contour	69.53	237.94	1.04
Happy	III	Contour	69.85	239.55	0.88
Happy	II	Narrative	59.07	198.93	3.81
Happy	II	Narrative	62.59	200.87	4.86
Happy	I	Narrative	66.43	203.52	3.22
Happy	I	Narrative	64.76	204.65	2.84
Happy	III	Narrative	65.92	205.64	2.94
Happy	II	Narrative	62.35	205.82	4.00
Happy	III	Narrative	66.73	209.67	2.98

Happy	I	Narrative	56.36	210.31	3.14
Happy	III	Narrative	64.85	217.01	3.18
Happy	II	Phrase	58.98	202.27	0.83
Happy	I	Phrase	69.82	213.26	1.37
Happy	I	Phrase	69.34	214.05	0.85
Happy	III	Phrase	69.11	214.25	0.81
Happy	III	Phrase	69.58	218.63	0.72
Happy	III	Phrase	66.93	219.02	0.71
Happy	II	Phrase	62.77	221.61	1.57
Happy	II	Phrase	55.37	224.75	1.07
Happy	I	Phrase	68.99	229.57	0.86
Neutral	III	Contour	70.30	160.94	0.86
Neutral	I	Contour	68.34	196.70	1.19
Neutral	II	Contour	70.78	202.26	1.04
Neutral	I	Contour	70.68	216.91	1.24
Neutral	III	Contour	71.94	218.97	0.99
Neutral	II	Contour	72.06	219.32	1.04
Neutral	II	Contour	71.05	226.03	0.99
Neutral	I	Contour	71.33	236.49	1.19
Neutral	III	Contour	73.44	245.99	0.91
Neutral	III	Narrative	59.73	175.31	2.18
Neutral	III	Narrative	60.67	178.63	2.13

Neutral	I	Narrative	61.12	181.77	2.73
Neutral	II	Narrative	56.30	182.37	3.52
Neutral	II	Narrative	55.26	187.53	3.51
Neutral	I	Narrative	59.17	190.16	2.73
Neutral	I	Narrative	63.00	191.26	2.61
Neutral	III	Narrative	62.84	203.01	2.07
Neutral	II	Narrative	54.64	208.26	3.57
Neutral	III	Phrase	65.66	176.65	0.78
Neutral	I	Phrase	64.29	182.10	1.04
Neutral	I	Phrase	64.01	201.54	0.73
Neutral	III	Phrase	64.02	208.12	0.68
Neutral	III	Phrase	68.07	213.22	0.72
Neutral	II	Phrase	57.99	217.85	0.96
Neutral	I	Phrase	64.04	226.81	0.94
Neutral	II	Phrase	53.82	227.35	1.02
Neutral	II	Phrase	60.22	238.17	0.81
Sad	I	Contour	71.05	148.40	1.47
Sad	II	Contour	69.23	179.86	1.22
Sad	II	Contour	70.84	193.56	1.61
Sad	II	Contour	73.73	204.18	1.34
Sad	III	Contour	71.63	205.52	1.29
Sad	I	Contour	70.87	208.68	1.41
Sad	I	Contour	74.22	222.78	1.29

Sad	III	Contour	73.30	230.26	1.25
Sad	III	Contour	78.53	246.71	1.25
Sad	II	Narrative	53.91	149.65	3.97
Sad	II	Narrative	55.00	167.44	4.67
Sad	II	Narrative	56.83	167.88	4.21
Sad	III	Narrative	58.03	179.14	3.28
Sad	I	Narrative	62.35	185.07	3.33
Sad	III	Narrative	61.94	186.24	3.33
Sad	I	Narrative	62.69	196.29	3.42
Sad	I	Narrative	60.96	197.29	3.12
Sad	III	Narrative	62.87	198.60	3.46
Sad	II	Phrase	58.86	164.13	1.26
Sad	II	Phrase	56.49	168.77	1.52
Sad	II	Phrase	59.58	170.66	1.23
Sad	I	Phrase	64.64	207.34	1.06
Sad	I	Phrase	65.19	209.16	0.91
Sad	III	Phrase	70.58	221.49	1.06
Sad	III	Phrase	69.86	228.02	0.93
Sad	I	Phrase	65.48	244.59	0.86
Sad	III	Phrase	68.18	262.03	0.93

Appendix E 3
Average Duration by Emotion, Set and Condition

EMOTION	SET	CONDITION	dB	Hz	Sec.
Angry	I	Contour	73.46	216.94	0.85
Angry	I	Contour	74.34	191.33	0.86
Angry	I	Contour	74.39	206.53	0.95
Angry	II	Contour	75.41	196.43	0.96
Angry	III	Contour	72.09	189.97	1.01
Angry	II	Contour	76.90	221.63	1.05
Angry	II	Contour	73.50	179.85	1.09
Angry	III	Contour	75.84	209.56	1.10
Angry	III	Contour	76.07	159.14	1.13
Angry	I	Narrative	64.13	183.96	2.80
Angry	I	Narrative	62.57	183.77	3.15
Angry	I	Narrative	63.21	180.24	3.20
Angry	III	Narrative	65.72	195.35	3.21
Angry	III	Narrative	68.74	213.87	3.27
Angry	III	Narrative	68.10	206.12	3.27
Angry	II	Narrative	63.06	190.73	3.68
Angry	II	Narrative	61.83	190.02	3.93
Angry	II	Narrative	62.17	183.35	3.97

Angry	II	Phrase	64.07	199.04	0.92
Angry	III	Phrase	70.25	216.59	0.96
Angry	III	Phrase	73.75	213.26	0.98
Angry	III	Phrase	73.84	219.44	0.99
Angry	I	Phrase	67.58	203.09	0.99
Angry	II	Phrase	43.89	195.89	1.00
Angry	I	Phrase	63.97	208.70	1.02
Angry	II	Phrase	60.77	187.22	1.10
Angry	I	Phrase	67.05	225.77	1.11
Happy	III	Contour	69.32	210.24	0.83
Happy	III	Contour	69.85	239.55	0.88
Happy	II	Contour	70.50	222.65	0.90
Happy	II	Contour	69.58	226.20	0.96
Happy	I	Contour	70.75	230.73	0.98
Happy	II	Contour	70.69	237.63	1.02
Happy	III	Contour	70.35	220.49	1.04
Happy	I	Contour	66.84	211.53	1.04
Happy	I	Contour	69.53	237.94	1.04
Happy	I	Narrative	64.76	204.65	2.84
Happy	III	Narrative	65.92	205.64	2.94
Happy	III	Narrative	66.73	209.67	2.98
Happy	I	Narrative	56.36	210.31	3.14
Happy	III	Narrative	64.85	217.01	3.18

Happy	I	Narrative	66.43	203.52	3.22
Happy	II	Narrative	59.07	198.93	3.81
Happy	II	Narrative	62.35	205.82	4.00
Happy	II	Narrative	62.59	200.87	4.86
Happy	III	Phrase	66.93	219.02	0.71
Happy	III	Phrase	69.58	218.63	0.72
Happy	III	Phrase	69.11	214.25	0.81
Happy	II	Phrase	58.98	202.27	0.83
Happy	I	Phrase	69.34	214.05	0.85
Happy	I	Phrase	68.99	229.57	0.86
Happy	II	Phrase	55.37	224.75	1.07
Happy	I	Phrase	69.82	213.26	1.37
Happy	II	Phrase	62.77	221.61	1.57
Neutral	III	Contour	70.30	160.94	0.86
Neutral	III	Contour	73.44	245.99	0.91
Neutral	II	Contour	71.05	226.03	0.99
Neutral	III	Contour	71.94	218.97	0.99
Neutral	II	Contour	72.06	219.32	1.04
Neutral	II	Contour	70.78	202.26	1.04
Neutral	I	Contour	71.33	236.49	1.19
Neutral	I	Contour	68.34	196.70	1.19
Neutral	I	Contour	70.68	216.91	1.24
Neutral	III	Narrative	62.84	203.01	2.07

Neutral	III	Narrative	60.67	178.63	2.13
Neutral	III	Narrative	59.73	175.31	2.18
Neutral	I	Narrative	63.00	191.26	2.61
Neutral	I	Narrative	59.17	190.16	2.73
Neutral	I	Narrative	61.12	181.77	2.73
Neutral	II	Narrative	55.26	187.53	3.51
Neutral	II	Narrative	56.30	182.37	3.52
Neutral	II	Narrative	54.64	208.26	3.57
Neutral	III	Phrase	64.02	208.12	0.68
Neutral	III	Phrase	68.07	213.22	0.72
Neutral	I	Phrase	64.01	201.54	0.73
Neutral	III	Phrase	65.66	176.65	0.78
Neutral	II	Phrase	60.22	238.17	0.81
Neutral	I	Phrase	64.04	226.81	0.94
Neutral	II	Phrase	57.99	217.85	0.96
Neutral	II	Phrase	53.82	227.35	1.02
Neutral	I	Phrase	64.29	182.10	1.04
Sad	II	Contour	69.23	179.86	1.22
Sad	III	Contour	73.30	230.26	1.25
Sad	III	Contour	78.53	246.71	1.25
Sad	III	Contour	71.63	205.52	1.29
Sad	I	Contour	74.22	222.78	1.29
Sad	II	Contour	73.73	204.18	1.34

Sad	I	Contour	70.87	208.68	1.41
Sad	I	Contour	71.05	148.40	1.47
Sad	II	Contour	70.84	193.56	1.61
Sad	I	Narrative	60.96	197.29	3.12
Sad	III	Narrative	58.03	179.14	3.28
Sad	I	Narrative	62.35	185.07	3.33
Sad	III	Narrative	61.94	186.24	3.33
Sad	I	Narrative	62.69	196.29	3.42
Sad	III	Narrative	62.87	198.60	3.46
Sad	II	Narrative	53.91	149.65	3.97
Sad	II	Narrative	56.83	167.88	4.21
Sad	II	Narrative	55.00	167.44	4.67
Sad	I	Phrase	65.48	244.59	0.86
Sad	I	Phrase	65.19	209.16	0.91
Sad	III	Phrase	68.18	262.03	0.93
Sad	III	Phrase	69.86	228.02	0.93
Sad	III	Phrase	70.58	221.49	1.06
Sad	I	Phrase	64.64	207.34	1.06
Sad	II	Phrase	59.58	170.66	1.23
Sad	II	Phrase	58.86	164.13	1.26
Sad	II	Phrase	56.49	168.77	1.52

BIBLIOGRAPHY

Adolphs, R., & Tranel, D. (1999). Intact recognition of emotional prosody following amygdala damage. Neuropsychologia, 37, 1285-1292.

Blumstein, S., & Cooper, W. E. (1974). Hemispheric processing of intonation contours. Cortex, 10, 146-158.

Borod, J.C., Andelman, F., Obler, L. K., Tweedy, J. R., & Welkowitz, J. (1992). Right hemisphere specialization for the identification of emotional words and sentences: Evidence from stroke patients. Neuropsychologia, 30 , 827-844.

Borod, J. C., Cicero, B. A., Obler, L. K., Welkowitz, J., Erhan, H. M., Santschi, C., Grunwald, I. S., Agosti, R. M., & Whalen, J. R. (1998). Right hemisphere emotional perception: evidence across multiple channels. Neuropsychology, 12, 446-458.

Bowers, D., Coslett, H. B., Bauer, R. M., Speedie, L., & Heilman, K. M. (1987). Comprehension of emotional prosody following unilateral hemispheric lesions: processing defect versus distraction defect. Neuropsychologia, 25, 317-328.

Brownell, H., Gardner, H., Prather, P., & Martino,G. (1994). Language, communication, and the right hemisphere. In H. S. Kirshner (Ed.), Handbook of Neurological Speech and Language Disorders . New York: Marcel Dekker. (325-349).

Collier, G., Kuiken, D., & Enzle, M. E. (1982). The role of grammatical qualification in the expression and perception of emotion. Journal of Psycholinguistic Research, 11 , 631-650.

Cruttenden, A. (1995). Preliminaries. In Intonation. New York : Cambridge University Press. (1-15).

Emmorey, K.D. (1987). The neurological substrates for prosodic aspects of speech. Brain and Language, 30, 305-320.

Gainotti, G., Caltagirone, C., Miceli, G. ,& Masulo, C. (1981). Selective semantic-lexical impairment of language comprehension in right-brain-damaged patients. Brain and Language, 13, 201-211.

George, M. S., Parekh, P. I., Rosinsky, N., Ketter, T. A., Kimbrell, T. A., Heilman, K. M., Herscovitch, P., & Post, R. M. (1996). Understanding emotional prosody activates right hemisphere regions. Arch. Neurol, 53, 665-670.

Goodglass, H., & Kaplan, E. (1983). Major aphasic syndromes and illustrations of test patterns. In The Assessment of Aphasia and Related Disorders. Second Edition. Philadelphia, PA: Lea & Febiger. (74-100).

Heilman, K. M., Bowers, D., Speedie, L., & Coslett, H. B. (1984). Comprehension of affective and nonaffective prosody. Neurology, 34, 917-921.

Heilman, K. M., & Gilmore, R. L. (1998). Cortical influences in emotion. J. Clin. Neurophysiol, 15, 409-423.

Joanette, Y., Goulet, P., & Hannequin, D. (1990). Prosodic aspects of speech. In Right Hemisphere and Verbal Communication. New York, NY: Springer-Verlag. (132-159).

Johnson-Weiner, K. M. (1984). The effects of right and left hemisphere damage on the comprehension of stress and intonation in English. Unpublished Ph.D. dissertation. Montreal, Canada: McGill University.

Kent, R. D., & Rosenbek, J.C. (1982). Prosodic disturbance and neurologic lesion. Brain and Language, 15, 259-291.

Kimura, D. (1967). Functional asymmetry of the brain in dichotic listening. Cortex, 3, 163-178.

Lalande, S., Braun, C. M. J., Charlebois, N.,& Whitaker, H.A. (1992). Effects of right and left hemisphere cerebrovascular lesions on discrimination of prosodic and semantic aspects of affect in sentences. Brain and Language, 42, 165-186.

Ley, R.G., & Bryden, M. P. (1982). A dissociation of right and left hemispheric effects for recognizing emotional tone and verbal content. Brain and Cognition, 1, 3-9.

McRoberts, G.W., Studdert-Kennedy, M., & Shankweiler, D. (1995). The role of fundamental frequency in signaling linguistic stress and affect: Evidence for a dissociation. Perception & Psychophysics, 57, 159-174.

Miller N., & Docherty, G. (1995). Acquired neurogenic speech disorders: Applying linguistics to treatment. In K. Grundy, (Ed.), Linguistics in Clinical Practice. Second Edition. San Diego, CA: Singular Publishing Group, Inc. (358-384).

Molfese, D. L. (1980). Hemispheric specialization for temporal information: Implications for the perception of voicing cues during speech perception. Brain and Language, 11, 285-299.

Ostrove, J. M., Simpson, T., & Gardner, H. (1990). Beyond scripts: A note on the capacity of right hemisphere-damaged patients to process social and emotional content. Brain and Cognition, 12, 144-154.

Paivio, A., Yuille, J. C., & Madigan, S. (1968). Concreteness, imagery and meaningfulness for 925 nouns. J. Exp. Psychol. Monograph Supplement, 76, 1-25.

Pell, M. D. (1998). Recognition of prosody following unilateral brain lesion: linguistic/emotional influence of functional and structural attributes of prosodic contours. Neuropsychologia, 36, 701-715.

Pell, M. D., & Baum, S. R. (1997a). The ability to perceive and comprehend intonation in linguistic and affective contexts by brain-damaged adults. Brain and Language, 57, 80-99.

Pell, M. D., & Baum, S. R. (1997b). Unilateral brain-damage, prosodic comprehension deficits, and the acoustic cues to prosody. Brain and Language, 57, 195-214.

Ross, E. D. (1981). The aprosodias: Functional-anatomic organization of the affective components of language in the right hemisphere. Arch. Neurology, 38, 561-569.

Ross, E. D., Thompson, R. D., & Yenkosky, J. (1997). Lateralization of affective prosody in brain and the callosal integration of hemispheric language functions. Brain and Language, 56, 27-54.

Schlanger, B., Schlanger, P., & Gerstman, L. (1976). The perception of emotionally toned sentences by right-hemisphere-damaged and aphasic subjects. Brain and Language, 3, 396-403

Semenza, C., Pasini, M., Zettin, M., Tonin, P., & Portolan, P. (1986). Right hemisphere patients' judgments on emotions. Acta Neurol. Scand., 74, 43-50.

Shankweiler, D., & Studdert-Kennedy, M. (1967). Identification of consonants and vowels presented to left and right ears. Quart. J. Exper. Psychol., 19, 59-63.

Shipley-Brown, F., Dingwall, W. O., Berlin, C. I., Yeni-Komshian, G., & Gordon-Salant, S. (1988). Hemispheric processing of affective and linguistic intonation contours in normal subjects. Brain and Language, 33, 16-26.

Spence, S., Shapiro, D., & Zaidel, E. (1996). The role of the right hemisphere in the physiological and cognitive components of emotional processing. Psychophysiology, 33, 112-122.

Starkstein, S. E., Federoff, J. P., Price, T. R., Leiguarda, R. C., & Robinson, R.G. (1994). Neuropsychological and neuroradiologic correlates of emotional prosody comprehension. Neurology, 44, 515-522.

STATISTICA. (1995). CSS Statistica basic statistics and ANOVA/MANOVA programs. Release 5. Tulsa, OK: StatSoft, Inc

Strauss, E. (1983). Perception of emotional words. Neuropsychologia, 21, 99-103.

Studdert-Kennedy, M., & Shankweiler, D. (1970). Hemispheric specialization for speech perception. Journal of the Acoustical Society of America, 48, 579-594.

Toglia, M. P., & Battig, W. F. (1978). Handbook of Semantic Word Norms. Hillsdale, N.J.: Lawrence Erlbaum Associates, Publishers.

Tompkins, C. A. (1990). Knowledge and strategies for processing lexical metaphor after right or left hemisphere brain damage. Journal of Speech and Hearing Research, 33, 307-316.

Tompkins, C. A. (1991a). Automatic and effortful processing of emotional intonation after right or left brain damage. Journal of Speech and Hearing Research, 34, 820-830.

Tompkins, C. A. (1991b). Redundancy enhances emotional inferencing by right- and left-hemisphere-damaged adults. Journal of Speech and Hearing Research, 34, 1142-1149.

Tompkins, C. A, Baumgaertner, A., Lehman, M. T., & Fassbinder, W. (2000). Mechanisms of discourse comprehension impairment after right hemisphere brain damage: suppression in lexical ambiguity resolution. Journal of Speech, Language, and Hearing Research, 43, 62-78.

Tompkins, C. A., & Mateer, C .A. (1985). Right hemisphere appreciation of prosodic and linguistic indications of implicit attitude. Brain and Language, 24, 185-203.

Tucker, D. M., Watson, R. T., & Heilman, K. M. (1977). Discrimination and evocation of affectively intoned speech in patients with right parietal disease. Neurology 27, 947-950.

Van Lancker, D., & Sidtis, J. (1992). The identification of affective-prosodic stimuli by left- and right-hemisphere-damaged subjects: All errors are not created equal. Journal of Speech and Hearing Research, 35, 963-970.

Van Lancker, D., & Sidtis, J. (1993). Brain damage and prosody errors reconsidered: Reply to Heilman. Journal of Speech and Hearing Research, 36, 1191-1192.

Wechsler, A. F. (1973). The effect of organic brain disease on recall of emotionally charged versus neutral narrative texts. Neurology, 23, 130-135.

Wells, B., Peppe, S., & Vance, M. (1995). Linguistic assessment of prosody. In K. Grundy, (Ed.), Linguistics In Clinical Practice. Second Edition. San Diego, CA: Singular Publishing Group, Inc. (234-266).

Zurif, E. B. (1974). Auditory lateralization: prosodic and syntactical factors. Brain and Language, 1, 391-404.