Alexithymia, Stroop Interference, and Verbal Abilities: Sex differences

by

Gordon C. Cole

B.A. (Honours), The University of Ottawa, 1982

M.A., Simon Fraser University, 1984

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in the Department

of

Psychology

SIMON FRASER UNIVERSITY

May 1991

APPROVAL

Name: Gordon Campbell Cole

Degree: Doctor of Philosophy

Title of Thesis: Alexithymia, Stroop Interference, Verbal Abilities: Sex Differences

Examining Committee:

Chair: Dr. William Krane

Dr. Paul Bakan
Senior Supervisor

Dr. Robert Ley

Dr. Ray Koopman

Dr. Christopher Davis
Internal Examiner

Dr. Robert Pihl
External Examiner
McGill University

Date Approved: May 3/91

PARTIAL COPYRIGHT LICENSE

Title of Thesis/Project/Extended Essay

Alexithymia, Stroop Interference, and Verbal Abilities:

Sex Differences

Author:

(signature)

Gordon C. Cole

(name)

May 6, 1991

(date)

Abstract

Alexithymia (a term meaning no words for feelings) is a hypothetical construct representing a constellation of cognitive-affective characteristics observed in people with a wide range of psychological and physical disorders, and in people who derive little benefit from insight oriented psychotherapy. Two general questions about alexithymia were addressed in this thesis: "Do alexithymics have a 'deficit' of feeling? Do vocabulary or word fluency deficiencies account for the alexithymic's expressive difficulties?". An emotional Stroop task was constructed to measure the cognitive representation of emotion, while verbal abilities were measured with the Vocabulary and Similarities WAIS-R subtests, and a verbal fluency test. There were three main findings. (1) Males with high alexithymia scores exhibited greater interference on neutral, as well as positive and negative emotion Stroop stimuli, suggesting a Stroop effect for males with high alexithymia scores, regardless of emotional valence. Verbal fluency was found to be a factor contributing variance to the relationship between alexithymia and Stroop scores for males. (2) Females with high alexithymia scores had lower vocabulary and emotional vocabulary scores than females with low alexithymia scores. No significant differences in vocabulary scores were obtained between the male alexithymia groups, and there were no significant differences in word fluency or abstract reasoning between both male and female alexithymia groups. (3) Sex differences in color

naming ability were observed. Males were generally slower than females at color naming. For females color naming scores were significantly correlated with alexithymia scores (while insignificant among males, these relationships were of similar strength and direction). Slowed color naming may be included in the constellation of characteristics associated with alexithymia. Overall, the results of this thesis may be interpreted as suggesting that the affective difficulties of alexithymics may be secondary to cognitive difficulties. There also seems to be a sexual dimorphism in cognitive correlates of alexithymia. Similarities between alexithymia and neuropsychological syndromes, perceptual styles, and sex differences in cognitive abilities and hemispheric lateralization provide some theoretical support for this interpretation of the results.

Acknowledgements

I wish to thank Paul Bakan for believing in me, challenging my limits, and for tolerating my wanderings from the path. Bob Ley has been a consistent source of inspiration in all areas of becoming a clinical psychologist. Ray Koopman has endured my statistical alogia with grace, and I thank him for his help in examining and analyzing a challenging data set. Chris Davis has been another challenging representation for me from beginning to end. I wish to thank Robert Pihl for being my external examiner and for providing me with a new window on the cognitive correlates of alexithymia. I also wish to acknowledge the contribution and support of Paul Sungalia who was instrumental in the design of the emotional Stroop test and was a true collegue in all senses. I thank Jim Marcia for providing the ideal location for the incubation of the final stages of the thesis. I thank Joan Foster for her patient assistance with the data crunching. Finally, I wish to thank my parents for their consistent support and understanding.

Table of Contents

Abstract.......... iii

Acknowledgements v

List of Tables ix

List of Figures xiii

I. INTRODUCTION.......... 1

Measurement of Alexithymia.......... 4

Etiological Explanations 9

Hemispheric Specialization and Alexithymia.......... 10

Cognitive Representation, Information Processing, and Subliminal Perception.......... 20

The Stroop Test.......... 24

Hypotheses.......... 33

II. METHOD.......... 35

Subjects.......... 35

Procedures 37

Measures 38

The Emotional Stroop Test.......... 38

The Toronto Alexithymia Scale.......... 46

The Vocabulary subscale of the WAIS-R 50

An emotional vocabulary subscale 51

The Similarities subtest of the WAIS-R 51

The Controlled Oral Word Association (FAS) Test 51

III. RESULTS 53

Emotional Stroop and Alexithymia 61

Repeated Measures of Stroop Variables 61

Neutral emotion Stroop interference 64

Positive emotion Stroop interference 67

Negative emotion Stroop interference 69

Word fluency and Stroop: controlling the effects of fluency 71

Age, alexithymia, and Stroop interference: 75

Controlling for the effects of age. 75

Controlling for both age and fluency 79

Alexithymia and Verbal Measures 81

Emotional Vocabulary 83

Word Fluency and Alexithymia 86

Similarities and Alexithymia 87

Color Naming and Alexithymia 90

Fluency and Color Naming 92

Age and Color Naming 93

IV. DISCUSSION 95

Emotional Stroop and Alexithymia 96

Sex Differences in Stroop Performance 101

Sex Differences in Color Discrimination Abilities 104

Sex Differences in Perceptual Speed and Cognitive Abilities 104

Sex Differences in Lateralization of Brain Function 105

Implications for Psychosomatic Theory 109

Similarity of alexithymia to neurological "syndromes" 111
Vocabulary and Alexithymia 120
Similarities and Alexithymia 124
Verbal Fluency and Alexithymia 124
Sex Differences in Verbal Abilities 125
Sexual Dimorphism of Alexithymia 126
Color Naming and Alexithymia 126
Conclusion 135
REFERENCES 138
APPENDICES 156
Summary Statistics All Ss 160
Female Summary Statistics (n=124) 160
Male Summary Statistics (n=54) 160

List of Tables

TABLE 1. Neutral Word Parameters 40

TABLE 2. Negative Word Parameters 41

TABLE 3. Positive Word Parameters 41

TABLE 4. Neutral Words Color Count 42

TABLE 5. Positive Words Color Count 43

TABLE 6. Negative Word Color Count 44

TABLE 7. Sample characteristics of Taylor et al. (1985) 47

TABLE 8. Sample characteristics of present study 48

TABLE 9. Correlation Matrix All Subjects (n=178) 58

TABLE 10. Correlation Matrix Female Subjects (n=124) 59

TABLE 11. Correlation Matrix for Males (n=54) 60

TABLE 12. All Ss Repeated Measures: Cell Means and Standard Deviations 62

TABLE 13 . All Ss Repeated Measures: Stroop Interference Scores 62

TABLE 14. Females: Alexithymia by Stroop Interference Repeated Measures 63

TABLE 15. Male Alexithymia by Stroop Interference Repeated Measures 64

TABLE 16. All Ss: Mean neutral Stroop interference scores as a function of alexithymia and sex 65

TABLE 17. Male Ss: Mean neutral Stroop interference scores as a function of alexithymia 66

TABLE 18. Female Ss: Mean neutral Stroop interference scores as a function of alexithymia 67

TABLE 19. All Ss: Mean positive Stroop interference scores as a function of alexithymia and sex 67

TABLE 20. Male Ss: Mean positive Stroop interference scores as a function of alexithymia 68

TABLE 21. Female Ss: Mean positive Stroop interference scores as a function of alexithymia 69

TABLE 22. All Ss: Mean negative Stroop interference as a function of alexithymia and sex 69

TABLE 23. Male Ss: Mean negative Stroop interference as a function of alexithymia 70

TABLE 24. Female Ss: Mean negative Stroop interference as a function of alexithymia 70

TABLE 25. All Ss: Mean neutral Stroop interference, with fluency covaried, as a function of alexithymia and sex 72

TABLE 26. Male Ss: Mean neutral Stroop interference, with fluency covaried, as a function of alexithymia 72

TABLE 27. All Ss: Mean positive Stroop interference, with fluency covaried, as a function of alexithymia and sex 72

TABLE 28. Male Ss: Mean positive Stroop interference, with fluency covaried, as a function of alexithymia 72

TABLE 29. All Ss: Mean negative Stroop interference, with fluency covaried, as a function of alexithymia 73

TABLE 30. Male Ss: Mean negative Stroop interference, with fluency covaried, as a function of alexithymia 73

TABLE 31. All Ss: Mean neutral Stroop interference, with age covaried, as a function of alexithymia 76

TABLE 32. All Ss: Mean positive Stroop interference, with age covaried, as a function of alexithymia 77

TABLE 33. All Ss: Mean negative Stroop interference, with age covaried, as a function of alexithymia 77

TABLE 34. Male Ss: Mean neutral Stroop interference, with age covaried, as a function of alexithymia 78

TABLE 35. Male Ss: Mean positive Stroop interference, with age covaried, as a function of alexithymia 78

TABLE 36. Male Ss: Mean negative Stroop interference, with age covaried, as a function of alexithymia 78

TABLE 37. All Ss: Mean neutral Stroop interfererence, with age and fluency covaried, as a function of alexithymia 79

TABLE 38. All Ss: Mean positive Stroop interference, with age and fluency covaried, as a function of alexithymia 79

TABLE 39. All Ss: Mean negative Stroop interference, with age and fluency covaried, as a function of alexithymia 80

TABLE 40. Male Ss: Mean negative Stroop interference, with age and fluency covaried, as a function of alexithymia 80

TABLE 41. Male Ss: Mean positive Stroop interference, with age and fluency covaried, as a function of alexithymia 80

TABLE 42. Male Ss: Mean negative Stroop interference, with age and fluency covaried, as a function of alexithymia 81

TABLE 43. All Ss: Mean vocabulary scores as a function of alexithymia and sex 82

TABLE 44. Female Ss: Mean vocabulary scores as a function of alexithymia 82

TABLE 45. Male Ss: Mean vocabulary scores as a function of alexithymia 82

TABLE 46. All Ss: Mean emotional vocabulary scores as a function of alexithymia and sex 84

TABLE 47. Female Ss: Mean emotional vocabulary scores as a function of alexithymia 85

TABLE 48. Male Ss: Mean emotional vocabulary scores as a function of alexithymia 85

TABLE 49. All Ss: Mean fluency scores as a function of alexithymia and sex 86

TABLE 50. Male Ss: Mean fluency scores as a function of alexithymia 87

TABLE 51. Female Ss: Mean fluency scores as a function of alexithymia 87

TABLE 52. All Ss: Mean similarities scores as a function of alexithymia 88

TABLE 53. Female Ss: Mean similarities scores as a function of alexithymia 89

TABLE 54. Male Ss: Mean similarities scores as a function of alexithymia 89

TABLE 55. All Ss: Mean color naming scores as a function of alexithymia and sex 90

TABLE 56. Male Ss: Mean color naming scores as a function of alexithymia............91

TABLE 57. Female Ss: Mean color naming scores as a function of alexithymia............91

TABLE 58. All Ss: Mean color naming scores, with fluency covaried, as a function of alexithymia and sex............92

TABLE 59. Female Ss: Mean color naming scores, with fluency covaried, as a function of alexithymia............92

TABLE 60. Male Ss: Mean color naming scores, with fluency covaried, as a function of alexithymia............92

TABLE 61. Male Ss: Mean color naming scores, with age and fluency covaried, as a function of alexithymia............93

List of Figures

Figure 1. Raw Stroop Scores of Low Alexithymia Males 54

Figure 2. Raw Stroop Scores of Medium Alexithymia Males 55

Figure 3. Raw Stroop Scores of High Alexithymia Males................................ 56

Figure 4. Alexithymia and Neutral Interference Means 66

Figure 5. Positive Emotion Interference and Alexithymia 68

Figure 6. Negative Emotion Interference and Alexithymia 70

Figure 7. Vocabulary and Alexithymia... 83

Figure 8. Emotional Vocabulary and Alexithymia 85

Figure 9. Similarities means as a function of alexithymia................................. 88

Figure 10. Color means as a function of alexithymia 90

I. INTRODUCTION

> Whereas the truth is that fullness of soul can sometimes overflow in utter vapidity of language, for none of us can ever express the exact measure of his needs or his thoughts or his sorrows; and human speech is like a cracked kettle on which we tap crude rhythms for bears to dance to, while we long to make music that will melt the stars (Flaubert's lament in *Madame Bovary*, cited by Yalom, 1989, p.181).

The term alexithymia (a=not, lexi=words, thymos=feelings) was created by Sifneos (1973) to refer to a characteristic he initially observed in individuals with psychosomatic disorders: having no words for feelings. There are a number of additional alexithymic characteristics: difficulty discriminating between emotional states and physical sensations (Nemiah, Freyberger, & Sifneos, 1976); diminished ability to fantasize or recall dreams (Nemiah, 1975; 1984); diminished hypnotizability (Frankel, Apfel-Savitz, Nemiah, & Sifneos, 1977); a reliance on an obsessional-concrete thinking style known as '*pensee operatoire*' that can be characterized as thought that is more influenced by external factors (events, objects, and people) than inner drives and imagination processes (Apfel & Sifneos, 1979; Marty & M'Uzan, 1963; Nemiah, 1984); impaired capacity for empathy (Krystal, 1979); and diminished spontaneous non-verbal expression of positive and negative emotion (McDonald & Prkachin, 1990). People with alexithymic characteristics do not respond well to psychodynamically oriented psychotherapy (Sifneos, 1975), possibly due in part to the observation that they elicit counter-transference from psychotherapists who find them lacking insight or psychological mindedness (Taylor, 1977).

Historically the concept of alexithymia encompasses earlier psychoanalytic observations of the psychosomatic personality. According to Taylor (1987) it is similar to the infantile personality (Ruesch, 1948), the "as-if" personality (Deutsch, 1942), and theoretically inconsistent with the specificity hypothesis forwarded by Alexander (1943). Alexander suggested that specific personality types were associated with specific psychosomatic disorders, while alexithymia is thought to confer general physical and psychological vulnerability. Alexithymia is also thought to involve some degree of cognitive disruption or deficit while Alexander thought that repressed unconscious affect rather than cognitive disruption was the basic factor implicated in the development of psychosomatic disorders.

Alexander (1943) hypothesized that each psychosomatic disorder resulted from a specific pathogenic unconscious "emotional constellation". While a specific relationship between alexithymia and the "classical" psychosomatic disorders (asthma, hypertension, neurodermatitis, peptic ulcer, thyrotoxicosis, rheumatoid arthritis, ulceritive colitis) has not been consistently found (Klieger & Jones, 1980; Lesser, Ford, & Friedman, 1979; Shipko, 1982; Taylor, Doody, & Newman, 1981) alexithymia is thought to cut across psychiatric diagnostic criteria and has been observed in patients with a variety of physical and psychological disorders including hypertension (Gage & Egan, 1984), pain syndromes (Cole, 1984; Mendelson, 1982), breast cancer (Todarello, La Pesa, Zaka, Martino, & Lattanzio (1989), violent tendencies (Keltkangas-Jarvinen, 1982), males at high genetic risk for alcoholism (Finn, Martin & Pihl, 1987), rheumatoid arthritis (Fernadez, Sriram, Rajkumar & Chandrasekar, 1989), chronic respiratory illness (Kleiger & Jones, 1980), substance abuse (Haviland, Shaw, MacMurray & Cummings, 1988; Taylor, Parker, & Bagby, 1990), obesity (Legorreta, Bull, & Kiely, 1988), somatoform disorders (Acklin & Alexander, 1988; Flannery, 1977; Lesser, Ford, & Friedman, 1977; Shipko, 1982), post traumatic stress disorder (Shipko, Alveras, & Noviellos, 1983), depression (Wise, Jani, Kass, Sonnenschein, & Mann 1988), depressed mood and obsessoid personality style (Wise, Mann, & Hill, 1990), masked depression (Fisch, 1989), abnormal illness behavior (Wise, Mann, Hryvniak, Mitchell, & Hill, 1990) and persons with acquired immune deficiency syndrome (Thome, 1990). Approximately 35% of patients presenting to physicians and mental health professionals have been found to be "clinically" alexithymic (Lesser & Lesser, 1983).

Taylor (1987) suggests that alexithymia is associated with difficulties in self-regulation and object relations and that a link may exist between alexithymia, addiction, perversion, narcissistic personality disorder, and bodily disease. McDougall (1982) suggests that "sexual perversions are probably the most alexithymic form of libidinal expression that exists" (p.82). Horton, Gerwirtz, and Kreutter (1989) found that alexithymics used fewer self-solacing strategies (comforting objects and activities) than panic disorder patients and suggested that alexithymics may have an incapacity for positive soothing feelings: ". . .not to have the emotional basis for developing feelings such as love, fascination, generosity, awe, joy, or bliss, or invest in the goals which may accompany such feelings" (p.94). McDougall (1982) suggests that all psychological symptoms, including alexithymia, are attempts at self-cure and the avoidance of affective flooding.

There is little research that answers the question of whether alexithymic characteristics are "symptoms" of a cognitive-affective "disorder" or "disturbance", or whether they represent the operation of defense mechanisms, personality traits, and cognitive abilities within the normal range? The concept of alexithymia seems to obscure the semantic difference between psychological symptoms and personality characteristics. While there are specific alexithymic tendencies and behavior patterns that support the notion of an alexithymic personality, there is little discussion of the values, attitudes, and motivations that distingiush alexithymic from non-alexithymic personalities. Regarding the use of the term symptom, do alexithymic characteristics represent a deviation from normal functioning indicative of a physical or mental disorder? Given that alexithymia is generally accepted to be a continuous variable with considerable overlap with the normal range of functioning, it is unlikely that alexithymia qualifies as a disorder by itself, though it may present concurrently with another disorder. Most of the alexithymia construct validation studies use samples of university students with mean differences among intelligence and personality variables generally in the normal range. Despite the heuristic usefulness of the concept, construct validation of alexithymia is as elusive as the distinction between personality characteristics and symptoms.

It may be useful to approach the construct validation of alexithymia from the same nomological network development approach used to validate the concept of intelligence: Spearman's "g" (Thomson, 1951). Is there a single "a" factor that best explains alexithymia; does some non-specific factor explain alexithymia, or is alexithymia a "multi-factorial" phenomenon? The most recent attempt to construct a self-report measure of alexithymia, the Toronto Alexithymia Scale (TAS; Taylor, Ryan, & Bagby, 1985), uses a multifactorial approach with proper psychometric methodology to quantify the constellation of characteristics thought to represent alexithymia.

Measurement of Alexithymia

The following is a selective review of attempts to create a reliable and valid measure of alexithymia. For more complete reviews of psychometric methods of quantifying alexithymia see Aherns and Deffner (1986) and Taylor and Bagby (1988). To quantify his clinical observations of alexithymic characteristics among patients with classical psychosomatic disorders, Sifneos (1973) created an interviewer-rated clinical interview, the Beth-Israel Psychosomatic Questionnaire or BIQ (Sifneos, 1973). The BIQ is a 17 item forced-choice checklist used by an examiner to rate a person on the presence or absence of alexithymic characteristics. While the BIQ has good face validity, problems result from a lack of validation studies and findings that the scoring is highly dependent on the the interviewers' experience, bias, style, and training (Kleiger & Jones, 1980; Lolas, de la Parra, Aronsohn, & Collin, 1980; Taylor et.al., 1981).

The Schalling Sifneos Personality Scale (Apfel & Sifneos, 1979) or SSPS was subsequently created in an attempt to control for these factors. The SSPS was the first self-report measure of alexithymia. Although widely used, this measure, constructed with minimal psychometric sophistication, does not correlate with the BIQ, has poor internal consistency, and has an unstable factor structure (Bagby, Taylor, & Ryan, 1986). The first self-report measure constructed with psychometric methodology was the MMPI alexithymia scale (Kleiger & Kinsman, 1980), the MMPI-A. Scores on the MMPI-A correlate with neither BIQ nor SSPS scores. The body of research using these measures of alexithymia has resulted in the reification of the concept despite the measurement problems.

Taylor, Ryan, and Bagby (1985) developed a 26 item scale, the Toronto Alexithymia Scale (TAS), using factor analytic, trait specification methods. With the TAS it is hoped that alexithymia can be measured with sufficient reliability and confidence that we are measuring "alexithymia" and not a non-specific factor. Bagby, Taylor, & Atkinson (1988) compared the psychometric properties of the SSPS, the MMPI-A, and the TAS and found that the SSPS and the MMPI-A had response-gender biases and poor internal reliabilities while the TAS did not. The TAS had a stable factor structure while the SSPS was found to have poor factor stability. The negative correlation (r= -.19) between TAS scores and SSPS scores (with low SSPS scores indicating higher alexithymia) was small but significant, while the correlation between TAS scores and MMPI-A scores was negative, very small (r= -.06), and insignificant.

The methods used to construct the TAS, and the subsequent construct validation research, inspire confidence that the TAS is a psychometrically sound measure of alexithymia. Taylor et al. (1985) inititally used 41 self-descriptive statements, rated on a 5 point scale ranging from "strongly disagree" to "strongly agree", taken from the Schalling-Sifneos Personality Scale, the Introceptive Awareness subscale of the Eating Disorder Inventory, and the Need for Cognition Scale. Item selection was done on the basis of an item-item correlation matrix which was subjected to factor analysis, from which they selected items if they met two criteria: they had to load significantly on those factors theoretically consistent with the alexithymia construct, and the items had to have sufficient item-total correlations. The resulting 26 items (yielding scores ranging from a low of 26 to a high of 130) were subjected to a factor analysis which yielded four factors: (1) the ability to identify and describe feelings and to distinguish between feelings and bodily sensations; (2) the ability to communicate feelings to other people; (3) daydreaming; (4) the tendency to focus on external events rather than inner experiences. As reviewed by Parker et al., (1989) and Taylor, Bagby, Ryan, and Parker (1990), the TAS has high internal consistency (Cronbach's alpha=0.79, and good test re-test reliability (over one week, r=0.82, five weeks, r=0.75). Factor analytic studies using the TAS with clinical and non-clinical samples yield a four factor solution theoretically consistent with the construct of alexithymia, thus providing the concept some degree of construct validity (Taylor & Bagby, 1988).

To provide construct validity for the TAS, Bagby, Taylor and Ryan (1986b) administered it to 81 university students (33 males and 48 females) as well as the Beck Depression Inventory (BDI), the Need for Cognition Scale (NCS), the Psychological Mindedness Scale (PY), the Shipley-Harford Scale, the State-Trait Anxiety Inventory, and the Basic Personality Inventory (BPI). The correlations between the TAS scores and BPI denial, interpersonal problems, alienation, and deviation subscale scores were not significant, nor were the correlations between the TAS and nonverbal (abstract) intelligence significant. There were small significant negative correlations between TAS scores and Verbal IQ scores, Full Scale IQ scores, and PY scores, while there were strong positive correlations between TAS scores and BDI scores and scores from the depression and hypochondriasis subscales of the BPI, and the State and Trait Anxiety Inventories. While they suggest that the mean levels of depression were not in the clinically significant range and the means of the state and trait anxiety inventories were low, they partialled the variability from these tests out and found that the correlations between the TAS and the "relevant constructs" were generally maintained and suggested that the TAS was measuring a construct other than anxiety and depression (although these findings support the notion that alexithymics do experience affect). They suggested that the negative correlations between the TAS and the scales measuring psychological mindedness and need for cognition were consistent with the hypothesis that *pensee operatoire* is a central feature of alexithymia. They also suggested that the positive correlation between the TAS and the hypochondriasis subscale of the BPI supports the hypothesis that alexithymics communicate emotional distress somatically. The lack of significant correlations between the TAS and the hypochondriasis and the denial subscales of the BPI was interpreted as support for Nemiah's (1973;1975) suggestion that alexithymia and its association with psychosomatic manifestations was not due to "neurotic defenses against drives, affects, and fantasies" (p.212). The negative correlations between the TAS and the measures of psychological mindedness and need for cognition gave support to the notion that alexithymics are not amenable to psychotherapy. There were also significant correlations between the TAS and the thinking disorder subscale of the BPI, although they state that the thinking disorder score was low and positively skewed and thus not representative of psychotic features. The correlations between the persecutory ideation, social introversion subscales, measures of interpersonal trust and capacity for affiliation were interpreted as being consistent with the alexithymic's tendency to have impoverished relationships. The significant correlation between TAS scores and the self-depreciation subscale (with high scores suggesting a sense of worthlessness and low self-esteem) of the BPI was interpreted as consistent with Krystal's (1982/1983) suggestion that alexithymic individuals have an incapacity for self-care. The significant correlation between TAS scores and the impulse expression BPI subscale was seen as consistent with the tendency of alexithymics to be impulsively action oriented and to exhibit brief and violent expressions of affect. While this study can be criticized for capitalizing on chance given the small sample size and the large number of comparisons, the direction of the findings are consistent with a multi-factorial approach to the construct of alexithymia.

Etiological Explanations

While alexithymia has some construct validity, given the consistency of the relationships with relevant constructs, there are numerous etiological explanations that further support a multi-factorial explanation of the construct. To account for observations that alexithymia may be an enduring trait or a situational response to external factors, a distinction has been made between primary (trait) and secondary (state) alexithymia. Freyberger (1977) has suggested primary alexithymia is irreversible and due to neurophysiological deficits, while secondary alexithymia is a reversible 'functional' condition resulting from the influence of psychological defenses, developmental, or sociocultural factors.

Attempts have been made to explain alexithymia from the following theoretical perspectives: neuropsychological (Hoppe & Bogen, 1977; Miller, 1986-87; Nemiah, 1975; Shipko, 1982); information processing-hemisphericity (Cole & Bakan, 1985); psychodynamic (Krystal, 1979; 1982; McDougal, 1974;1982; Taylor, 1977; 1987); social-learning (Borens, Grosse-Schultz, Jaemsch, & Kortemme, 1977); developmental (Nemiah, 1977), and genetic (Heiberg & Heiberg, 1977;1978).

Nemiah (1977;1984) suggests that alexithymia is likely caused by the interaction of a number of factors, and is best explained by one of three models: the denial/conflict, deficit, or structural models. According to the denial/conflict model alexithymia results from the effects of the psychological defense mechanisms of denial and repression leading to a global <u>inhibition</u> of affect and fantasy. With this model a reversal of the defensive process and the subsequent reduction of alexithymic characteristics should be possible. With the deficit model, alexithymic characteristics are thought to be caused by irreversible ego deficits leading to an <u>absence</u> of cognitive functions involved in the experience of affect and fantasy. The deficit model provides a rationale for the general failure of psychodynamic psychotherapy with alexithymic individuals. With the structural model, alexithymia is thought to result from an a deficit in the pathways between cerebral structures underlying verbal expression and affect, or in the structures underlying affect. Nemiah (1977) suggests that disturbances may be found:

> in the pathway between the center for psychic elaboration and that for consciousness; (2) in the pathway between the center underlying

emotion and that for psychic elaboration; or (3) in the center for psychic elaboration itself (p.200).

The deficit and structural models account for primary alexithymia while the denial model accounts for secondary alexithymia. Wise et al (1990) present evidence suggesting that alexithymia is not related to denial of feelings, and contend that alexithymics are unable to verbalize their emotional state. This is consistent with findings by Bagby et al (1986b) who found a lack of correlation between TAS scores and scores on the denial subscale of the BPI. The deficit and structural models have received some support from studies on relationships between alexithymia and hemispheric functions and corpus callosum defects. A review of the hemispheric specialization model and the etiological implications it has for alexithymia follows.

Hemispheric Specialization and Alexithymia

It is generally accepted that the left and the right hemispheres make differential contributions to cognitive and affective functioning (Springer & Deutsch, 1989). The strongest finding in the hemispheric specialization literature is that the left hemisphere is specialized or "dominant" for language abilities, especially among right-handed males (Segalowitz, 1983). While split brain research indicates that the right hemisphere has some language abilites, e.g., it can associate an object with its corresponding name (Gazzaniga, Ledoux, & Wilson, 1977; Sperry, 1968; Sperry & Gazzaniga, 1967), it has access to a much smaller lexicon than the left hemisphere (Zaidel, 1976; 1978c).

The right hemisphere, in addition to playing an important role in mediating visuospatial functions, is thought to process most emotional information. In research with normals using a variety of measurement techniques (reviewed by Bryden & Ley, 1982) there are strong right hemisphere effects in processing both positive and negative emotional stimuli, relative to neutral stimuli. Bryden and Ley (1982) report that a difficulty with interpreting findings with normals is the difficulty in establishing whether the right hemisphere effects are due to the emotionality of the stimuli or the right hemisphere's specialization for processing complex stimuli. Research with patients with neurological damage, however, provides support for the hypothesis that the right hemisphere is specialized for the processing of emotions (i.e., Bear, 1983). For example, the recognition and expression of the prosodic components of speech has been shown to be impaired in patients with right hemisphere damage (Ross, 1988; Ross & Mesulam, 1979; Weintraub, Mesulam, & Kramer, 1981). Ahern and Schwartz (1985) found that parietal areas in the right hemisphere, and not the left, are specialized for processing emotion independent of "affective valence". Heilman and Van den Abell (1979) provide considerable evidence of the importance of the right hemisphere in mediating attention and cerebral activation and suggest that the right hemisphere may also be responsible for mediating emotional behavior.

Some neurological studies, however, suggest that both hemispheres make unique contributions to the processing and expression of emotions (Sackeim, Greenberg, Welman, Gur, Hungerbuhler & Geschwind, 1982; Silberman & Weingartner, 1986; Tucker, 1981). Indifferent or euphoric responses are observed more frequently with disruption of the right hemisphere than the left hemisphere (Gainotti, 1972; Hecaen, et al., 1951; Lee, Loring & Meader, 1990; Rossi and Rosadini, 1967; Terzian, 1964) while many patients with left hemisphere lesions and aphasia exhibit a profound depression which Goldstein (1948) called a "catastrophic reaction".

While there is inconclusive support for either model of hemispheric involvement in the processing and expression of emotion, split brain studies and neuropsychological assessments of individuals with alexithymia suggest a relationship between dysfunction of either the right or the left hemisphere, their callosal connectors, and cognitive characteristics of alexithymia .

Split Brain Studies

Hoppe and Bogen (1977) initially observed that the 12 split brain patients they examined were strongly alexithymic. TenHouten et al. (1987) compared commissurotomy subjects with normal controls on a measure of interhemispheric communication (EEG measures of interhemispheric coherence), and found that reduced levels of hemispheric coherence were associated with an increase in the degree of alexithymia.

TenHoughten et al. (1985) compared commissurotomized patients with controls on content-analytic measures of their spoken and written reponses to an emotionally provocative film and found that commissurotomized patients used fewer affect laden words, a higher number of incomplete sentences, more auxiliary verbs, and fewer adjectives than normal controls.

Thus, split brain studies suggest a relationship between alexithymia, speech deficits, and disruptions of interhemispheric communication. Language studies of non-split brain alexithymics also suggest they have diminished verbal expressive abilities. These studies do not explain, however, the process by which semantic processing is compromised, nor do they examine the cognitive representation of emotions.

Alexithymia, Language Abilities and Disorders

Sriram et al. (1987) found that, in 30 patients diagnosed with psychogenic pain disorder, the presence of alexithymic characteristics (measured with the TAS) was associated with the use of fewer words in responding to the Thematic Apperception Test (TAT). Bagby, Taylor and Ryan (1986) used a brief pencil and paper test of intelligence, the Shipley-Hartford Scale, to measure verbal and non verbal (abstract) intelligence in 81 university students (33 males and 48 females) with alexithymia measured with the TAS. They found a significant negative correlation between alexithymia and verbal intelligence ($r = -0.269$, $p<0.01$) while the correlation between alexithymia and abstract IQ was not significant. Bagby et al. (1986) did not report separate results for males and females. Pierloot and Vinck (1977) found that, in a group of patients referred for psychotherapy (31 females and 19 males), alexithymia as measured by the BIQ, was negatively correlated with WAIS-R Vocabulary scores. While they reported that there were no sex differences in BIQ alexithymia scores, they did not report sex differences in the negative alexithymia-Vocabulary correlation. Without adequate explanation of their estimation methods Pierloot and Vinck suggested that alexithymia was associated with an "impression" of lower intelligence, i.e. patients were judged to be less intelligent than they really were.

Alexithymia, as these studies indicate, is associated with a disruption of, or deficit in, general semantic processing and expression. Overbeck (1977) did a quantitative study of the language used by patients in psychotherapy, and found that alexithymics, relative to "neurotics", spoke less, had less spontaneous speech production, and were more silent. Loiselle and Dawson (1988) found that alexithymic individuals find topics related to personal feelings and problems to be significantly more difficult to discuss, though they did not rate the importance of such disclosures differently from nonalexithymics. They also found that, in addition to having a reduced tendency to daydream, think and reflect about the self, and a greater inclination to orient thinking to external events, the alexithymic restrictive communicative style is limited to the expression of emotions and includes other self-relevant information low in affective content as well.

Regarding the relationship between alexithymia and established speech disorders, alexithymia seems to be similar to problems of receptive and expressive aphasia with the characterisitic "no words for emotions". Alexithymia may involve a left hemisphere expressive anomia (diminshed ability to name things) and a right hemisphere emotional aprosodia (a loss of prosody or affective intonation).

Studying the loss of affect following brain injury Ross (1981) coined the term aprosodia to refer to the various combinations of aprosody found in patients with right hemisphere damage. Ross (1984) stated that "the aprosodias should be viewed as encoding and decoding disorders of affective behavior" mediated by the right hemisphere (p.344):

> ...patients with right brain lesions have shown that focal brain damage may seriously impair the affective (intellectual and emotional) components of prosody and gestures without disrupting the more linguistic features of language" (p.343).

Canacelliere and Kertesz (1990), however, report the importance of the basal ganglia in the mediation of emotional expression and comprehension They rated 28 right hemisphere stroke patients, 18 left hemisphere stroke patients, and 20 controls on a standardized test of the expression, repetition, and comprehension of emotional prosody and measured their ability to visually recognize emotional faces and situations. With lesions in either hemisphere, basal ganglia involvement was associated most frequently with aprosodic syndromes, followed by lesions involving the anterior temporal lobe and the insula. Impaired comprehesion of emotional facial expressions and situations was also associated with basal ganglia and anterior temporal lobe damage.

Alexithymia may be similar to anomic aprosodia, which literally means 'without name and emotional contour'. Is the decreased affective awareness and expression and word loss to name emotions a speech difficulty due to left hemisphere difficulties? Case studies of alexithymic individuals demonstrate that, in addition to language difficuties, alexithymics have other diminished cognitive abilities.

Case Studies

Buchanan, Waterhouse, & West, 1980 reported a case of alexithymia involving agenesis of the corpus callosum. Despite having an average level of verbal ability with a Wechsler verbal IQ of 98, "Mr. H" described his primary problem as an inability to communicate his feelings to others or to understand the motivations of others. Buchanan et al. suggested that his interpersonal communication difficulty resulted from his inability to label or differentiate affect. This supports findings with split-brain patients and emphasizes the importance of the corpus callosum in alexithymia. Two cerebral lesion cases (Blackshaw & Bowen, 1987; Fricchione & Howanitz, 1985) suggest that disruption of the frontal areas of the brain are consistent with an alexithymic presentation. Interestingly one of these cases had a lesion in the right frontal area while the other had a left sided lesion. Perhaps alexithymia has different presentations depending on the side of the brain compromised. Research on hemispheric specialization may indictate brain correlates of alexithymia in individuals without documented brain "pathology".

Hemisphericity Research

Hemisphericity and lateralization research suggests a relationship between right hemisphere functioning and some of the cognitive-affective difficulties observed in alexithymics. Hemisphericity is a term coined by Bogen (1969) to refer to a hypothesis that humans tend to greater reliance on either the left or right cerebral hemisphere in overall psychological functioning. Bakan (1969) hypothesized that the direction of the conjugate lateral eye movements (CLEMs) that people make when thinking about a question is indicative of relatively greater activation of one hemisphere over the other. A predominance of CLEMs in one direction is thought to indicate hemisphericity. In Bakan's typology (Bakan, 1971), people showing a predominance of left CLEMs are called "left movers", while people showing a predominance of right CLEMs are called "right movers". Bakan (1969) found that left movers were more hypnotically susceptible than right movers and suggested that CLEM direction may account for some individual differences in cognition and personality. Katkin (1985) reviewed electrophysiological and cerebral blood flow studies supporting Bakan's (1969) hypothesis. Gur and Gur (1975) found that left movers differed from right movers in their reliance on defense mechanism "clusters" as measured by the Defense Mechanism Inventory; right movers scored higher on defense mechanism clusters of projection and turning against others, while left movers had higher scores on the defense mechanism cluster of reversal which includes repression, denial, negation, and reaction formation.

Some of the cognitive abilites and psychological processes thought to be disrupted, or absent in alexithymics have been associated with right hemisphere functioning by CLEM researchers. Schwartz, Davidson, and Maer (1975) found that emotional questions were associated with significantly more left CLEMs (and significantly fewer right CLEMs) than non-emotional questions, suggesting greater right hemisphere activation during the processing of emotional information. They also suggested that the hemispheric involvement in affective processes could be differentiated from cognitive processes. Left movers, relative to right movers, have been found to be more hypnotically susceptible (Bakan, 1969) and to recall a greater number of dreams (Van-Nuys, 1979-80), and to rely on the "reversal" defense mechanisms of repression, denial, negation, and reaction formation (Gur & Gur, 1975). Given that alexithymics have been found to have diminished hypnotizability (Frankel et al., 1977), possibly diminished emotionality, ability to fantasize and recall their dreams, and a possible reliance on the defense mechanism of denial (Nemiah, 1975), alexithymic cognitive difficulties may stem from the absence, disruption, or operation of right hemisphere processes. In brain injured individuals, eye movements are predominantly towards the lesion, while heightened brain activation (as in epilepsy) is associated with eye movements predominantly away from the lesion or activated hemisphere (de Renzi, 1982).

In light of these observations Cole and Bakan (1985) hypothesized that alexithymic characteristics were characteristic of left hemisphericity, and that, with a 'deficit' in right hemisphere processes, alexithymia should be associated with a predominance of right CLEMs. Paradoxically, they found a small but significant positive correlation between left CLEMs and alexithymia, suggesting more of an association with right than left hemisphericity. Cole and Bakan suggested overactivation of the right hemisphere may result in a functional inhibition of the cortical structures mediating the cognitive abilities diminished in alexithymics. The pathway or mechanism by which this could occur may involve the limited capacity information processing system. In a stressful situation (i.e. "hot" interpersonal communication) the alexithymic may be unable to process emotional information due to the processing of external-concrete information. According to Mandler (1984):

> Whenever such events claim and preoccupy some part of the limited capacity system, other cognitive functions will suffer, that is, they will be displaced from conscious processing (p.99)

Thus, cognitive functions involved in the identification and expression of feelings, hypnotizability, and dream recall may be displaced from conscious processing in alexithymia. This model would apply to cases of secondary alexithymia while in cases of primary alexithymia there appears to be a deficit or lack of these cognitive abilites.

Given the hemispheric specialization model, there are a number of possible neuropsychological explanations of alexithymia. Taking into account the hypotheses forwarded by Nemiah (1977): (1) the affective "behavior" mediated by the right hemisphere is for some reason not transmitted to the speech centers in the left hemisphere, resulting in a lack of cognitive integration of emotional experience; (2) the right hemisphere's emotional information processing capabilites are dysfunctional because of either a lack of, or an inhibition, of the relevant cerebral structures, resulting in diminished emotional processing and conscious experience of affect. Nemiah (1984) makes a distinction between two kinds of psychological structure and their modes of information processing. In one, unconscious elements predominante (neurotic cognition), while in the other, there is a lack of unconscious processing:

> In many individuals. . .one finds a complex psychic organization of drives, feelings, fantasies, memories of past experience and relationships, and other mental functions, all of which are subject to defensive mechanisms that render many of the mental elements

> unconscious. By contrast, however, there are many individuals in whom this elaborate structure of psychological functions and processes does not exist. Subjected to the arousal prompted by an environmental stress, they have no psychic apparatus over which to process, modulate and shape that arousal, which is constanly short-circuited directly into the somatic symptoms that constitute a psychosomatic disorder. It must be emphasized that both types of indivduals are reacting to stress; the difference lies in the internal processes of transformation that lead in each to a distinctly different form of response - that is, to either a neurotic or psychosomatic disorder. In the former, unconscious factors play a pathophysiological role in symptom production; in the latter they do not (p. 83).

If alexithymia could be explained by a lack of "internal processes" involved in the processing or transformation of emotional information, a method to measure this is necessary. Recent attempts to measure cognitive development and the representation or different access thresholds of "salient" cognitions and affects have relevance to the task of measuring the cognitive disruptions or difficulties associated with alexithymia.

Cognitive Representation, Information Processing, and Subliminal Perception

Much of the cognitive development research has addressed issues of intellectual and language functioning. According to Mandler (1984) many of the insights gained from a knowledge of those processes have relatively little bearing on emotional functioning. Lane and Schwartz (1987), however, provide a theoretical cognitive basis for alexithymia by demarcating levels of emotional awareness corresponding to levels of cognitive development in a Piagetian framework. The ability to differentiate complex emotional states is dependent on cognitive development and differentiation (i.e. cognitive development is necessary but not sufficient for emotional awareness). This framework supports the hypothesis that the cognitive complexity in general corresponds to the cognitive complexity of emotional experience, and suggests how differences in cognitive development may be associated with differences in the recognition and differentiation of emotional states. The results of a study by Martin and Pihl (1986) using the SSPS alexithymia measure provide some support for the hypothesis that alexithymic characteristics are manifestations of deficits in cognitive schemata that mediate affective responses (Martin & Pihl, 1985). In addition to finding that high alexithymics may have higher levels of physiological stress responses Martin and Pihl (1986) found a dissociation between subjective and physiological measures of stress among subjects with high alexithymia scores.

Recent developments in psychodynamic theory on the relationship between affect and repetition compulsion may have implications for understanding the development of cognitive differences associated with alexithymia. According to Wilson and Malatesta (1990) repetition compulsion may reflect the influence of pre-verbal affect that remains undifferentiated with the onset of defensive operations, lexical representation, and speech:

> We hypothesize that certain emotional experiences may escape the net of lexical appropriation and remain outside of conscious awareness and recall, still influential in the personality organization, unconscious yet exerting a repetitive claim on action with the archaic logic of prelexical mentation. . . the existence of feeling states, we have seen, precedes the capacity of language to describe them, and, in fact, language at first does a rather poor job of communicating such state...early language is far superior in communicating categorical information; gradient information is the type of information of which early affect states are constituted. The advent of language introduces an original sense of alienation and estrangement into the patterning of early mental life, a radical discontinuity between that which is felt and that which attains lexical representation. It is this bifurcation that characterizes the schism into primal and symbolic representation (pp 291-292).

Alexithymics may lack emotional symbolic and lexical representation, but do alexithymic characteristics represent a repetition compulsion of early affective states? This hypothesis would be supported by a defense mechanism explanation, a view inconsistent with Nemiah's hypothesis that alexithymia is associated with a lack of unconscious processing. While Bagby et al. (1986) report findings that suggest that alexithymia is not associated with defensive operations they do not, however, explain the mechanisms involved in the cognitive-affective differences between alexithymics and non-alexithymics. A general review of the distinction between conscious and unconscious cognitive processing may help explain how cognitive-affective schemata may be different in alexithymics.

The notion that much of cognitive processing operates 'outside' of awareness, is in accordance with Miller's (1962) idea that consciousness "...is the result of thinking, not the process of thinking that appears spontaneously in consciousness' (p.56). In a recent review of the unconscious mechanisms underlying cognitive processes Kihlstrom (1987) suggested that

> . . .the cognitive unconscious encompasses a very large portion of mental life . . . [and that] a good deal of mental activity is unconscious in the strict sense of being innaccessible to phenomenal awareness under any circumstances (pp. 1446-1447).

Unconscious procedural knowledge (i.e. we are aware of the meaning of words but not of the phonological and linguistic principles used to decipher the meaning of speech) is thought to be mediated by cognitive modules, specific to a given modality (i.e. language and visual perception), that are 'hardwired' in the nervous system and operate or perform cognitive computations without conscious awareness (Fodor, 1983). Skills that are not innate are thought to become routinized with practice and their operations subsequently committed to the unconscious. Unconscious procedural knowledge is thought to be automatic (i.e., without elements of cognitive control or effort). These processes and their respective computation of stimulus characteristics are activated automatically by appropriate stimuli and require minimal attentional mechanisms or resources.

The importance of research on automatic cognitive processing is that it shows that a great deal of complex cognitive activity operates outside of conscious awareness. An example of how the emotional meanings and implications of events can be unconsciously processed is that people reach conclusions about events (i.e. their emotional valence) and act on these judgements without being able to articulate the reasoning involved in formulating them (Zajonc, 1980). While it is assumed that cognitive activity is involved in the formulation of judgements and inferences there is a distinction between those processes which are available to conscious awareness and those which are not (automatized cognitive activity is unconscious given that it is unavailable to conscious awareness) (Kihilstrom, 1987).

Research on subliminal perception (Dixon, 1971; Erdelyi, 1974) attempts to integrate findings from perception, personality, and motivation and gives empirical support to the psychodynamic hypothesis that people defend against potentially threatening percepts, memories, ideas, and impulses by excluding them from awareness (Kihilstrom, 1987). For example, Bruner & Postman (1947) and McGinnies (1949) reported individual differences in thresholds and reaction times for identifying emotional words and neutral words. These, and more recent studies (Kunst-Wilson & Zajonc, 1980), show that words can be analyzed for their emotional significance and physical features before reaching awareness. Results from recent research using emotional forms of the Stroop test suggest that this analysis of emotional words varies according to the salience that these words have for the subject's network of cognitive schemas or representational structures. The following is a review of the

Stroop test, the involvement of hemispheric processes in Stroop test performance, and the use of emotional Stroop tests to demonstrates the interaction between conscious intentions and automatic "unconscious" processes.

The Stroop Test

The original Stroop test format (Stroop, 1935) requires a subject to name the color of color words (e.g. red, blue, green) printed in colors incongruent with the color represented by the word. For example the word "red" may printed with green ink, and the subject is required to disregard the word, ~~and~~ to attend to and name only the color green. The Stroop effect, interference of the word in the naming of the color, represents the interference that can occur between conscious strategies and automatic activation processes (Posner & Snyder, 1975) and shows that the visual and verbal information processing systems do not act independently. The Stroop phenomenon has a research history that spans a century (Cattell, 1886; Ligon, 1932; Stroop, 1935) and has been well documented to show interference between one's conscious intentions (to name the color of ink that color words are printed in) and automatic activation processes (responses to the written word). Thus, "...subjects cannot choose to avoid processing aspects of an input item that they desire to ignore" (Posner & Snyder, 1975, p.56). For reviews of the Stroop phenomenon and variations of the Stroop test see Dyer (1973), Izawa and Silver (1988), and Jensen and Rohwer (1966). According to Jensen and Rohwer (1966) the high test-retest reliability of Stroop scores, which increases with each retesting, suggests that the Stroop test measures highly stable individual differences. Although the nature of these differences are not well understood, the processes tapped by the Stroop are basic and have broad significance.

As reviewed by Izawa and Silver (1988) two of the most popular explanations for the Stroop effect are that interference occurs (1) in an early stage emphasizing perceptual, attentional, or encoding factors, or (2) in a late stage emphasizing response competition factors. Some of the early stage hypotheses involve: perceptual conflict (Hock & Egeth, 1970; Nealis, 1973; Williams, 1977), sensory interference (Flowers, 1975), selective attention (Francolini & Egeth, 1980; MacKinnon, Geiselman, & Woodward, 1985; Treisman & Gelade, 1980), and duration of stimulus processing (Duncan-Johnson & Kopell, 1981). The perceptual conflict hypothesis suggests subjects are unable to restrict their attention to the relevant aspect or feature of the Stroop stimuli (Dyer, 1973; Glaser & Dolt, 1977; Treisman, 1969). The selective attention component and the fact that word reading is faster than ink color naming (Brown, 1915) lead to the formulation of "horse race" (Dunbar & MacLeod, 1984) explanations, i.e. both word and ink color may be processed at the same time but word reading is processed before ink color naming. Thus the word information interferes with the latter processed ink color information. Seymour (1977) suggests interference occurs in the conceptual encoding stage. The response conflict explanation of the Stroop effect (reviewed by Dyer, 1973) suggests the increase in color naming time is a result of

> ...faster assignment of spoken words to written word stimuli than to colors and the resulting conflict between this faster response to the

irrelevant word aspect of the stimulus and the response to the relevant color aspect of it (p.108).

Glaser and Glaser (1982) suggest that neither perceptual or response interference models adequately explain the effect. Williams and Nulty (1986) suggest that interference appears to occur at an intermediate processing level where stimuli are semantically analyzed. While there is no conclusive evidence for response competition or encoding explanations of the Stroop effect, it may be seen as involving cognitive processes important in attention to and naming of complex stimuli such as emotions.

The Stroop test and the cerebral hemispheres

The Stroop test is thought to draw on the abilities of both the right and the left cerebral hemispheres (Newman, 1981). With verbal abilities largely mediated by the left hemisphere, the processing of color is thought to be mediated by the right hemisphere (Davidoff, 1976; De Renzi & Spinner, 1967; Pennal, 1977), although color-naming responses require verbal mechanisms. Levy (1978) had split brain patients name the characteristic color of objects depicted in line drawings presented to the disconnected left hemisphere, and found that their performance was inferior to that of normal subjects suggesting that the right hemisphere provides the left hemisphere with some semantic color information. Newman suggests the Stroop test requires the subordination of an automatic verbal, left hemisphere task, for the right hemisphere task of color recognition, which is then encoded for verbal expression by the left hemisphere.

Right hemisphericity has been associated with relatively slower Stroop performance and alexithymia. Bakan and Shotland (1969) found that right movers (as defined by the CLEM test) had superior Stroop performance and faster reading speed than left movers. Sex differences were not reported in this study. The association between right hemisphericity and slower Stroop performance is consistent with a study by Cole and Bakan (1985), who found that left movers had higher alexithymia scores than right movers. They suggested that alexithymia may be associated with disruption of the limited capacity information processing system resulting in a disruption of functions of the right hemisphere that mediate some of the cognitive functions compromised in alexithymics. It may be that the color analysis ability of the right hemisphere is diminished in alexithymics, resulting in compromised processing of color information.

In a study of how emotion can affect Stroop performance, Newman (1981) reported that state anxiety in high and low task demand conditions impaired Stroop performance, and was associated with more left conjugate lateral eye movements (suggesting right hemisphere activation). Newman (1990) presented Stroop stimuli to the left and right visual fields of subjects scoring either high or low in Trait anxiety in relaxed versus aroused conditions. He found that high or low arousal situations caused longer interference times when stimuli were presented to either the left or the right visual fields, while moderate arousal facilitated performance. He also found that subjects with high trait anxiety scores had higher interference scores in the relaxed condition and "apparant left-hemisphere impairment" regardless of which visual half-field the stimuli was presented to:

> . . .this suggests that the locus of Stroop Color-Word interference effect rests specifically with difficulty in disengaging left hemisphere control and achieving a balance of activation favoring the right hemisphere over the left. This is even more difficult for anxious subjects. . .as trait anxiety reaches high levels, it appears to result in inability to shift from a verbal cognitive mode. . .the end result is consistent with impairment of task-appropriate right hemisphere response to color (p.6)

He also suggested that a paradoxical effect of trait anxiety is rigidity and stereotypy of cognitive functioning impairing ability to assume appropriate alternative cognitive modes. The detrimental effects of anxiety on Stroop performance has also been shown by Martin and Franzen (1989) who also found that the performance of males deteriorated under mild anxiety conditions while females' performance either remained stable or improved.

In summary, the Stroop effect is influenced by emotional factors, and there seems to be an interaction with sex in that, under stressful conditions, males perform more poorly than females. The relationship between emotions and Stroop performance will now be further reviewed.

With regard to the processing of emotional words Posner & Snyder (1975) suggest that:

> Emotional information is stored as a high level but habitual associate to given words or constellations of words. One would expect that the presentation of an item would automatically activate associated emotional responses. These responses might feed back to affect the conscious mechanism guiding its processing of the various kinds of information associated with the input item. The complexity of this view fits with the rather diverse results obtained in many experiments involving emotional items. . .Thus, the presence of emotional information may lead in some contexts to perceptual vigilance, and in other cases, to perceptual defense (p.81).

Research on retrieval bias (Bower & Cohen, 1982) shows that subjects recall information congruent with their reported mood. Variations in mood may be associated with differences in the cognitive representation of emotion. In their discussion of information encoding, storage, and retrieval processes Williams & Nulty (1986) discuss individual differences in representational systems:

> ...if the way information is stored and retrieved, i.e. some constructs are more accessible than others - then this will in turn bias the encoding of information. A vicious circle is set up within the cognitive system in which information congruent with what is most salient and accessible is selectively processed which in turn activates and enriches these memory structures (p.485).

Several researchers have recently used emotional words in a Stroop test format to test the hypothesis that emotional words will be associated with color naming interference when they are salient or relevant to the subject. The advantage of using the Stroop format in this regard is that emotional Stroop performance is automatic and thus not affected by the operation of psychological defense mechanisms. Mathews and MacLeod (1985) found that 24 subjects (12 male and 12 female) referred by their GP for anxiety treatment, relative to 24 (12 male and 12 female) controls, had greater color naming interference with words related to physical or social threat. They also found that interference was greater when words were specific to the type of anxiety reported (i.e. health related concerns vs. social worries).

Gotlieb and McCann (1984) found that subjects who scored in the clinically significant range on the Beck Depression Inventory, relative to non-depressed controls, exhibited more Stroop interference on 50 words rated by depressed patients as being most self-descriptive than 50 words so rated by manic patients, and 50 neutral content words. Thus, most Stroop interference was observed with words consistent with the subjects' cognitive constructs. This gives some support for the hypothesis that depressed individuals differ from non-depressed individuals in the relative accessibility of positive and negative cognitive constructs.

Watts, McKenna, Sharrock, and Trezie (1986) found that a sample of 35 spider phobics, 2 males and 33 females relative to a non-phobic control group of 16 males and two females, exhibited significantly more color naming interference with spider related words, than the standard Stroop test, or a Stroop test using general threat words. There was no difference on standard Stroop scores between the phobic group and a matched group of non-phobic control subjects. Chammon, Hemsley, and de Silva (1988) found that 20 anorexic subjects have greater interference with food related words than 20 non-anorexic controls. Ray (1979) found that students just about to take an exam had greater interference in color naming words related to examination anxiety compared with neutral words, with the effect being strongest among subjects with high state anxiety.

Mogg and Marden (1990) used stimulus words referring to social threat, physical threat, positive emotion, and two groups of neutral words (one matched with the emotional words for word frequency and the other consisting of high frequency words) to compare 12 medical students with high trait anxiety with 12 students with low trait anxiety. They found that high trait anxiety was associated with selective processing of emotional stimuli, and not threat stimuli.

Williams and Broadbent (1986) found that recent suicide (drug overdose) attempters (17 females and 8 males) had greater color naming interference with suicide related words than controls (25 hospital patients, and 25 non-hospitalized subjects). They also found that interference was greatest when words specifically related to overdose were presented. They suggested that recent suicide attempters have highly accessible overdose related cognitive constructs or schemata.

Bower (1981) found that subjects in either a happy or angry emotional state show greater color-word interference with both pleasant and unpleasant words compared with neutral words. Williams and Nulty (1986) studied the possibility that color naming on an emotional Stroop test using negative emotion words could be due to the effects of transient mood states. Women who had taken the Beck Depression Inventory one year before the experiment and indicated that they were somewhat improved, though still chronically depressed, showed the greatest amount of color naming interference. They suggested that interference in color naming reflects not just a transient effect of mood, but a stable cognitive difference associated with depression.

Giles and Cairns (1989) used an emotional Stroop with violence related words with English and Irish students living and studying in Northern Ireland, and English students studying in England (with a total of 120 subjects with each of the three groups having equal numbers of males and females). They found that English students living in Northern Ireland demonstrated significantly greater color naming interference on the Violent Stroop than the Irish Students, or the English students living in England. They suggested that the Irish students may have habituated to violence while the English students had not.

Bentall and Kaney (1989) compared 16 patients with persecutory delusions to 15 matched psychiatric controls and 16 normal controls on 4 Stroop measures: color naming of strings of "0's", neutral words, negative affect words, and words judged to be of paranoid content. Deluded patients, relative to controls, had a selective increase of reaction time for the color naming of paranoid words. Bentall and Thompson (1990) measured interference associated with neutral, depressive, and manic or euphoric words in an emotional Stroop format with groups of undergraduate students scoring high (6 males and 8 females), medium (8 males and 6 females), and low (4 males and 10 females) on a self report measure of hypomanic personality. They found that interference was greatest with depressive words, and suggested that this was consistent with the psychodynamic hypothesis that hypomanic traits reflect a defense against depressive feelings.

Dawkins and Furnham (1989) found that "repressors" (n=12) showed more interference on an emotional Stroop test using negative words than did "low-anxious" subjects (n=12), and that the performance of "high anxious" (n=12) subjects was similar to that of the "repressors". There are mixed results with regard to the relationships between alexithymia, "repression", and anxiety. Wise et al, (1990) provide data that suggests alexithymia is not associated with a denial of feelings but rather with difficulty in the expression of feelings. Taylor et al. (1990) also provide data in support of the hypothesis that alexithymia is not associated with a repressive coping style or excessive use of denial. However, Bagby et al (1986b) report data indicating that high alexithymia scores are associated with high scores on both the State and Trait Anxiety Inventories. While it is debatable whether empirical data from university students can be generalized to cases of alexithymia in clinical settings, there appears to be a lack of support for Nemiah's (1975) denial/conflict model. One of the aims of the present study is to use an emotional Stroop test to address the deficit model hypothesis that irreversible ego deficits are associated with an <u>absence</u> of cognitive functions involved in the experience of affect and fantasy.

Hypotheses

Two sets of hypotheses were tested in this study. The first set were formulated to investigate the degree of presence or absence of emotional schemata among alexithymics. There are at least two plausible hypotheses regarding the relationship between alexithymia and emotional Stroop performance. The first would be consistent with Nemiah's (1975) hypothesis that alexithymics have a lack of feelings or emotional schemata, that is, alexithymics may exhibit less Stroop interference with emotional words. The second would be consistent with the hypothesis that alexithymics *have* feelings and emotional schemata (with the alexithymic having difficulty with the expression of feelings), that is, alexithymics may show greater Stroop interference with emotional words.

The second set of hypotheses were formulated to examine the possibility that the alexithymic's emotional difficulties may be secondary to difficulties with general verbal abilities. Consistent with findings that alexithymics, relative to non-alexithymics, use fewer words to describe stimuli with regard to emotional valence and adjectives, subjects with high alexithymia scores may have an overall verbal deficiency that would be suggested by lower vocabulary, similarities, and word fluency scores.

These hypotheses were tested with the administration of a number of tests to subjects with high, medium, and low alexithymia scores. An emotional Stroop test was administered to compare the degree of color naming interference with positive emotion words, negative emotion words, and neutral words. The Vocabulary subtest of the WAIS-R (Wechsler, 1981) was administered to measure vocabulary abilities and an "emotional vocabulary" measure was developed by removing the scores on three "emotional" words from the vocabulary test (compassion, remorse, and tirade), while the Similarities subtest (Wechsler, 1981) was administered to test the notion that alexithymia is associated with concrete thinking. The Controlled Oral Word Association Test or FAS test (Benton & Hamsher, 1976; Benton et al.., 1983) was administered to measure word fluency.

II. METHOD

Subjects

Three hundred students from two Introductory Psychology classes completed the Toronto Alexithymia Scale and signed a consent form indicating that they were available for further aspects of the study (vocabulary, fluency, and Stroop testing). This represented a compliance rate of about 43% as the classes had a combined n of about 700. The primary researcher was kept blind to the alexithymia scores until all the scoring of the verbal tests was complete. The distributions of scores for males and females were separately examined to see if the assumption of normality was warranted. Subjects for further experimentation were chosesn randomly from the n of 300. Randomness was approximated by putting slips of paper numbered one to three hundred into an envelope and choosing individual subjects by the number drawn. While attempts at contact were made with all 300 Ss, 224 Ss arrived for testing. Subjects were asked if they were color blind and to name the colors of the first three items on the pure color stimulus (columns of XXXX's printed in red, blue, or green ink). One male subject had to be excluded from the study because he reported being color blind and was unable to distinguish the colors of the Stroop stimuli. Two males reported that they may be a little color blind, but did not have any difficulty discriminating the three colors used. Their alexthymia and Stroop scores were generally similar to the final group of males used, and their data was included. A total of 223 subjects were tested.

English as second language subjects

Subjects were asked if they spoke a language other than English in the first few years of their lives. As shown in the appendix there were some large differences between the means and standard deviations of vocabulary and Stroop test scores between the language groups. Vocabulary scores were about ten points lower and the standard deviations for Stroop scores were two times larger with males who had a language other than English as their first language, while females had larger standard deviations and larger interference scores. To create a homogeneous sample a total of 33 subjects with a first language other than English, or who learned English concurrently with another language, were excluded from statistical analysis.

Left handed English first language subject mean differences

Following up research finding that left handers have differences in cerebral lateralization (e.g. Springer & Deutsch, 1989) and that left handers had higher alexithymia scores than right handers (Rodenhauser, Khamis & Faryna, 1986), the data for left handers was compared with that from right handers. As shown by the data in the appendix, Stroop scores were lower among left handed males relative to right handed males, while left handed females had lower alexithymia scores than right handed female subjects. To maximize the homogeneity of the groups for comparison, left handed subjects were excluded from statistical analysis.

Outlyer

An examination of scatterplots (BMDP6D) of the data revealed one female subject had scores consistently deviating from the majority of the other scores. Her Stroop scores were between two and three standard deviations above the female mean and her alexithymia score was over one standard deviation below the mean. With the aim of making the sample as homogeneous as possible her data was excluded from the analysis resulting in the female sample being reduced to 124.

Summary of subjects excluded

The tested sample of 223 subjects was reduced by 45 to a total of 178. Thirty three subjects (11 male and 22 female) with a first language other than English or another language learned concurrently with English were exluded. Eleven (7 male and 4 female) left handed subjects, and one female outlier were also excluded.

Procedures

Ss were asked by phone to meet at a room at Simon Fraser University, CC5323, at a mutually convenient time, and, after an explanation of their participation was given, the following tests were administered: the emotional Stroop test (comprised of a color naming stimulus and neutral, positive, and negative emotion word Stroop stimuli), the Vocabulary WAIS-R subtest, the FAS test of verbal fluency, and the Similarities WAIS-R subtest. The tests were administered to all subjects in the following order: Pure Color, Similarities, Neutral Words, Word Fluency, Positive Words, Vocabulary, and Negative Words. The rationale for the order of presentation was the possibility that the similarities subtest may be associated with more distress than the other verbal tests. To avoid "priming" an affective state before the emotional Stroop stimuli, it was given before the neutral color-word stimulus. The administered tests will be described following an outline of the experimental procedures.

The subjects were all seated at a table facing the same direction, and a tape recorder was placed on a chair, out of view of the subject, beside the researcher and started at the beginning of the administration of the color naming test. They were told that the session was being recorded because some of the tests were timed and the tape recorder served to ensure that if a mistake was made retesting would not be necessary. Timing of the tests was recorded with a digital stopwatch. A total of seven subjects were run through the experimental procedures to establish a degree of familiarity-automaticity for the researcher in administrating the tests. The data from these subjects was not included in the statistical analysis.

Measures

The Emotional Stroop Test

The Stroop test can be generally described as a cognitive stress test used to measure aspects of cognitive flexibility and complexity, resistance to interference from outside stimuli, brain dysfunction, personality variables, and psychopathology (Golden, 1978; see Dyer, 1973; Jensen & Rohwer, 1966 for reviews of research on the Stroop phenomenon, scoring procedures, and variations of the test). The measure of the Stroop effect (Stroop, 1935) most often used clinically was constructed and standardized by Golden (1978) referred to here as the "standard" Stroop test.

In the Stroop test an overlearned, "automatic" response (reading words aloud) competes against a slightly more difficult task (naming colors), resulting in semantic interference during stimulus processing; the test taker has difficulty attending to the salient color aspect of the stimulus. The Stroop test scores W, C, CW are the number of seconds it takes to: name color names printed in black, name the color that XXXX's are printed in, and naming the color that color words (red, blue, green) are printed in. The CW task is challenging in that the words are incongruent with the color that they are printed in (i.e., red will be printed with green ink), causing an interference effect as the subject cannot help but have color naming influenced by the word printed. The interference effect is seen in the average W, C, & CW scores obtained by 436 undergraduates Jensen (1965): 38.09 secs, 58.24 secs, and 100.36 secs respectively. Jensen (1965) reported that reliabilities of these scores are W=.88, C=.79, CW=.71. While there are some practice effects with color naming, the ranking of individual's scores on this test are maintained (Jensen & Rohwer, 1966) so the interference phenomenon is consistent despite the effects of practice. The consistency of the phenomenon despite wide variations in the method of stimulus presentation adequately demonstrates its validity.

The Stroop stimuli used in this study were constructed with a spreadsheet program (Excel 1.5) on a Macintosh Plus computer. Neutral emotion words, positive emotion words, and negative emotion words between 5 and 7 letters long were selected from a word list compiled by Rubin & Friendly (1986). The 'best' 5 words in each group were chosen on the basis of the homegeneity of their mean emotionality, pronounceability, and frequency ratings, and standard deviations. Following a description of these word parameters, Tables 1, 2, and 3 list the emotionality, pronounceability, and frequency ratings of the final groups of 5 words used.

Emotionality

Rubin and Friendly (1986) measured emotionality of 925 nouns by having university students rate the 925 words using a 7-point scale that ranged from not emotional (1) to average (4) to emotional (7). The Cronbach alpha calculated for the emotionality scale was .975.

Pronounceability

Rubin and Friendly (1986) measured pronounceability by having university students rate the 925 nouns on a 9-point rating scale that ranged from easy (1) to average (5) to hard (9). The Cronbach alpha calculated for the pronounceability scale was .977.

Frequency

Based on an anaylsis of American English words by Kucera and Francis (1967), frequency scores represent the frequency of occurence of a total of 1,014,232 words compiled from samples of a wide range of categories of published written material (i.e., scientific articles, fiction, newspapers, religion, and popular magazines). Frequencies ranged from a high of 69,971 for the word "the" to a low of 1 for the word "x-ray". The importance of controlling for word frequency is suggested by the "word frequency rule": high frequency words are easier to process than low-frequency words (Joanette, Goulet, & Hannequin, 1990).

TABLE 1. Neutral Word Parameters

Word	Emotionality	Pronounceability	Frequency
Plain	2.45	1.89	48
Ticket	2.59	2.91	16
Clock	2.38	2.38	20
Journal	2.45	4.46	42
Gallery	2.57	4.23	31
Mean	2.48	3.17	31.40
Std. Dev.	12	1.13	13.74

TABLE 2. Negative Word Parameters

Word	Emotionality	Pronounceability	Frequency
Misery	6.25	3.91	15
Anger	6.20	3.09	48
Shame	5.61	2.09	21
Panic	6.36	2.46	22
Anxiety	6.05	5.68	42
Mean	6.01	3.33	29.60
Std. Dev.	.29	1.43	14.47

TABLE 3. Positive Word Parameters

Word	Emotionality	Pronounceability	Frequency
Warmth	5.64	4.20	28
Virtue	5.11	4.11	30
Charm	5.18	2.64	26
Passion	6.59	3.25	28
Pride	5.60	2.20	42
Mean	5.62	3.28	30.80
Std. Dev.	.59	.88	6.42

The words were printed (using a Canon color laser printer) in three colors (red, blue, and green) and were fully randomized (with a pseudo-randomization technique) for color and order. The decision to use only three colors was based on findings by Golden (1974) that the number of colors used has little effect on Stroop performance and that the use of a simple three color test is preferable. Successive repetitions of words or colors were avoided by relocating individual words and colors, and, in each column no color or word is repeated consecutively. As seen in tables 4, 5, and 6, the colors used are balanced and each word is shown 20 times per page, with a total of 100 words per page.

TABLE 4. Neutral Words Color Count

Word	Col 1	Col 2	Col 3	Col 4	Col 5	B R G	Total
Journal	BBGRG	BRRG	BBG	RBGG	RRBG	7 7 6	20
Clock	RRGB	RGRB	BRBG	GBRR	BGGR	6 8 6	20
Ticket	GRBB	GBGR	RGGB	RGRB	GBGR	6 6 8	20
Plain	RGRB	RBGG	GRGR	GRGB	BBBG	6 6 8	20
Gallery	BGR	GBRB	RGBGR	BGRB	GRRB	7 7 6	20
	BGR	BGR	BGR	BGR	BGR		
Freq.	7 6 7	6 7 7	6 8 6	6 7 7	7 7 6		
Total	20	20	20	20	20		100

TABLE 5. Positive Words Color Count

Word	Col 1	Col 2	Col 3	Col 4	Col 5	BRG	Total
Virtue	RGBGR	RBG	GGGB	RBGB	BRRB	7 6 7	20
Pride	GBRR	GRBRB	BBG	GRRG	RGGG	5 7 8	20
Charm	RGBG	BGBGR	BBRR	BRBG	GBR	8 6 6	20
Warmth	RBG	GBR	RRGG	GRBRR	GBBRB	6 8 6	20
Passion	BGRB	RGGB	RRRBB	GBG	BGGR	7 6 7	20
	BGR	BGR	BGR	BGR	BGR		
Freq.	6 7 7	7 7 6	7 6 7	6 7 7	7 7 6		
Total	20	20	20	20	20		100

TABLE 6. Negative Word Color Count

Word	Col 1	Col 2	Col 3	Col 4	Col 5	R G B	Total
Misery	BRRG	BBBG	GRGR	RBRB	RBBG	7 5 8	20
Anger	BGBG	GGRBR	RBGR	BRBG	GBB	5 8 7	20
Panic	GGBB	RRR	GGBGB	RRRG	GGBB	6 8 6	20
Shame	RGGG	RGBR	BBRR	GGRB	BRGR	8 7 5	20
Anxiety	RBRB	BGRG	RBB	GBGR	GGRRG	7 7 6	20
	RGB	RGB	RGB	RGB	RGB		
Freq.	5 8 7	8 6 6	7 7 6	8 6 6	5 8 7		
Total	20	20	20	20	20		100

A card with XXX's printed in the three colors was also constructed to get a measure of color naming ability. The cards were presented in the following order: color naming, neutral words, positive words, negative words. The control sets (color naming, neutral words) were presented before the emotional words so that any within-session practice effect would tend to minimize emotional Stroop interference.

The score recorded with all the Stroop stimuli consisted of the number of seconds it took to name all the colors on the page. Consistent with Stroop's (1935) original instructions, subjects were told to correct any errors they made, and to continue naming the colors as quickly as possible. Errors were not recorded consistent with other Stroop researchers (i.e., Golden, 1978; Izawa & Silver, 1989; Williams, 1977; Williams & Nulty, 1986; Williams & Broadbent, 1986) reporting that few errors are made.

The Toronto Alexithymia Scale

The Toronto Alexithymia Scale promises to be the most valid self-report measure of alexithymia to date. Taylor, Ryan, and Bagby (1985) inititally used 41 self-descriptive statements, rated on a 5 point scale ranging from "strongly disagree" to "strongly agree", taken from the Schalling-Sifneos Personality Scale, the Introceptive Awareness subscale of the Eating Disorder Inventory, and from the Need for Cognition Scale. Item selection was done on the basis of an item-item correlation matrix which was subjected to factor analysis from which they selected items if they met two criteria: they had to load significantly on those factors theoretically consistent with the alexithymia construct, and the items had to have sufficient item-total correlations. The resulting 26 items , yielding scores ranging from a low of 26 to a high of 130, were subjected to a factor analysis which yielded four factors: (1) items that refer to the ability to identify and describe feelings and to distinguish between feelings and bodily sensations (12.3% of the variance); (2) items reflecting the ability to communicate feelings to other people (7% of the variance); (3) items referring to daydreaming (6.4% of the variance); (4) items reflecting a preference for focusing on external events rather than inner experiences (6.1% of the variance). The internal consistency of the scale is demonstrated to be adequate by Cronbach's alphas of a=.79 (Taylor et al., 1985) and a=.77 (Loiselle & Dawson, 1988). Good test-retest reliablility is shown by correlations of .82, .75, and .77 for 1-week, 5-week, and 3-month periods (Taylor et al., 1985).

With a sample of 542 university students, scores on the TAS did not correlate with age, education, response-set bias, or socio-economic factors as have earlier measures of alexithymia such as the Schalling-Sifneos Personality Scale (Taylor et al., 1985). Support for the convergent and divergent validity of the test is shown by its lack of correlation with a measure of reliance on the defense mechanism of denial; its negative correlation with measures of psychological mindedness, and need for cognition; its positive correlation with a measure of hypochondriasis (Bagby Taylor & Ryan, 1986b; Taylor and Bagby, 1988). These findings support the hypothesis that people scoring in the alexithymic range on the TAS are low on insight, have a concrete cognitive style, and are poor psychotherapy candidates. Taylor et al. (1988) gave evidence for the criterion validity of the TAS by showing that, in a sample of behavioral medicine outpatients, patients rated as alexithymic using a semi-structured interview scored significantly higher on the TAS than did non-alexithymic patients. From this they constructed TAS cut-off scores (Taylor & Bagby, 1988):

> Recognizing the limitations of using observer-rated interviews as a criteria of alexithymia and that alexithymia is best viewed as a graded or continuous personality variable rather than as an all or none phenomenon, we selected statistically conservative cut-off scores in

order to maximize the diagnostic validity of the TAS. While total scores obtained with the TAS may range from 26 to 130, we have recommended that a score of 74 or higher be used to identify alexithymic patients, and that scores of 62 or less be used for identifying non-alexithymic patients (p.357).

Using these cutpoints with the present sample there were 21 subjects (14 females, 11.3%, and 7 males, 12.3%) with alexithymia scores of 74 or above suggesting that a total of 21 or 11.8% of the subjects were "clinically" alexithymic. These rates differ from those found by Loiselle and Dawson (1988) who report, with a sample of 333 university students, that despite having an approximately normal distribution, a larger proportion of females than males scored in the alexithymic range (20.1% vs. 14.7%) although a Student's-t test indicated this sex difference was not significant.

The distribution of male TAS scores was negatively skewed, while the female TAS scores were positively skewed as seen in a comparison of the descriptive data of the original sample used for the construction of the TAS and the data for the present sample:

TABLE 7. Sample characteristics of Taylor et al. (1985)

Subjects	n	Range	Means	Std. Dev.	Mode	Skewness
Male	172	35-91	63.32	10.90	69	-0.46
Female	370	29-99	61.11	11.33	57	-0.01
Total	542	29-99	61.80	11.27	69	-0.17

TABLE 8. Sample characteristics of present study

Subjects	n	Range	Means	Std. Dev.	Mode	Skewness
Male	54	36-84	61.76	11.01	61	-0.42
Female	124	30-88	61.09	10.46	not unique	0.23
Total	178	30-88	61.29	10.60	66	0.02

Thus, despite Taylor et al.'s (1985) assertion that the distribution of TAS scores is normal, in both Taylor and Bagby (1988) and the present study, scores for males differ from those for females in that there were fewer males scoring in the low range of alexithymia. As mentioned earlier, these findings are inconsistent with those by Loiselle and Dawson (1988) who found that a larger proportion of females than males scored in the alexithymic range (20.1% vs. 14.7%). Thus, while the distribution obtained in the present study is dissimilar to the university sample used by Loiselle and Dawson it is generally similar to the distribution reported by Taylor and Bagby (1988) also using a university sample.

Grouping based on alexithymia scores

Three approximately equal groups of subjects with alexithymia scores in the high, medium, and low ranges were created by using the 'tertile' or thirty-third percentile scores provided by the BMDP2D data description program. The unequal n's that resulted from some subjects obtaining the same alexithymia scores were corrected by adjusting the cutoff scores until approximately even groups were produced. The cutoff scores for high and low alexithymia female subjects were 55 and 66 respectively, yielding groups containing 43 and 41 subjects in each. The adjusted medium alexithymia cutoff scores for females were 56 and 67, yielding 40 subjects in the middle group. For males the cutoff scores for the high and low alexithymia groups were 60 and 67: 18 subjects were in the low alexithymia group and 17 were in the high group. The middle group was created using cutoff scores of 61 and 66 for the middle group (n=19). To create equal groups, and to include the data from all subjects tested, the groupings used for anaylsis of variance were not based on the "clinical" cutoff scores suggested by Taylor and Bagby (1988). The result of this was the inclusion of people in the high alexithymia group with scores lower than the cutoff of 74 suggested for "clinical" alexithymia, and people with scores lower than the suggested "non-alexithymic" cutpoints used to create the low alexithymia group.

The Vocabulary subscale of the WAIS-R

The Wechsler Adult Intelligence Scale - Revised (WAIS-R) is an individually administered, composite intelligence test in a battery format that was updated in 1981 from an earlier version developed in 1955 by Wechsler and associates (Wechsler, 1955;1981). It is used to assess different areas of intellectual abilites and provides a context in which personality functioning can be observed. According to Lezak (1983) the Vocabulary subtest has been identified as the best WAIS-R measure of both verbal and mental ability. There are 35 words arranged in order of difficulty, and the test is administered with the examiner asking "What does ________ mean?" the subject is given a score of 0, 1, or 2 according to the 'goodness of fit' of the subject's response to the criteria listed in the WAIS-R manual. The obtained score reflects the extent of a subject's recall vocabulary and the effectiveness of his/her speaking vocabulary.

An emotional vocabulary subscale

The scores on three words from the WAIS-R vocabulary subtest, compassion, remorse, and tirade were used as a rough measure of emotional vocabulary. Ranging from possible scores of zero to four, the scores were analyzed in three ways: (1) scores on both items were left in as part of the score on the standardized WAIS-R vocabulary subscale; (2) scores on both items were removed and combined to create a separate measure: "emotional" vocabulary, (3) vocabulary scores were compiled with the emotional words removed, yielding a "neutral" vocabulary score.

The Similarities subtest of the WAIS-R

This test measures verbal concept formation and abstract reasoning ability. Inductive reasoning is used to create a general rule or principle from specific or particular facts. Higher scores on this test are associated with increasing precision and abstractness of expression with increasing difficulty of items. People with a good ability for insight and introspection tend to perform highly on this subtest. Lower scores are seen in people who have poor abstraction abilities and who are rigid or inflexible thinkers while high scorers show good verbal concept formation (Groth-Marnot, 1984).

The Controlled Oral Word Association (FAS) Test

Benton and associates (Benton & Hamsher, 1976; Benton et al., 1983) created the FAS test to study word fluency, or the ability to organize verbal output into meaningfully related words (Estes, 1974), as measured by the oral production of spoken words. In addition to cognitive flexibility and the involvement of memory processes to keep track of words produced, the FAS measures a subject's ability to organize his/her thinking. The test consists of three word naming trials using either the letters CFL or PRW (these letters were selected on the basis of the frequency of English words starting with these letters: Frequency decreases with each letter). To administer the test, the examiner asks the subject to say as many words as he can think of that begin with a given letter (C,F, or L), excluding proper nouns, numbers, and the same word with a different suffix. The score traditionally used is the sum of all acceptable words produced in the three one-minute trials. The score used in the present study was an average of the three trials. The rationale for this was that despite findings that C, F, & L have different frequencies, this variance is not reflected in the total score. The FAS test has been shown to be a sensitive measure of frontal lobe dysfunction: Bilateral frontal lesions have been found to strongly depress fluency scores (reviewed by Lezak, 1983), while left frontal lesions more often disrupt fluency than right frontal lesions.

III. RESULTS

Three statistical methods were used to analyze the data. (1) Correlation matrices were produced for all subjects combined, and males and females separately. All the test scores: alexithymia (alx or alex), vocabulary (voc), emotional vocabulary (evo), neutral vocabulary (v-e), similarities (sim), fluency (flu), color naming (col), and neutral (neu), positive (pos), and negative (neg) Stroop interference scores and ages were intercorrelated Partial correlations were also calculated to control for the Stroop score variability associated with variability in fluency scores and age. (2) A repeated measures ANOVA analysis was calculated with alexithymia and gender, and the interaction between alexithymia and sex, as the between group independent variables with neutral, positive, and negative Stroop interference scores as the repeated variables. As discussed in the measures section, Toronto alexithymia scale (TAS) scores were used to create blocks of subjects scoring high, 'medium', and low on alexithymia. (3) ANOVAs were also calculated with subjects grouped according to gender and high, medium, and low range of alexithymia scores. Within subject comparisons were made with nine dependent variables: voc, evo, v-e, sim, flu, col, neu, pos, and neg. These ANOVAs were also calculated covarying fluency and age variability.

Data transformation

Comparing the raw Stroop data of males grouped according to alexithymia, shown in Figures 1, 2, & 3, there appearts to be considerable heteroscadasticity in the data.

Figure 1. Raw Stroop Scores of Low Alexithymia Males

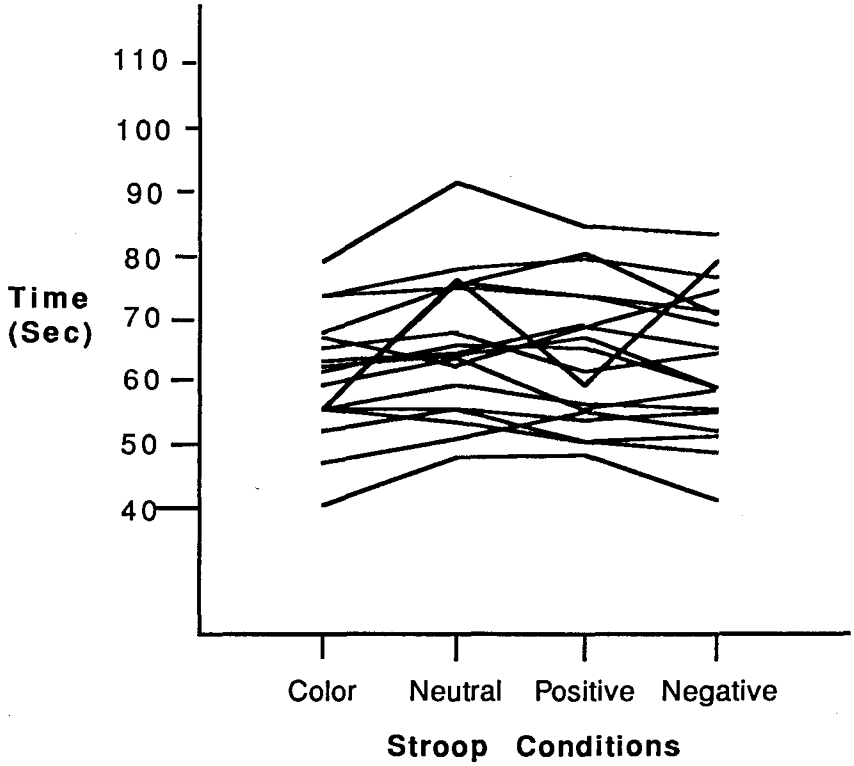


Figure 2. Raw Stroop Scores of Medium Alexithymia Males

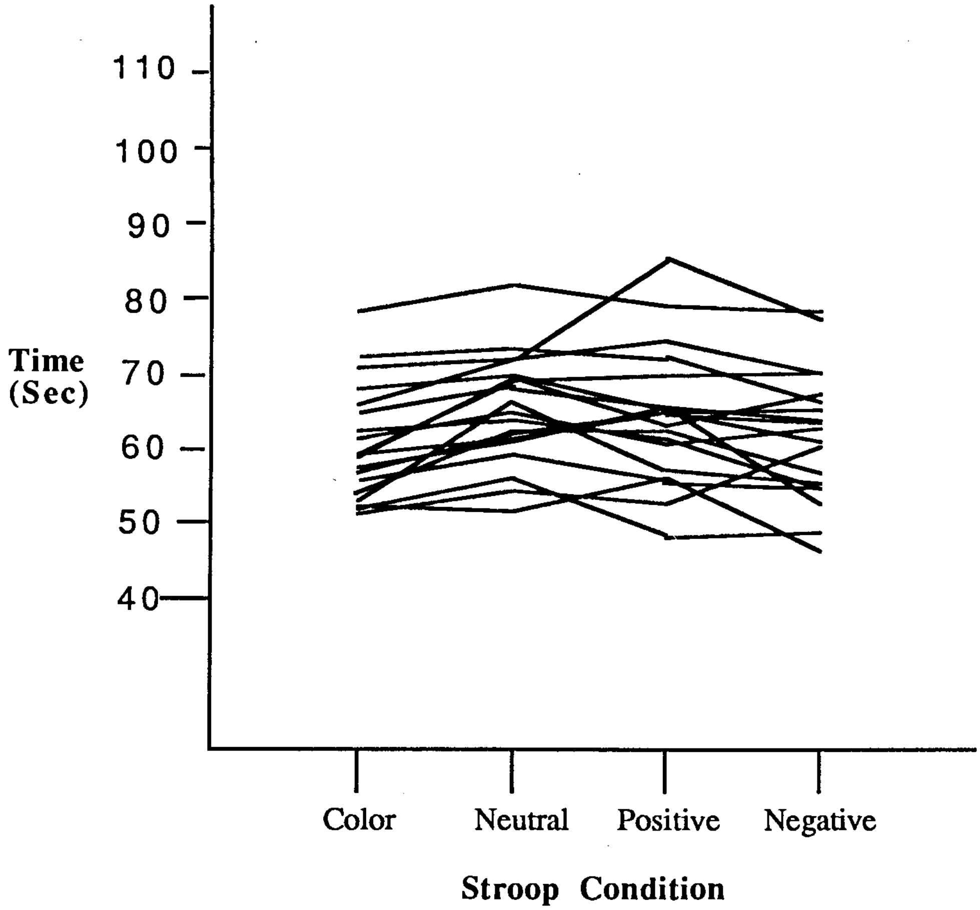
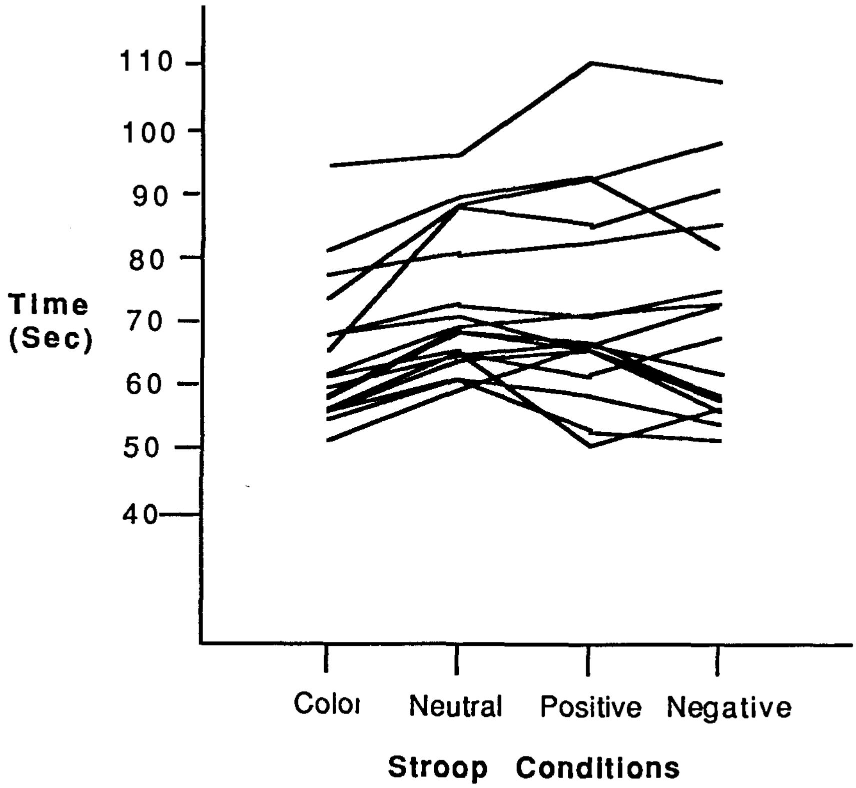


Figure 3. Raw Stroop Scores of High Alexithymia Males



As seen in any of the ANOVA tables in which Stroop interference is the dependent variable, the standard deviations tended to increase as the means increased. To provide some control for this a natural logarithmic transformation of the color naming and Stroop interference data was performed. Interference scores were calculated by subtracting the natural logarithim of color scores from the natural logs of the neutral, positive, and negative scores. From this point on in the thesis reported Stroop interference results are based on the use of transformed interference scores.

Statistical Caveat

Specific hypotheses were tested in this study and not all possible comparisons were calculated. However, given the calculation of a large number of correlations and mean comparisons, there is a risk of interpreting correlations and mean differences significant by chance alone. Although this can be controlled for statistically with Bonferroni corrections, such control would create a demand for mean differences and correlations of a magnitude almost never found in such research, hence obscuring real but weak relationships. Thus, no per comparison correction for type one errors was used.

Correlation matrices for all Ss combined, and for females and males separately are presented in tables 9, 10, and 11. Regarding 'significance' levels for correlations with all subjects combined (n=178), using two-tailed tests, a correlation coefficient of .13 was necessary to 'approach significance' (.05< p <.10.); to be significant at the .05 level, a correlation coefficient must have been at least .15; to be significant at the .01 level a correlation coefficient must have been at least .18, while for significance at the .001 level a correlation coefficient must have been at least .24.

TABLE 9. Correlation Matrix All Subjects (n=178)

	SEX	AGE	VOC	EVO	V-E	SIM	FLU	COL	NEU	POS	NEG	ALX
SEX	1.00											
AGE	.04	1.00										
VOC	-.06	.26	1.00									
EVO	.13	.27	.69	1.00								
V-E	-.10	.24	.98	.55	1.00							
SIM	.02	.15	.34	.24	.33	1.00						
FLU	.03	.04	.20	.19	.19	.16	1.00					
COL	-.24	.02	-.03	-.05	-.03	-.13	-.23	1.00				
NEU	-.15	.15	-.05	-.11	-.04	-.07	-.19	.76	1.00			
POS	-.14	.15	-.02	-.01	-.02	-.09	-.16	.73	.81	1.00		
NEG	-.15	.12	-.06	-.12	-.04	-.10	-.18	.68	.81	.81	1.00	
ALX	-.03	.04	-.19	-.23	-.16	-.13	-.11	.20	.20	.13	.17	1.00

Regarding 'significance' levels for correlations with female subjects (n=124), using two-tailed tests, a correlation coefficient of .16 was necessary to 'approach significance' (.05< p <.10.); to be significant at the .05 level, a correlation coefficient must have been at least .20; to be significant at the .01 level a correlation coefficient must have been at least .23, while for significance at the .001 level a correlation coefficient must have been at least .29.

TABLE 10. Correlation Matrix Female Subjects (n=124)

	AGE	VOC	EVO	V-E	SIM	FLU	COL	NEU	POS	NEG	ALX
AGE	1.00										
VOC	.27	1.00									
EVO	.26	.71	1.00								
V-E	.25	.99	.59	1.00							
SIM	.10	.29	.17	.30	1.00						
FLU	-.02	.14	.14	.13	.08	1.00					
COL	.13	-.01	.02	-.02	-.07	-.07	1.00				
NEU	.28	-.02	-.02	-.02	-.05	-.13	.75	1.00			
POS	.24	-.01	.05	-.02	-.09	-.09	.72	.80	1.00		
NEG	.14	-.06	-.13	-.04	-.15	-.10	.66	.79	.79	1.00	
ALX	.06	-.25	-.27	-.23	-.16	-.10	.19	.14	.02	.12	1.00

Regarding 'significance' levels for correlations with male subjects (n=54), using two-tailed tests, a correlation coefficient of.22 was necessary to 'approach significance' (.05< p <.10.); to be significant at the .05 level, a correlation coefficient must have been at least .26; to be significant at the .01 level a correlation coefficient must have been at least .34, while for significance at the .001 level a correlation coefficient must have been at least .44.

TABLE 11. Correlation Matrix for Males (n=54)

	AGE	VOC	EVO	V-E	SIM	FLU	COL	NEU	POS	NEG	ALX
AGE	1.00										
VOC	.27	1.00									
EVO	.29	.70	1.00								
V-E	.23	.98	.53	1.00							
SIM	.26	.44	.36	.42	1.00						
FLU	.16	.35	.27	.33	.30	1.00					
COL	-.22	-.14	-.09	-.14	-.24	-.53	1.00				
NEU	-.13	-.16	-.22	-.12	-.12	-.30	.76	1.00			
POS	-.03	-.06	-.05	-.06	-.08	-.27	.74	.81	1.00		
NEG	.08	-.08	-.06	-.08	-.02	-.31	.71	.83	.83	1.00	
ALX	.01	-.06	-.17	-.02	-.09	-.11	.21	.33	.32	.25	1.00

Emotional Stroop and Alexithymia

Repeated Measures of Stroop Variables

To determine if there were any differences between the interference scores as a function of alexithymia and gender, a repeated measures analysis was performed with neutral, positive, and negative emotion Stroop interference scores as the repeated measures, and alexithymia and gender as the grouping variables. Subjects were nested within sex and alexithymia, while Stroop stimulus type was crossed with alexithymia and sex. As summarized in Table 12 there were significant main effects for alexithymia ($F=3.57$, $p=.0301$) and gender ($F=4.96$, $p=.0273$) accross Stroop stimulus type, but the interaction of these factors only approached significance ($F=2.42$, $p=.0916$). This suggests, a) differences in Stroop scores between subjects with high alexithymia scores and subjects with low and medium alexithymia scores, that is, interference scores increase as alexithymia scores increase; b) a gender difference in Stroop interference scores: males generally have higher interference scores than females, and c) the pattern of relationships between alexithymia and Stroop interference differs for males and females.

The main effect for Stroop emotional valence was highly significant ($F=23.32$, $p=.0000$) indicating that there were significant differences between neutral, positive, and negative Stroop interference scores. However, the interaction between interference trials and alexithymia group was not significant, nor were the sex by trials, or sex by trials by alexithymia interactions. Thus, while there were significant within group differences in the neutral, positive, and negative conditions, there were no significant between group (alexithymia and sex, and their interaction) differences in the neutral, positive, or negative emotion conditions. Thus while there was variance in common between interference scores and alexithymia scores, no unique variance was contributed by the emotional valence of the stimuli.

TABLE 12. All Ss Repeated Measures: Cell Means and Standard Deviations

			CELL	MEANS			
Sex	Male	Male	Male	Female	Female	Female	Marginal
Alex	Low	Med	High	Low	Med	High	
Count	18	19	17	43	40	41	178
Neut	2.76	2.76	2.85	2.73	2.76	2.77	2.76
Pos	2.74	2.75	2.84	2.73	2.76	2.73	2.74
Neg	2.72	2.71	2.82	2.67	2.72	2.71	2.71
Marginal	2.74	2.74	2.83	2.70	2.75	2.74	2.74
			Std.	Dev.			
Neut	.14	.09	.12	.11	.11	.13	
Pos	.14	.12	.18	.12	.11	.15	
Neg	.16	.12	.19	.13	.11	.13	

TABLE 13 . All Ss Repeated Measures: Stroop Interference Scores

Source	SS	DF	MS	F	Prob.	GG Prob	HF Prob
Alex	.31	2	.15	3.57	.0301		
Sex	.21	1	.21	4.96	.0273		
Inter	.21	2	.10	2.42	.0916		
Error	7.43	172	.04				
E	.16	2	.08	23.32	.0000	.0000	.0000
E X A	.012	4	.003	.90	.4622	.4617	.4622
E X S	.001	2	.001	.16	.8560	.8547	.8560
E X S X A	.015	4	.004	1.10	.3587	.3586	.3587
Error	1.184	344	.003				

E=emotional valence, S=sex, A=alexithymia; Epsilon factors for degrees of freedom adjustment: Greenhouse-Geisser: .9938, Huynh-Feldt: 1.0000

When the sexes are analyzed separately significant differences appear between the alexithymia groups. As seen in Table 14, for females the main effect for alexithymia is not significant (F=1.80, p=.1700) while there were significant differences in interference scores among the neutral, positive, and negative conditions (F=24.35, p=.0000), and these differences were significantly related to levels of alexithymia (F=2.60, p=.0375).

TABLE 14. Females: Alexithymia by Stroop Interference Repeated Measures

Source	SS	DF	MS	F	Prob.	GG Prob	HF Prob
Alex	.14	2	.07	1.80	.1700		
Error	4.75	121	.04				
E	.15	2	.08	24.35	.0000	.0000	.0000
E X A	.03	4	.008	2.60	.0369	.0375	.0369
Error	.75	242	.003				

E=emotional valence, A=alexithymia Epsilon factors for degrees of freedom adjustment: Greenhouse-Geisser: .9902, Huynh-Feldt: 1.0000

With males, as summarized in Table 15, the main effect for alexithymia approached significance (F=2.93, p=.0625) suggesting some variance in common between interference scores and alexithymia scores. While there was a significant difference between the neutral, positive, and negative Stroop interference scores (F=5.93, p=.0037), this difference did not interact with levels of alexithymia (F=.33, p=.8545): interference scores did not change significantly according to emotional valence or alexithymia, that is, males in the high alexithymia group had consistently high interference scores in the neutral, positive, and negative Stroop conditions:

TABLE 15. Male Alexithymia by Stroop Interference Repeated Measures

Source	SS	DF	MS	F	Prob.	GG Prob	HF Prob
Alex	.31	2	.15	2.93	.0625		
Error	2.69	51	.05				
E	.05	2	.02	5.93	.0037	.0037	.0037
E X A	.01	4	.001	.33	.8545	.8539	.8545
Error	.43	102	.004				

E=emotional valence, A=alexithymia Epsilon factors for degrees of freedom adjustment: Greenhouse-Geisser: .9968, Huynh-Feldt: 1.0000

There were significant differences between the Stroop conditions as indicated by the significant F ratios for the emotional valence factor in the repeated measures analysis. ANOVAs with alexithymia and sex as between subject factors and Stroop interference scores as the within subject variables suggest that despite the differences between the conditions, the relationships between alexithymia and neutral emotional valence interference scores are similar to the relationships between alexithymia and either positive or negative emotional valence interference scores. When the sexes are analyzed separately, this relationship approaches significance only with males.

Neutral emotion Stroop interference

From Table 9 the correlation between alexithymia scores and Neutral interference scores was significant for all subjects combined (r=.20, p=.006). As seen in Table 16, this correlation is generally consistent with a significant F score (F=3.9, P=.02) from an ANOVA with alexithymia scores and sex (Male and female is represented as Mal and Fem) as the independent variables and the Neutral Stroop interference scores as the dependent variable:

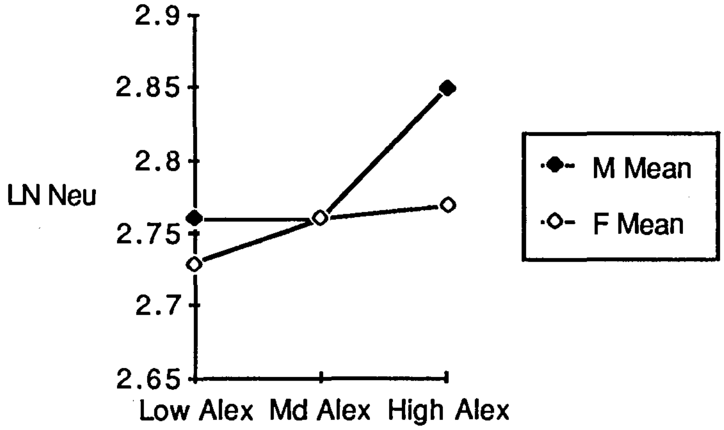
TABLE 16. All Ss: Mean neutral Stroop interference scores as a function of alexithymia and sex

Mal Grp(n)	Mean	Std Dev	Fem.Grp(n)	Mean	Std Dev
Hi Alx (17)	2.85	.12	Hi Alx(41)	2.77	.13
Md Alx(19)	2.76	.09	Md Alx(40)	2.76	.11
Lo Alx(18)	2.76	.14	Lo Alx(43)	2.73	.11

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	.11	2	.06	3.90	0.0220
Sex	.07	1	.07	4.69	0.0316
Inter	.03	2	.02	1.15	0.3185
Error	2.43	172	.01		

The significant F ratio for sex (F=4.69, p=.03), indicates that, overall, males had significantly higher neutral interference scores than females. This is further reflected in Figure 4.

Figure 4. Neutral interference means as a function of alexithymia and sex



The correlation between alexithymia and neutral interference scores was stronger for males (r=.33, p=.014) than females (r=.14, p=.118). This sex difference is also reflected in ANOVAs seen in Tables 17 and 18. With neutral interference as the dependent variable, males had an F value that approached significance (F=2.96, p=.061) while for females the corresponding F value did not (F=1.46, p=.235), suggesting that, for males, high alexithymia scores tended to be associated with higher neutral interference scores, while for females high alexithymia scores were not significantly associated with higher neutral interference scores while the correlation was in the same direction.

TABLE 17. Male Ss: Mean neutral Stroop interference scores as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	.08	2	.04	2.96	0.0607
Error	.72	51	.01		

TABLE 18. Female Ss: Mean neutral Stroop interference scores as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	0.04	2	0.02	1.46	0.2354
Error	1.70	121	0.01		

Positive emotion Stroop interference

For all Ss the correlation between alexithymia and positive interference scores approached significance (r=.13, p=.091) and was smaller than that obtained with neutral scores (r=.20). The weakness of this relationship was reflected in Table 19 by an insignificant F ratio (F=2.28, P=.1049) from an ANOVA with alexithymia scores and sex as the independent variables and the positive interference scores as the dependent variable:

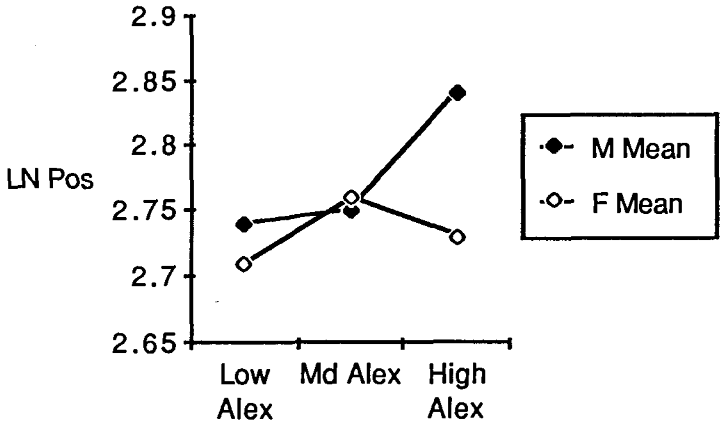
TABLE 19. All Ss: Mean positive Stroop interference scores as a function of alexithymia and sex

Mal Grp(n)	Mean	Std Dev	Fem.Grp(n)	Mean	Std Dev
Hi Alx(17)	2.84	.18	Hi Alx(41)	2.73	.15
Md Alx(19)	2.75	.12	Md Alx(40)	2.76	.11
Lo Alx(18)	2.74	.14	Lo Alx(43)	2.71	.12

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	.08	2	0.04	2.28	0.1049
Sex	.06	1	0.06	3.59	0.0600
Inter	.10	2	0.05	2.93	0.0562
Error	3.01	172	0.02		

Males tended to have higher positive interference scores than females. However, as seen in the means shown above and in Figure 5, high alexithymia males had slightly higher positive interference scores than the other male groups and the female groups, while middle alexithymia females had higher positive interference scores than low or high alexithymia females, accounting for the finding that the interaction between alexithymia, sex, and positive interference scores approached significance.

Figure 5. Positive interference means as a function of alexithymia and sex



As seen in Tables 20 and 21, this sex difference is also reflected in ANOVAs calculated separately for each sex, with alexithymia as the independent variable and positive interference as the dependent variable. While the F's are both insignificant, their direction is consistent.

TABLE 20. Male Ss: Mean positive Stroop interference scores as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	.10	2	.05	2.40	0.1012
Error	1.09	51	.02		

TABLE 21. Female Ss: Mean positive Stroop interference scores as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	0.06	2	0.03	1.94	0.1478
Error	1.92	121	0.02		

Negative emotion Stroop interference

For all Ss combined the correlation between alexithymia and negative interference scores was small but significant (r=.17, p=.022): high alexithymia scores were associated with high negative interference scores. As seen in Table 22, this is consistent with a significant F score (F=3.55, p=.0309) from an ANOVA with alexithymia scores and sex as the independent variables and negative interference scores as the dependent variable:

TABLE 22. All Ss: Mean negative Stroop interference as a function of alexithymia and sex

Mal Grp(n)	Mean	Std Dev	Fem.Grp(n)	Mean	Std Dev
Hi Alx(17)	2.82	.19	Hi Alx(41)	2.71	.13
Md Alx(19)	2.71	.12	Md Alx(40)	2.72	.11
Lo Alx(18)	2.72	.16	Lo Alx(43)	2.67	.16

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	.13	2	.07	3.55	0.0309
Sex	.09	1	.09	4.67	0.0320
Inter	.09	2	.04	2.43	0.0915
Error	3.17	172	.02		

Consistent with findings with the neutral and positive conditions, males had relatively higher negative Stroop interference scores than females (F=4.67, p=.0320). Again, the male high alexithymia group appeared to account for most of this variance, as seen in Figure 6:

Figure 6. Negative interference means as a function of alexithymia and sex

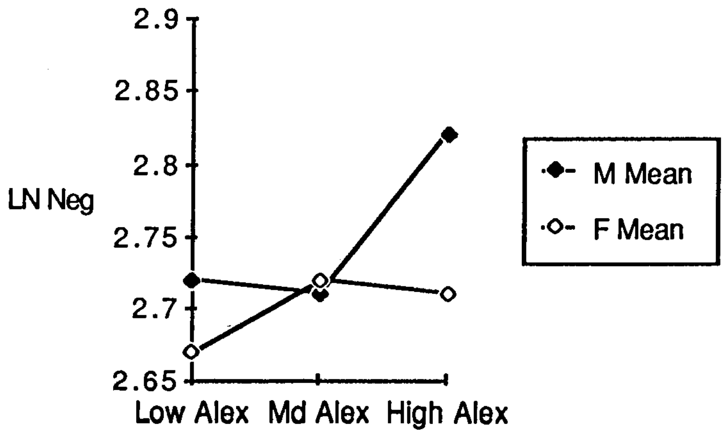


TABLE 23. Male Ss: Mean negative Stroop interference as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	.13	2	.06	2.50	0.0924
Error	1.30	51	.03		

TABLE 24. Female Ss: Mean negative Stroop interference as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	.07	2	.04	2.28	.1071
Error	1.88	121	.02		

Word fluency and Stroop: controlling the effects of fluency

Word fluency scores, representing the ability to organize thought and to produce and verbalize words, and to remember words already used, is strongly associated with scores on the Stroop test, especially among males. As reviewed in Table 9 the correlations between fluency scores and Stroop interference scores were small but significant for all subjects combined: Neutral words (r= -.19, p=.012); Positive words (r= -.16, p=.030); Negative words (r= -.18, p=.014). As seen in Tables 11 and 10 respectively, these correlations were larger for males (Neutral words: r= -.30, p=.027; Positive words: r= -.27, p=.046; Negative words: r= -.31, p=.023) and "significant", while the corresponding correlations for females were smaller and insignificant: (Neutral words: r= -13, p=.166; Positive words: r= -.09, p=.303; Negative words: r= -.10, p=.276). To investigate the possibility that word fluency may have accounted for a large part of the differences in Stroop scores between alexithymia groups, partial correlations were calculated to remove the variablility contributed by word fluency. For all Ss the correlations between alexithymia and the Stroop variables, with the effects of fluency partialed out were similar to the original correlations: neutral (r=.19, r=.012), positive (r=.11, p=.139), negative (r=.15, p=.040). For males the correlations between the Stroop variables and alexithymia, with the effects of fluency removed were a little smaller but generally consistent with the original correlations: neutral ($r=.31$, $p=.022$), positive ($r=.30$, $p=.026$), negative ($r=.23$, $p=.097$). For females, with the variablity of fluency partialled out, the correlations between alexithymia and the Stroop variables remained smaller and insignificant: neutral ($r=.13$, $p=.153$), positive ($r=.01$, $p=.923$), negative ($r=.11$, $p=.220$).

To further determine if the variability associated with fluency accounted for the relationships between alexithymia and Stroop interference scores, fluency scores were used as a covariate. For all subjects combined, with the effects of fluency covaried out there continued to be significant main effects for alexithymia in the neutral and negative conditions. Given the small insignificant correlations for females between alexithymia and Stroop variables with the variability of fluency removed, the ANOVAs for females with fluency covaried will not be reported (none of the F ratios in any of the six comparisons approached significance).

TABLE 25. All Ss: Mean neutral Stroop interference, with fluency covaried, as a function of alexithymia and sex

Source	Sums of Squares	Degr's of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.09	2	.05	3.32	0.0385	
Sex	.06	1	.06	4.52	0.0349	
Inter	.03	2	.01	0.99	0.3729	
Fluency	.07	1	.07	4.77	0.0303	-0.00653
Error	2.37	171	.01			

TABLE 26. Male Ss: Mean neutral Stroop interference, with fluency covaried, as a function of alexithymia

Source	Sums of Squares	Degr's of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.07	2	.03	2.42	0.0995	
Fluency	.05	1	.05	4.02	0.0505	-0.00973
Error	.67	50	.01			

TABLE 27. All Ss: Mean positive Stroop interference, with fluency covaried, as a function of alexithymia and sex

Source	Sums of Squares	Degr's of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.06	2	.03	1.79	0.1704	
Sex	.06	1	.06	3.43	0.0656	
Inter	.09	2	.05	2.70	0.0702	
Fluency	.06	1	.06	3.23	0.0739	-0.00600
Error	2.95	171	.02			

TABLE 28. Male Ss: Mean positive Stroop interference, with fluency covaried, as a function of alexithymia

Source	Sums of Squares	Degr's of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.08	2	.04	1.87	0.1645	
Fluency	.06	1	.06	3.09	0.0851	-0.01052
Error	1.03	50	.02			

TABLE 29. All Ss: Mean negative Stroop interference, with fluency covaried, as a function of alexithymia

Source	Sums of Squares	Degr's of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.11	2	.05	2.98	0.0534	
Sex	.08	1	.08	4.50	0.0353	
Inter	.08	2	.04	2.24	0.1095	
Fluency	.08	1	.08	4.42	0.0370	-0.00718
Error	3.09	171	.02			

TABLE 30. Male Ss: Mean negative Stroop interference, with fluency covaried, as a function of alexithymia

Source	Sums of Squares	Degr's of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.10	2	.05	2.07	0.1370	
Fluency	.11	1	.11	4.49	0.0392	-0.01368
Error	1.19	50	.02			

Consistent with the partial correlation findings which suggested that the effects of fluency were minimal, covarying out the variability associated with fluency scores did not significantly diminish the alexithymia-Stroop interference relationships when the data for all Ss combined is analyzed. However, the results for males, with fluency controlled for, indicate that the original marginal ANOVA findings are now insignificant. Thus, when alexithymia scores are used as a continuous variable (as with correlations) the variability contributed by fluency does not significantly diminish the alexithymia-interference relationships, while with the less sensitive ANOVA where alexithymia is used as a blocking variable where the variance contributed by alexithymia is minimized, the small relationships between alexithymia and interference scores become generally insignificant.

In general it appears that fluency, alexithymia, and Stroop interference scores have a complex relationship, with Stroop interference having variance in common with both alexithymia and fluency, with little variance in common between alexithymia and fluency. An examination of Figures 1, 2, & 3, representing plots of the raw Stroop data of the male low, medium, and high alexithymia groups shows relatively greater variability in the high alexithymia group. This heteroscadisticity is reflected by the larger standard deviation of the high group relative to the low and medium groups. There is a natural division of scores within the high group: there is a group of 5 subjects with scores that are higher than the other 12 subjects. While there are no significant differences between the alexithymia scores of these groups, the group with higher Stroop scores had higher fluency scores, although this difference was insignificant ($t=2.053$, $.10 > p > .05$, two tailed test: a t of 2.131 was necessary for significance at the .05 level), than the group with lower Stroop scores. It would appear that the higher fluency scores may have played a part in producing the heteroscadasticity in the male data: the variance introduced by the fluency variable may have contributed to the variance of Stroop scores having the result of inflating the mean and standard deviation of the male high alexithymia group, and thus contributing to the variance in common between alexithymia and Stroop.

The heteroscadasticity in the Stroop scores, as a function of alexithymia, diminishes the applicability of both the correlational (continuous) and the linear statistical approaches to the analysis of Stroop data as a function of alexithymia. While this phenomenon can be seen in other personality research studies, it may have special significance, the meaning of which can only be determined with further research.

Age, alexithymia, and Stroop interference: Controlling for the effects of age.

For all Ss combined, the correlation between age and alexithymia was small and insignificant ($r=.04$, $p=.580$) indicating tbat alexithymia scores did not vary significantly according to age. This lack of correlation was also seen with the sexes analyzed separately: males ($r=.001$, $p=.992$); females ($r=.06$, $p=.502$).

However, the correlations between age and neutral and negative Stroop interference were small but significant (neutral: r=.15, p=.042; positive: r=.15, p=.050), while the correlation between age and negative Stroop interference scores was small and insignificant (r=.12, p=.126) though in the same direction. For females the correlation between age and neutral interference scores was positive and significant (r=.28, p=.002) as was the correlation between age and positive interference scores (r=.24, p=.006), however, the correlation between age and negative interference scores was small, positive, and insignificant (r=.14, p=.109). Thus, for females in this sample, as age increased neutral and positive interference scores increased.

For males the corresponding correlations between age and Stroop interference scores were small and insignificant and in the opposite direction (neutral: r= -.13, p=.363; positive: r= -.03, p=.829) while the correlation with negative interference was insignificant but in the same direction (r=.08, p=.542).

Controlling for the variance contributed by age, for all Ss the correlations between alexithymia and interference were bigger in the neutral condition (r=.20, p=.008) and the negative condition (r=.17, p=.026), while the correlation between age and positive condition was somewhat smaller (r=.12, p=.105). These results are supported by ANOVAs with alexithymia and sex as the independent grouping variables and the Stroop interference scores as the dependent variable.

For all Ss, controlling for age in all conditions diminished the F somewhat as seen in tables 31, 32, and 33, although the F's for neutral and negative conditions remain significant.

TABLE 31. All Ss: Mean neutral Stroop interference, with age covaried, as a function of alexithymia

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.10	2	.05	3.48	.0331	
Sex	.07	1	.07	5.06	.0258	
Inter	.03	2	.01	1.05	.3536	
Age	.05	1	.05	3.42	.0663	-0.00439
Error	2.39	171	.01			

TABLE 32. All Ss: Mean positive Stroop interference, with age covaried, as a function of alexithymia

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.07	2	.03	1.92	.1500	
Sex	.07	1	.07	3.88	.0505	
Inter	.10	2	.05	2.79	.0640	
Age	.05	1	.05	3.17	.0770	.00471
Error	2.95	171	.02			

TABLE 33. All Ss: Mean negative Stroop interference, with age covaried, as a function of alexithymia

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.12	2	.06	3.22	.0422	
Sex	.09	1	.09	4.89	.0283	
Inter	.08	2	.04	2.29	.1045	
Age	.03	1	.03	1.64	.2015	.00350
Error	3.14	171	.02			

For females, controlling for age did not significantly influence the pattern of results: all the correlations between alexithymia and interference scores remained insignificant: neutral ($r=.13$, $p=.154$); positive ($r=.004$, $p=.967$); negative ($r=.11$, $p=.212$). The ANOVA tables for females will not be reported (the F values in all three comparisons remained insignificant). With males, controlling for age also had a minimal impact on the correlations between alexithymia and interference scores: neutral interference ($r=.33$, $p=.014$) and positive interference ($r=.32$, $p=.018$) correlations increased somewhat while the correlation with negative interference decreased somewhat ($r=.25$, $p=.067$). This pattern of results is also reflected in ANOVAs for male subjects with age controlled for, alexithymia as the independent variable, and interference scores as the dependent variable:

TABLE 34. Male Ss: Mean neutral Stroop interference, with age covaried, as a function of alexithymia

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.09	2	.05	3.31	.0446	
Age	.02	1	.02	1.55	.2187	-0.00563
Error	.71	50	.01			

TABLE 35. Male Ss: Mean positive Stroop interference, with age covaried, as a function of alexithymia

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.10	2	.05	2.45	.0966	
Age	.01	1	.01	.23	.6350	-0.00267
Error	1.08	50	.02			

TABLE 36. Male Ss: Mean negative Stroop interference, with age covaried, as a function of alexithymia

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.12	2	.06	2.33	.1076	
Age	.00	1	.00	.15	.7016	0.00236
Error	1.30	50	.03			

Thus, like fluency, age appears to be another factor with interesting sex differences in relation to the Stroop variables. To examine the combined effects of these two variables, the following statistics will now be reported: the partial correlation coefficients for the Stroop variables and alexithymia, with the effects of age and fluency removed, and the F values from ANOVAs with alexithymia and sex as the independent variables and the Stroop variables with the variability contributed by both age and fluency controlled for.

Controlling for both age and fluency

For all Ss combined, partialling out the variability associated with both age and fluency appeared to have the effect of diminishing the correlations between alexithymia and Stroop variables while the pattern of results remained the same: neutral (r=.18, p=.015); positive (r=.11, p=.163); and negative (r=.15, p=.047). This was also the case with males: neutral (r=.32, p=.022); positive (r=.30, p=.028); and negative (r=.23, p=.101), while with females the correlations remained insignificant: neutral (r=.13, p=.154); positive (r=.00, p=.967); and negative (r=.11, p=.212).

TABLE 37. All Ss: Mean neutral Stroop interfererence, with age and fluency covaried, as a function of alexithymia

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.08	2	.04	2.90	.0578	
Sex	.07	1	.07	4.90	.0281	
Inter	.02	2	.01	.87	.4194	
Age	.05	1	.05	4.03	.0463	0.00472
Flu	.07	1	.07	5.38	.0216	-0.00688
Age & Flu	.12	2	.06	4.44	.0132	
Error	2.31	170	.01			

TABLE 38. All Ss: Mean positive Stroop interference, with age and fluency covaried, as a function of alexithymia

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.05	2	.02	1.42	.2436	
Sex	.06	1	.06	3.74	.0549	
Inter	.09	2	.04	2.54	.0816	
Age	.06	1	.06	3.63	.0585	0.00501
Flu	.06	1	.06	3.70	.0562	-0.00638
Age & Flu	.12	2	.06	3.46	.0338	
Error	2.89	170	.02			

TABLE 39. All Ss: Mean negative Stroop interference, with age and fluency covaried, as a function of alexithymia

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.10	2	.05	2.66	.0731	
Sex	.09	1	.09	4.74	.0309	
Inter	.08	2	.04	2.09	.1273	
Age	.04	1	.04	2.03	.1560	0.00385
Flu	.09	1	.09	4.80	.0299	-0.00747
Age & Flu	.12	2	.06	3.24	.0417	
Error	3.06	170	.02			

TABLE 40. Male Ss: Mean negative Stroop interference, with age and fluency covaried, as a function of alexithymia

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.07	2	.04	2.65	.0810	
Age	.01	1	.01	.84	.3629	-0.00413
Flu	.04	1	.04	3.23	.0787	-0.00889
Age & Flu	.07	2	.03	2.42	.0992	
Error	.66	49	.01			

TABLE 41. Male Ss: Mean positive Stroop interference, with age and fluency covaried, as a function of alexithymia

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.08	2	.04	1.84	.1691	
Age	.00	1	.00	.03	.8681	-0.00093
Flu	.06	1	.06	2.82	.0996	-0.01033
Age & Flu	.06	2	.03	1.53	.2273	
Error	1.02	49	.02			

TABLE 42. Male Ss: Mean negative Stroop interference, with age and fluency covaried, as a function of alexithymia

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.09	2	.04	1.83	.1720	
Age	.02	1	.02	.65	.4246	0.00483
Flu	.12	1	.12	4.94	.0308	-0.01466
Age & Flu	.12	2	.06	2.55	.0883	
Error	1.18	49	.02			

Generally, controlling for both age and fluency had the effect of diminishing the alexithymia-Stroop interference relationships. Thus, these variables need to be controlled for in research on Stroop phenomenon.

Alexithymia and Verbal Measures

Alexithymia and Vocabulary

As shown in Table 9, for males and females combined the correlation between vocabulary and alexithymia was negative and significant (r= -.19, p=.011): high alexithymia scores tended to be associated with low vocabulary scores. With the sexes separated, the correlation was stronger for females (r= -.25, p=.005) as seen in Table 10, and insignificant for males (r= -.06, p=.688) as seen in Table 11. This was not supported by an ANOVA calculated for all Ss combined with high, medium, and low alexithymia scores and sex as the independent variables, and vocabulary as the dependent variable as seen in Table 43. However, an examination of the means for females show a differences that is significant as seen in Table 44, while the differences among male means were not significant as seen in Table 45. The mean differences in vocabulary scores between males and females grouped according to alexithymia are displayed in Figure 7.

TABLE 43. All Ss: Mean vocabulary scores as a function of alexithymia and sex

M Grp(n)	Mean	Std.Dev.	F Grp (n)	Mean	Std.Dev.
Hi Alx (17)	50.47	6.52	Hi Alx (41)	48.49	6.87
Md Alx(19)	51.32	6.15	Md Alx(40)	49.80	6.51
Lo Alx (18)	51.44	7.72	Lo Alx (43)	52.33	6.78

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	143.72	2	71.86	1.58	0.2099
Sex	28.59	1	28.59	0.63	0.4296
Inter	59.15	2	29.58	0.65	0.5241
Error	7844.87	172	45.61		

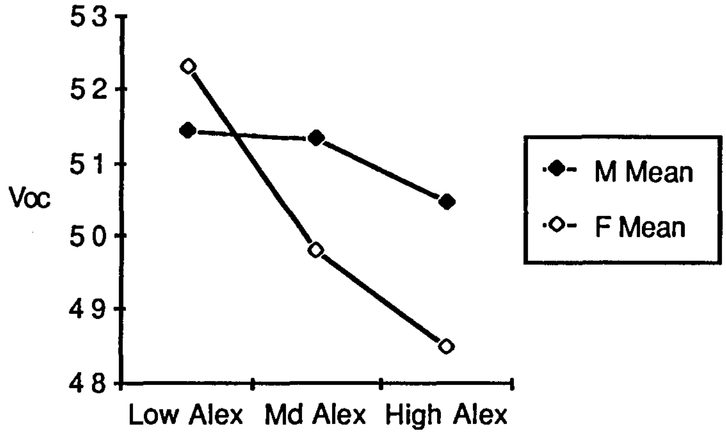
TABLE 44. Female Ss: Mean vocabulary scores as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	320.66	2	160.33	3.55	0.0319
Error	5472.09	121	45.22		

TABLE 45. Male Ss: Mean vocabulary scores as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	9.75	2	4.88	.10	0.9007
Error	2372.79	51	46.53		

Figure 7
Vocabulary means as a function of alexithymia and sex



Emotional Vocabulary

There was a "tendency" for gender differences in emotional vocabulary scores. Females tended to have higher emotional vocabulary scores. The correlation between emotional vocabulary scores and alexithymia scores for all subjects was negative and significant (r= -23, p=.002). The correlation was stronger for females (r= -.27, p=.003) and insignificant for males, though in the same direction (r= -.17, p=.221). The direction and strength of these correlations are consistent with findings from ANOVAs with emotional vocabulary as the dependent variable, and alexithymia and sex as the independent variables: the F for sex approached significance (F=3.01, p=.0844) indicating that females tended to have higher emotional vocabulary scores than males. The F for alexithymia was significant (F=5.01, p=.0077) emotional vocabulary scores varied as a function of alexithymia: high alexithymia scores were associated with lower emotional vocabulary scores. The F for females was significant (F=6.74, p=.0017) while the F for males was not (F=.99, p=.3778). This is generally consistent with the notion that alexithymics have fewer emotional words with which to describe their feelings.

TABLE 46. All Ss: Mean emotional vocabulary scores as a function of alexithymia and sex

MGroup(n)	Mean	Std. Dev.	F Group (n)	Mean	Std. Dev.
Hi Alx(17)	1.76	1.44	Hi Alx (41)	2.15	1.13
Md Alx(19)	2.26	1.56	Md Alx(40)	2.48	1.55
Lo Alx (18)	2.56	1.98	Lo Alx (43)	3.19	1.28

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	20.79	2	10.39	5.01	0.0077
Sex	6.25	1	6.25	3.01	0.0844
Inter	1.13	2	.57	.27	0.7615
Error	356.80	172	2.07		

Figure 8. Emotional vocabulary means as a function of alexithymia and sex

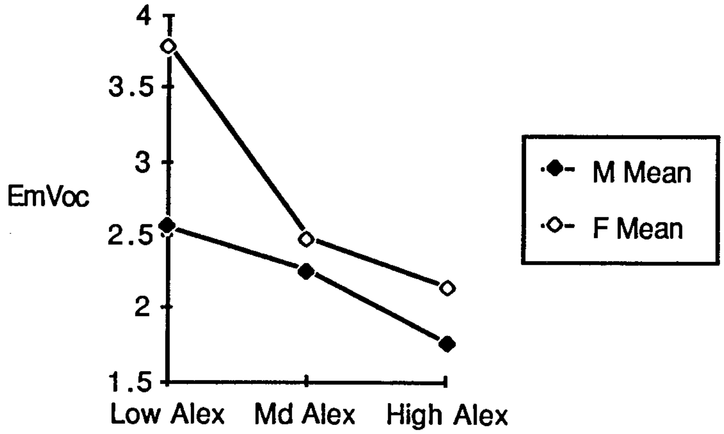


TABLE 47. Female Ss: Mean emotional vocabulary scores as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean. Square	F	Tail Prob.
Alex	23.81	2	11.91	6.74	0.0017
Error	213.61	121	1.77		

TABLE 48. Male Ss: Mean emotional vocabulary scores as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	5.57	2	2.79	.99	0.3778
Error	143.19	51	2.81		

Subtracting the three emotional items from the total vocabulary score decreased the size of the correlations between alexithymia scores and corrected or "neutral" vocabulary scores but the pattern of relationship was consistent: for females it was negative and significant (r= -.22, p=.011), for males it was negative and insignificant (r= -.02, p=.908), and for both sexes combined it was negative and significant (r= -.16, p=.033).

Word Fluency and Alexithymia

As seen in tables 9, 10, and 11, the correlations between fluency scores and alexithymia scores were negative and not significant for all subjects combined (r=-.11, p=.150), female subjects (r= -.10, p=.247), or male subjects (r= -.11, p=.414). This lack of significant association between alexithymia scores and word fluency scores was supported by ANOVAs as seen in Table 49 with alexithymia and sex as the independent variables and fluency as the dependent variable. Examination of the ANOVA tables for the sexes examined separately showed that the small mean differences between the high, low, and medium groups were not significant.

TABLE 49. All Ss: Mean fluency scores as a function of alexithymia and sex

M Group(n)	Mean	Std.Dev	F Group(n)	Mean	Std.Dev
Hi Alx(17)	11.94	3.51	Hi Alx (41)	12.72	2.69
Md Alx(19)	12.56	3.24	Md Alx(40)	12.47	2.87
Lo Alx(18)	13.44	3.30	Lo Alx(43)	13.30	2.96
Source	**Sum of Squares**	**Degrees of Freedom**	**Mean Square**	**F**	**Tail Prob.**
Alex	30.95	2	15.48	1.72	0.1825
Sex	1.28	1	1.28	0.14	0.7063
Inter	6.57	2	3.28	0.36	0.6952
Error	1549.65	172	9.01		

TABLE 50. Male Ss: Mean fluency scores as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	20.03	2	10.01	0.89	0.4156
Error	571.63	51	11.21		

TABLE 51. Female Ss: Mean fluency scores as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	15.21	2	7.61	0.94	0.3931
Error	978.03	121	8.08		

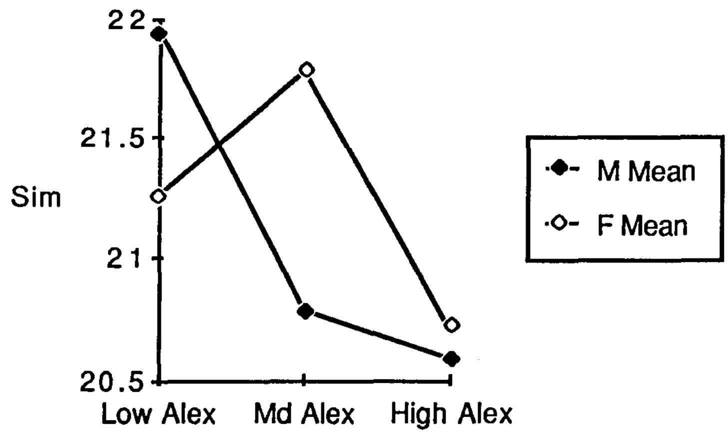
Similarities and Alexithymia

As seen in Tables 9, 10, and 11, the correlation between similarities scores and alexithymia was small, negative, and approached significance ($r= -.13$, $p=.078$) indicating a tendency for high alexithymia scores to be associated with low similarities scores.This can also be seen in Figure 9. This held for females ($r= -.16$, $p=.085$) but not for males ($r= -.09$, $p=.536$). As seen in Table 52 ANOVAs analysis yields an insignificant interaction effect with alexithymia and sex as the independent variables and similarities as the dependent variable.

TABLE 52. All Ss: Mean similarities scores as a function of alexithymia

M Group(n)	Mean	Std Dev	F Group(n)	Mean	Std Dev
Hi Alx(17)	20.59	3.68	Hi Alx(41)	20.73	2.91
Md Alx(19)	20.79	3.08	Md Alx(40)	21.78	2.29
Lo Alx(18)	21.94	2.21	Lo Alx(43)	21.26	2.67
Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	22.48	2	11.24	1.47	0.2324
Sex	0.81	1	0.81	0.11	0.7452
Inter	17.92	2	8.96	1.17	0.3119
Error	1313.43	172	7.64		

Figure 9. Similarities means as a function of alexithymia and sex



The F-value for females was insignificant (F=1.58, p=.2099) as seen in Table 53, and for males (F=1.15, p=.323) as seen in Table 54.

TABLE 53. Female Ss: Mean similarities scores as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	22.04	2	11.02	1.58	0.2099
Error	843.21	121	6.97		

TABLE 54. Male Ss: Mean similarities scores as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	19.11	2	9.56	1.04	0.3620
Error	470.22	51	9.22		

Color Naming and Alexithymia

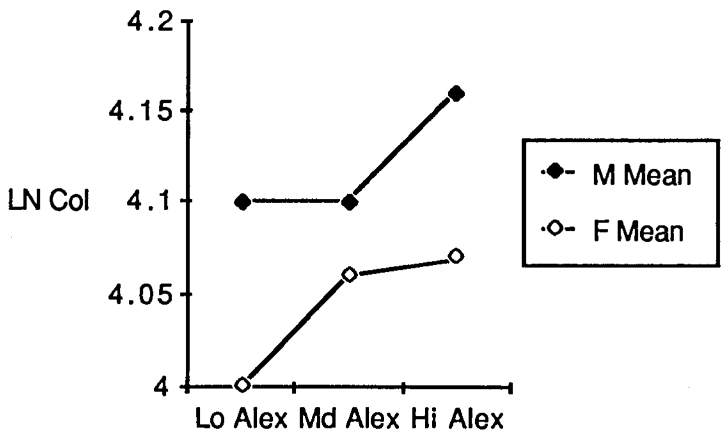
As seen in Table 9, for all subjects combined, the correlation between alexithymia scores and the color naming scores was small, positive and significant ($r=.20$, $p=.007$). This is consistent with an ANOVA seen in Table 55 with color naming as the dependent variable: for all Ss combined the F of 2.97 was significant ($p=.0538$).

TABLE 55. All Ss: Mean color naming scores as a function of alexithymia and sex

M Group(n)	Mean	Std Dev	F Group(n)	Mean	Std Dev
Hi Alx(17)	4.16	.16	Hi Alx(41)	4.07	.15
Md Alx(19)	4.10	.12	Md Alx(40)	4.06	.12
Lo Alx(18)	4.10	.16	Lo Alx(43)	4.00	.15

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	.12	2	.06	2.97	0.0538
Sex	.22	1	.22	10.76	0.0013
Inter	.02	2	.01	0.57	0.5686
Error	3.51	172	.02		

Figure 10. Color naming means as a function of alexithymia and sex



As shown in the cell means in Table 55 and in the plot in Figure 10, males consistently took longer to name the colors than did females as seen with a significant F for sex (F=10.76, p=.0013). For males the correlation between alexithymia and color naming scores was insignificant (r=.21, p=.119) as was the F with color as the dependent variable (F=1.07, p=.3508) while the correlation for females was significant (r=.19, p=.033) as was the corresponding F ratio (F=3.32, p=.0393). The lack of significance of the relationship for males is likely due to the smaller sample size of males.

TABLE 56. Male Ss: Mean color naming scores as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	.05	2	.024	1.07	0.3508
Error	1.14	51	.02		

TABLE 57. Female Ss: Mean color naming scores as a function of alexithymia

Source	Sums of Squares	Degrees of Freedom	Mean Square	F	Tail Prob.
Alex	.13	2	.07	3.32	0.0393
Error	2.37	121	.02		

Fluency and Color Naming

For all Ss there was a significant negative correlation between fluency scores and color naming scores (r= -.23, p=.002) indicating that verbal fluency accounted for some of the variance in color naming scores. This relationship was very strong for males (r= -.53, r=.000) and insignificant for females (r= -.07, p=.458). Partial correlations were calculated to control for the variance contributed by fluency. The correlations between color naming and alexithymia scores, with the variability contributed by fluency partialled out, remained significant for all Ss (r=.18, p=.016) and females (r=.19, p=.039) while the corresponding correlation for males remained insignificant though of similiar magnitude (r=.18, p=.188). This was generally supported by ANOVAs with the effects of fluency covaried out. For all Ss, with fluency covaried, the F ratio for alexithymia and color naming became insignificant (F=2.23, p=.1103), the corresponding F ratio for females remained significant (F=3.13, p=.0473), while for males it remained insignificant (F=.61, p=.5495).

TABLE 58. All Ss: Mean color naming scores, with fluency covaried, as a function of alexithymia and sex

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.09	2	.04	2.23	.1103	
Sex	.21	1	.21	10.64	.0013	
Inter	.02	2	.01	.54	.5853	
Flu	.15	1	.15	7.61	.0064	-0.00982
Error	3.36	171	.02			

TABLE 59. Female Ss: Mean color naming scores, with fluency covaried, as a function of alexithymia

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.12	2	.06	3.13	.0473	
Flu	.00	1	.00	0.23	.6353	-0.00213
Error	2.36	120	.02			

TABLE 60. Male Ss: Mean color naming scores, with fluency covaried, as a function of alexithymia

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.02	2	.01	.61	.5495	
Flu	.30	1	.30	18.01	.0001	-0.02297
Error	.84	50	.02			

Age and Color Naming

The correlations between age and color naming were insignificant for all Ss (r=.02, p=.806) and females (r=.13, p=.135), while the correlation between age and color naming for males, although insignificant (r= -.22, p=.108) is sufficiently large to suggest that color naming for males was somewhat influencd by age: as age increased, color naming scores tended to decrease. Partial correlations, controlling for the variability contributed by age, were calculated for males. For males, the correlation between alexithymia and color naming scores, with the variability contributed by age partialled out, remained insignificant (r=.22, p=.112). Controlling the variance contributed by both age and fluency with partial correlations further reduced the correlation between alexithymia and color naming scores for males (r=.19, p=.178). Consistent with this, covarying out the variability associated with both age and fluency reduced the F ratio for alexithymia and color naming and remained insignificant (F=.80, p=.4548).

TABLE 61. Male Ss: Mean color naming scores, with age and fluency covaried, as a function of alexithymia

Source	Sums of Squares	Degr. of Freedom	Mean Square	F	Tail Prob.	Regress Coeff.
Alex	.03	2	.01	.80	.4548	
Age	.03	1	.03	1.73	.1944	-0.00654
Flu	.26	1	.26	15.66	.0002	-0.02164
Age & Flu	.33	2	.17	10.00	.0002	
Error	.81	49	.02			

IV. DISCUSSION

The results of this study revealed three sets of findings. (1) High alexithymia males exhibited greater interference on the neutral, as well as the positive and the negative emotion Stroop stimuli, suggesting a greater Stroop effect, regardless of emotional valence, for high alexithymia males. There were no significant Stroop differences between the female alexithymia groups. Verbal fluency was found to be a factor accounting for some of the variance in Stroop performance for males, especially males in the high alexithymia group. The observed differences in Stroop performance do not categorically support either the deficit or defense models of alexithymia. While positive and negative emotional words were associated with less interference than neutral words, emotional valence interference did not vary as a function of alexithymia. High alexithymia males exhibited greater interference on all Stroop stimuli. Practice effects associated with the repeated processing of a complex stimulus likely account for the lower interference associated with the emotional words. (2) High alexithymia females had lower vocabulary and emotional vocabulary scores relative to low alexithymia females. There was no such relationship for males, suggesting the existence of sex differences in verbal correlates of alexithymia. The findings that high alexithymia females have indications of lower verbal intelligence, while high alexithymia males tend to have higher Stroop interference suggests sexual dimorphism in the correlates of alexithymia despite a lack of sex differences in alexithymia scores (Parker, Taylor, & Bagby, 1989). (3) High alexithymia males and females had higher (slower) color naming scores than low alexithymia subjects, suggesting that alexithymics may have diminished ability to verbalize color names. Color naming difficulties may represent an information processing weakness characteristic of alexithymia. It is possible that the cognitive processes involved in naming colors may be similar to those involved in the discrimination or digitalization of feelings, a cognitive process that may precede the verbal expression of feelings. Since color discrimination abilities or weaknesses were not stringently measured, these can only be seen as tentative suggestions. However, since the color naming - alexithymia correlation was observed with females (who have a very low prevalence of color discrimination difficulties), as well as males, the relationship appears fairly stable.

Emotional Stroop and Alexithymia

High alexithymia males exhibited a tendency to increased interference in naming the colors of neutral, and positive and negative emotion words. Age and fluency scores were found to correlate fairly strongly with Stroop interference scores, especially with males. When the variability in Stroop scores contributed by age and fluency was controlled by an analysis of covariance, the strength of these relationships was diminished but not eliminated. When viewing alexithymia as a continuous variable, as with the correlational analysis, partialling out the variability contributed by fluency did not significantly diminish the alexithymia-Stroop interference relationships.

Although there were significant differences among the neutral, positive, and negative emotion interference scores as shown by a repeated measures analysis, greatest interference was found in the neutral condition, followed by the positive and negative conditions. Since this is also the order in which the stimuli were presented, the decreased interference scores over the emotional conditions may have been due largely to practice effects rather than emotional valence. The strong correlations between all three interference scores suggests that the stimuli were more similar than they were different. Perhaps the frequency of the words, a well controlled variable, was more important than combined emotional valence of the words. While one can establish the frequency of a given word across a sample (as per Kucera & Francis, 1967) word frequency differs between individuals as indicated by findings from the emotional Stroop literature. Thus, for one group of subjects, **anger** may have been a salient or high frequency word causing greater "interference" than say **misery**, while for another **panic** may have been more salient than **shame**. These individual differences in the word frequency or saliency, "causing" differences in individual word interference may have averaged out across subjects in the alexithymia groups. To test more effectively for this, one could measure the salience that the individual words had for the subjects, group them accordingly, and then present the words individually to each subject.

While there was no specific evidence of an emotional Stroop effect, the results obtained do provide some support for a "standard" Stroop effect. While a small Stroop effect in relation to alexithymia was obtained in the present study, Watts et al., (1986) reported their spider Stroop test was associated with less interference than the "standard" Stroop format, but more interference than a general "emotional" Stroop, and a "control word" Stroop (associated with the least amount of interference) in a sample of spider phobics. In the present study, however, the "control" or neutral words were associated with more interference than the emotional words. It seems reasonable to predict that a stronger Stroop effect would have been achieved in the present study if only the "standard" Stroop format had been used.

Despite the weakness of the Stroop interference effect obtained in this study, the effect was stronger among high alexithymia males than medium and low alexithymia males, and females in all alexithymic groups. High interference on the Stroop test has been associated with personality characteristics that can be construed as being generally similar to those observed in alexithymics. Broverman (1962) classified individuals having high and low interference proneness (referred to as HI's and LI's respectively) and suggested that LI's are strong automatizers and have an "inner push" towards interpersonal dominance, independence, assertiveness, non-conformity, and rebelliousness with authority. These characteristics could be construed as being the obverse of personality characteristics attributed to alexithymics; alexithymics are thought to be generally passive, dependent, unassertive, and conforming, characteristics consistent with the "pseudonormal" description of the alexithymic individual (Cole, 1984; McDougal, 1974). Thurstone and Mellinger (1953), in a correlational study that involved the administration of the Stroop test and four personality inventories with a total of 475 items "covering the range of normal personality" (p.77) to 99 students, suggest that subjects showing low CW interference:

> ...have irregular habits and seek pleasure in life. They procrastinate, do not work intensively, lack perseverance, are not ambitious, and are not orderly or neat. They seem to dodge hard work and responsibility, they like to talk, and have little control over their habits. This

> interpretation is interesting in that it refutes the hypothesis that the controlled and determined person will plow right through the distraction. It seems instead that the deliberate, regular and energetic worker takes pains to do the task carefully and systematically. He finds it difficult to effect the required degree of dissociation to read card CW easily (p.13).

Again, the obverse of these characteristics are more consistent with alexithymic characteristics, which include a task oriented attention to detail (Sifneos, Apfel-Savitz, & Frankel, 1977). With 28 Ss, Callaway (1959; cited in Jensen & Rohwer, 1966) found a correlation of -.43 between Stroop interference and the E (extroversion) scale of the Maudsley Personality Inventory (MPI). Thus, the higher Stroop scores among high alexithymia males in the present study is consistent with findings of Bagby et al., (1986b) that TAS scores were significantly correlated with the social introversion subtest of the Basic Personality Inventory ($r=.269$, $p<.01$). In general, individuals showing high Stroop interference may have more alexithymic characteristics than individuals showing low Stroop interference.

The greater Stroop interference among high alexithymia males is consistent with findings relating hemisphericity to Stroop performance and alexithymia. Right hemisphericity has been associated with greater Stroop interference (Bakan & Shotland, 1969) as well as higher scores on the SSPS alexithymia measure (Cole & Bakan, 1985). Greater interference on all Stroop variables among high alexithymia males may help explain how male alexithymics process information differently from non-alexithymics. Greater Stroop interference (suggesting diminished ability to allocate attention to the salient aspect of a complex stimulus) may be interpreted as reflecting a characteristic "style" of information processing for which the right hemisphere is more "specialized" (Joseph, 1988; Sperry, 1982), i.e. a "holistic" or synthetic style with a tendency towards "gestalt" perception.

This interpretation would be consistent with other hemisphericity explanations for individual differences in personality and information processing styles. Smokler and Shevrin (1979) used Rorschach indices to screen for obsessive compulsive and hysterical personality characteristics in a sample of 316 right handed undergraduates. They then compared the conjugate lateral eye movements (according to procedures outlined by Gur & Gur, 1975) of 8 males and 18 females who satisfied the criteria for hysterical personality style, and 7 males and 8 females who satisified the criteria for obsessive compulsive style. The hysterical group had significantly more left eye movements, while the obsessive compulsive group had significantly more right eye movements. Thus, right hemisphericity was associated with a tendency to process information in a global, holistic manner, while left hemisphericity was associated with a tendency to process information more analytically. Nemiah (1975) has differentiated alexithymia from hysterical personality style:

> ...hysterical patients may in certain areas have a restriction of fantasy and emotion as severe as that of patients with psychosomatic disorders, but this constriction is limited to the specific aspect of their psychological conflict, in which repression plays a major defensive

role; in other respects they are highly emotional and imaginative, and are as lively and colorful in their behavior as the psychosomatics are flat and dull (p.142).

There may, however, be similarities between the alexithymic and hysterical cognitive styles of information processing. For example, hysterics are described as favoring a concrete-stimulus bound problem-solving approach and thus being incapable of persistent intellectual concentration (Abse, 1974; Shapiro, 1965). This is in accordance with the concrete stimulus-bound cognitive style (pensee operatoire) cognitive style thought to be characteristic of alexithymics (Marty & M'Uzan, 1963; Sifneos et al., 1977). Despite the differences between histrionic personality style and alexithymia there appear to be some similarities in cognitive style which may be associated with right hemisphericity. While alexithymia may be similar in some respects to the hysterical personality style, the differences between them suggest they are distinct psychological phenomenon that have in common a greater involvement of right hemisphere functions or processes.

If alexithymia can be associated with a gestalt, holistic, or synthetic perceptual style, the alexithymic's difficulty with the differention and expression of feelings may reflect an "overreliance" on the right hemisphere's synthetic processes. This right hemisphere overreliance could in turn preclude or compete with the differentiation processes of the left hemisphere (a possibility consistent with Bakan's findings that subjects demonstrating left hemisphericity exhibit less interference on the Stroop). Thus, the alexithymic's difficulty with expressing feelings may occur in an early processing stage where emotions are initally differentiated.

Sex Differences in Stroop Performance

Males in this study took longer time to name the colors of rows of X's, and had generally larger interference scores. This is consistent with Stroop studies reporting sex differences in which females are consistently superior (Golden, 1974b; Jensen, 1965; Jensen & Rohwer, 1966; Majeres, 1977; Peretti, 1971; Sarmany, 1977; Sovcikova & Bronis, 1989; and Stroop, 1935). Most researchers of both traditional and emotional Stroop paradigms do not examine sex differences. Only 7% of the 192 studies reviewed by Izawa and Silver (1988) examined sex differences in Stroop performance, while sex is a variable poorly controlled for in the reviewed emotional Stroop studies.

Martin and Franzen (1989) reported a sex difference in Stroop performance which is relevant to the present study. They found that the Stroop performance of males deteriorated under anxiety conditions while the performance of females did not. It is possible that the results of the present study showing greater Stroop interference scores among high alexithymia males was due in part to anxiety. Bagby et al., (1986b) found that, with a university sample (no sex differences were reported), TAS alexithymia scores (which were generally low) correlated positively with scores on the State-Trait Anxiety Inventory. Bagby et al., (1986b) controlled for the influence of anxiety with an analysis of covariance and found that alexithymia continued to be correlated with a number of variables consistent with the alexithymic "phenomenon" and suggested that alexithymia measures something other than anxiety. Cole (1982), using the SSPS alexithymia measure with a university sample, found a small but significant correlation between alexithymia and trait anxiety for males while for females the correlations were very small and insignificant. Martin and Pihl (1986) used the SSPS alexithymia measure and the Stimulus-Response Inventory of General Trait Anxiety and found greater "cognitive anxiety" among high alexithymics relative to low alexithymics. Thus, the present results showing sex differences in Stroop performance may be due in part to the effects of anxiety among high alexithymia males. This explanation would support a model of alexithymia that included the operation of defense mechanisms. Given the different ways in which hysterical and obsessive compulsive personality types defend against anxiety (Shapiro, 1965), alexithymics may differ in their characteristic defenses against anxiety. While there is little to support the denial model of alexithymia, isolation, a defense mechanism observed among obsessional neurotics (Freud, 1966) may also be relied upon by alexithymics to defend against anxiety. Anna Freud's (1966) description of obsessional patient is similar to *pensee operatoire* alexithymic cognitive style described as involving the endless description of details and symptoms with minimal affect:

> It [isolation] simply removes the instinctual impulses from their context, while retaining them in consciousness. Accordingly, the resistance of such patients takes a different form. The obsessional patient does not fall silent; he speaks, even when in a state of resistance. But he severs the links between his associations and isolates ideas from affects when his is speaking, so that his associations seem as meaningless on a a small scale as his obsessional symptoms on a large scale (p.35).

This description is also consistent with the suggestion by Martin et al., (1986) that the alexithymic, in addition to having higher sympathetic arousal and reduced experience and expression of affect, has ". . .a deficient ability to integrate somatic information into affective experience and expression" (p.139). They present results that suggest "...a continuum between alexithymic and neurotic characteristics" (p.138) and suggest that alexithymic characterisitcs result from defects in cognitive schema rather than defensive processes or a "functional neurophysiological disconnection" (p.138).

With regard to the neuropsycholgical correlates of anxiety and personality styles, the hemispheric involvement in anxiety is unclear as studies on anxiety and hemispheric activation are inconclusive. There is support for a hypothesis that anxiety is predominantly associated with either a decrease in right hemisphere activation (Tucker, Antes, Stenslie, & Barnhardt, 1978) or, alternatively, an increase in right hemisphere activation (Cole, 1982; Newman, 1981; Tucker, Roth, Arnson, & Buckingham, 1977). In addition to finding sex differences in the correlation between alexithymia and anxiety, Cole (1982) found sex differences in the relationships between right hemisphericity and alexithymia. For females the correlation between between alexithymia and CLEM direction was significant ($r=.34$, $p<.05$) while for males the corresponding correlation was small and insignificant ($r=.12$) though in the same direction. While this finding may in part be consistent with suggestions that females are more lateralized for emotional processes (e.g., Davidson & Schwartz, 1976) this hypothesis has not been consistently supported (e.g., Harrison, Gorelczenko, & Cook, 1990).

There are a number of other possible explanations for sex differences in Stroop performance. There are sex differences in color vision deficiencies, perceptual speed, color naming speed, and in the lateralization of cognitive functions, phenomenon which may be mututally interdependent.

Sex Differences in Color Discrimination Abilities

The prevalence of color deficiencies is lower among females. Jaegar (1972) reports that 8% of males and 0.4% of females of European descent have some type of color deficiency (difficulty discriminating between two colors that differ in hue). Izawa and Silver (1988) compared the Stroop performance of a group of color blind men with that of a normal, non-color blind, sample.and found that color blind men made more errors and had greater interference scores than the normal group. According to Matlin (1988) the term "color blind" is too strong given that only a few people are totally unable to discriminate colors. Thus, while it is possible that the higher Stroop scores of male subjects with high alexithymia scores may have been due in part to differences in color descrimination abilities, this hypothesis cannot be tested in the present study. It seems reasonable to assume that color discrimination ability is related to the ability to name colors. While the color naming task of the present study is not a very thorough measure, color naming scores did have some variance in common with alexithymia. Relatively poor color differentiation skills, and color naming abilities, may be a marker of the alexithymic's difficulty with the differentiation and identification of emotions.

Sex Differences in Perceptual Speed and Cognitive Abilities

Another factor that may explain sex differences in Stroop performance, and alexithymia, is that females have superior perceptual speed "...probably one of the most reliable sex differences in the cognitive domain" (Majeres, 1977, p.468). Females outperform males on perceptual speed tests involving rapid perception of details and frequent shifts of attention (Anastasi, 1958; Garai & Schienfeld, 1968; Guilford, 1967; Maccoby, 1966; Maccoby & Jacklin, 1974). Majeres (1977) suggested females' superior verbal skills may facilitate "decision processes" as the skills tested in clerical speed tests involve comparison and decision processes rather than perceptual encoding speed.

While females have superior verbal and perceptual speed abilities, males have superior spatial abilities (McGee, 1979; Nyborg, 1983). Males also have superior peformance with a number of sensorimotor functions including quicker reaction times, better depth perception, and daylight vision, while females have better night vision, sensitivity to touch, hearing, manual dexterity and fine co-ordination (Moir & Tessell, 1989; Seward & Seward, 1980). In Stroop task performance the superior verbal abilites and perceptual speed of females appear to outweigh whatever spatial or reaction time advantage males may have.

Sex Differences in Lateralization of Brain Function

Right handed males consistently exhibit more distinct hemispheric lateralization for spatial (right hemisphere) and verbal skills (left hemisphere), while females show greater bilateral representation of these abilities (Lake & Bryden, 1976; McGee, 1982; McGlone, 1978; Springer & Deutsch, 1989). This hypothesiss has not been consistently supported (e.g., Sherman, 1978). As well, a sex difference in 'within hemisphere' localization of verbal abilities has been reported by Kimura and Harshman (1984) with males having language difficulties more frequently with posterior lesions and females having language difficulties more frequently with anterior lesions.

Sex differences in color naming could also be explained by findings that females are less lateralized, and have the potential for greater inter-hemispheric communication relative to males. Tokar, Matheson, and Haude (1989) studied sex differences in accuracy of color naming and color matching using tachistiscopically presented stimuli. They found a right visual field advantage for the color naming task, a significant main effect for color matching among males (only with stimuli presented to the left visual field), and a significant sex by visual field interaction for the matching task. While the differences between males and females on the color naming tasks were not significant, there was greater accuracy in color naming with stimuli presented to the right visual field, while the color matching was more accurate, especially among males, with stimuli presented to the left visual field. These findings support the notion of greater lateralization among males, and that color naming predominantly involves the left hemisphere, while color matching predominantly draws on the abilities of the right hemisphere.

Males have also been found to have quicker reaction times and superior emotion identification relative to females in responding in a forced choice format (sad or happy) to visual half field stimuli (sad, happy, or neutral faces) presented to the left visual field

(Harrison, Gorelczenko, & Cook, 1990) supporting the hypothesis of greater right hemisphere lateralization of emotion functions among males.

While findings of sex differences in the lateralization of emotional processing are inconsistent, the interhemispheric communication of emotional information may also be a factor that accounts for sex differences in alexithymia and Stroop performance. Looking at the differences in Stroop scores among the male alexithymia groups, we can ask if the higher interference scores among the high alexithymia subjects is due to diminished interhemispheric transfer of information. Diminished interhemispheric communication, the "functional commissurotomy" model of alexithymia, has been suggested as a possible neurophysiological basis for the deficit or structural model of alexithymia (Buchanan et al., 1980; Hoppe, 1977; Hoppe & Bogen, 1977; Shipko, 1982; TenHoughten et al., 1986). Zeitlan, Lane, O'Leary and Schrift (1989), tested hypotheses formulated from interhemispheric communication research on split brain patients (reviewed in the introduction) with a study on post traumatic stress disorder (PTSD). They suggested alexithymia in neurologically intact people was due to a "functional commissurotomy". Using a behavioral measure of interhemispheric transfer, a tactile finger localization task, and the Toronto Alexithymia Scale to measure alexithymia, they found that interhemispheric transfer of information varied according to the presence of alexithymia. Subjects with alexithymia scores in the clinically significant range had diminished interhemispheric transfer of information relative to controls "without" alexithymia. Both PTSD subjects and controls without alexithymia scored in the normal range for adults on this measure, suggesting that the deficit in interhemispheric transfer was a function of alexithymia, and not PTSD.

Merriam and Wszynski (1990) questioned these conclusions on the basis of ceiling effects: when single hemisphere tactile localization scores reach ceiling levels, the poorer performance when interhemispheric transfer is required does not necessarily reflect inefficiency of transfer or a differential rather than a global performance deficit. Zeitlin et al. (1990) countered this criticism by reporting that there were no ceiling effects, nor were there significant differences between the groups in the uncrossed or "within hemisphere" conditions. Given that there were no "within hemisphere" differences between the groups while there were interhemisphere differences, they suggested that alexithymia does not represent a global deficit but rather a deficit that involves interhemispheric transfer of information. This hypothesis is interesting with regard to the present findings. The relatively poorer Stroop performance of the high alexithymia males could be reasonably explained by diminished interhemispheric transfer of information, while the lack of similar findings among females may be due to their relatively greater interhemispheric communication (as suggested by findings showing females have less lateralization of cognitive abilities including language). While Zeitlin et al., (1989) did not use female subjects, the present finding of relatively lower vocabulary scores among high alexithymia females is generally inconsistent with this explanation. Perhaps with females, alexithymia is associated with a global deficit, while with males alexithymia is associated with an interhemispheric communication deficit or a "functional commissurotomy".

There is evidence that for females (De Lacoste-Utamsing & Holloway, 1982) and left handers (Witelson, 1985) the corpus callosum is thicker, although these findings have not always been confirmed (Kertesz, Polk, Howell, & Black, 1987). While the size of the corpus callosum may or may not vary according to sex, findings of greater lateralization of cognitive and emotion processes among males suggests that males may rely more on information transferred accross the corpus callosum. Witelson (1976) suggests that because language is more bilaterally represented in females, they have superior performance on tasks combining spatial and linguistic functions in a single activity. The Stroop is such a task, involving the information processing abilites of both hemispheres. Females may be superior in processing two types of information concurrently, and males may exhibit relatively slower interhemispheric transfer of competing responses. These gender differences in general cognitive abilities, in addition to having general implications for sex differences in psychopathology, suggest that the processes disrupted in alexithymics may differ according to sex (females with regard to verbal abilities and males with regard to decoding a complex stimulus). However, even if alexithymic characteristics are due in part to either diminished interhemispheric communication or verbal intelligence, this does not explain the mechanisms involved in the alexithymic's tendency to somatize affect.

Implications for Psychosomatic Theory

With reference to findings that the right hemisphere is more involved in processes underlying attention and arousal (Dimond & Beamont, 1974; Heilman, 1979) than the left, the present research may have implications for understanding the mechanisms involved in the alexithymic's vulnerability to somatization of affect. There is good evidence that alexithymics have higher levels of physiological arousal than non-alexithymics. Martin, Pihl, Young, Ervin, & Tourjman (1986) report a higher level of sympathetic activation in the high alexithymic. Rabavilas (1987) also tested the hypothesis that alexithymics have relatively higher levels of arousal by measuring the electrodermal activity of 38 patients with generalized anxiety, phobic or obsessional disorders scoring high and low (one standard deviation above or below the mean) on the SSPS alexithymia measure (Apfel & Sifneos, 1979). There were 15 females and 4 males in the low alexithymia group, and 8 females and 11 males in the high alexithymia group. Individuals in the high alexithymia group exhibited significantly higher levels of arousal in "spontaneous activity" and "amplitude to novel stimulus" conditions. As well, subjects high in alexithymia, relative to subjects low in alexithymia, exhibited significantly slower recovery time during the presentation of novel stimuli. While subjective anxiety ratings did not differentiate these two groups, the product moment correlations between anxiety and spontaneous electrodermal activity for the low alexithymia group were significant ($r=0.62$, $p<0.01$), while for the high alexithymia group the correlations were negative and insignificant. Thus, individuals in the high alexithymia group may have difficulty accurately reporting the subjective components of their higher levels of physical arousal. Unfortunately the results were not reported separately for sex. Given the results of the present study, one might expect that males with high alexithymia scores would exhibit greater "decoupling" of their subjective and objective indices of emotion/arousal.

Lindholm, Lehtinen, Hyyppa and Puukka (1990) found a positive relationship between Beth Israel Questionnaire alexithymia scores, and percentage of positive dexamethasone suppression test (DST) results with the effects of age, social rank, marital status, and depression controlled. Their results support the hypothesis that a positive DST test may reflect an "aberrant" stress response in subjects with alexithymic characteristics. The cognitive stress induced by the Stroop test is associated with a physiological response characteristic of a stress reaction. Tulen, Moleman, Steenis and Boomsma (1989) used the Stroop test to study stress induced sympathetic activation and found that in 9 men (aged 22 to 25 years) the Stroop test induced increases in plasma and urinary adrenaline, heart rate, respiration rate, electrodermal activity, electromyography, feelings of anxiety, and decreased finger pulse amplitude. They concluded that the Stroop test is useful for studying stress responses. With reference to the present findings, it seems possible that the limited capacity information processing system of high alexithymia males was "overwhelmed" by the degree of vigilance necessary to attend to the salient aspect of the complex stimulus (the color), leading to a reduction of cognitive or attentional capacity, as manifested by the higher interference scores. Consistent with the findings of Tulen et al., (1989) this may have been associated with an increase in sympathetic arousal. While the present study did not measure the subjective experience of subjects while performing the Stroop tasks, other researchers have found a "decoupling" of subjective experience and objective physiological measures of 'stress responses' among people scoring high in alexithymia. Consistent with findings by Martin and Pihl (1986) of a physiological-subjective dissociation among high alexithymics, Papciak, Feuerstein, and Spiegel (1985) report a "decoupling" of autonomic arousal (using measures of heart rate and blood pressure) and subjective reports of tension among individuals with high alexithymia scores responding to a "stress quiz"; the high alexithymics had higher heart rates during the test than the low alexithymics while there were no group differences in reported tension during stress. Invoking a defensive model of alexithymia, Papciak et al. suggest the alexithymic's response style is similar to the response style of repressors, who have a tendency to deny cognitions of anxiety. Thus, in "stressful situations" that necessitate a sequential response (breaking a "stressful" stimulus or task down to its component parts or to make decisions about appropriate responses) the cognitive response of the male alexithymic may be "short-circuited" by autonomic responses which are not cognitively differentiated or represented. The subjective experience of arousal may be relatively undifferentiated and less accessible to the lexicon for verbal expression.

Similarity of alexithymia to neurological "syndromes"

There was heteroscadasticity in the Stroop data of males as a function of alexithymia. The standard deviation of Stroop score among males in the high alexithymia group was higher that the standard deviation of the middle and low alexithymia groups. This heteroscadasticity finding is consistent with findings by Martin and Pihl (1986) that high alexithymics show a higher and more variable pattern of stress ratings. The rationale of the present thesis was to investigate the relative **presence** or **absense** of cognitive processes thought to be involved in emotional "experience" and "expression". Color blindedness may be thought of as more of a dichotomous variable than most psychological variables, thus possibly being a factor that contributed to the greater variability in the Stroop data of males in the high alexithymia group. However, the two individuals that suggested that they **may** be somewhat color blind are in the middle alexithymia group rather than the high group. It is possible that the data may reflect the influence of "true" color weakness. Unfortunately, this hypothesis is untestable in the present study.

Alternatively, variability of fluency scores may account for some of the variability in Stroop scores within the high alexithymia group. There were 5 subjects within the high alexithymia group with scores that were generally higher than the other 12 subjects in the high alexithymia group (see Figures 1, 2, & 3). While this group of 5 subjects tended to have lower fluency scores than the other 12, the difference between the means was insignificant (although the insignificance of this difference may be a result of the n's being quite different: 5 vs. 12). Tests of verbal fluency have been construed as measures of thought organization (Lezak, 1980). Thus, subjects with high interference scores may have less efficient or effective thought organization (as shown by higher fluency scores) **as well as** less efficient or effective attentional resources (as shown by higher Stroop scores). Distractibility and slowing are two cognitive "markers" of brain damage (Lezak, 1980), and these may be construed as two factors measured by the Stroop and verbal fluency tasks. If so, this combination of poorer scores or "characteristics" **may** be "symptomatic" of less efficient or compromised brain function. With the sample used in the present study data pertaining to head injuries or pregnancy or birth complications was not collected. A reasonable question here is **at what point** can you say that an individual has compromised brain function. In the old view of "organicity" brain damage is a unitary phenomenon, a central and univeral defect. However, no single neuropsychological test has yet been developed to measure this "central defect", and present practice dictates the use of a combination of tests. Thus, we say that an individual has cognitive deficits secondary to brain damage when we have sufficient evidence that the indiviual's performance on a number of cognitive tasks is more similar to a normative sample of brain injured individuals than to a sample of non-brain damaged individuals. While the overall suggestion of brain damage is unwarranted in the present study, given the lack of sufficient information, the notion of brain damage or dysfunction may help to explain the alexithymic's lack of improvement in psychotherapy. While higher Stroop interference scores and fluency scores are **suggestive** of relatively diminished brain efficiency, this is far from conclusive evidence for a more definitive interpretation of the results. More extensive neuropsychological assessments of alexithymic individuals would provide a test of this hypothesis.

Controlling the variability of Stroop interference contributed by fluency decreased the Stroop-alexithymia relationship, however, some differences remained between the interference scores of the groups (as seen with the partial correlation analysis). This may be suggestive of differences in attentional efficiency between subjects with high or low levels of alexithymia.

There are some general similarities between alexithymia and syndromes of characterstics (including attentional deficits) observed in individuals with right hemisphere dysfunction that could be interpreted as suggesting that the Stroop-alexithymia relationship may be associated with a right hemisphere weakness or dysfunction secondary to a subtle brain injury possibly caused by pregnancy and birth complications. Weintraub and Mesulam (1983) reported a review of case studies of 14 individuals aged 11 to 42 years that suggests a relationship between right hemisphere impairment and: emotional and interpersonal difficulties (while many of the subjects were introverted and shy, and had difficulty conveying feelings, there was no evidence suggesting they could not experience affect); inadequate paralinguistic communication abilities (a lack of gestures,prosody, and eye contact); and problems with arithmetic and visuospatial performance. Weintraub and Mesulam (1983) suggested that early brain damage may have interfered with normal development:

> Difficulties with speech prosody impaired their ability to convey their emotional state and may have further jeopardized their interpersonal relations. The neurologic and neuropsychological findings were consistent with dysfunction of the right hemisphere. Historical details suggested that the presumptive insult to the brain had occurred early in life (from in utero to 8 years of age)...Our clinical observations suggest that early injury to the right hemisphere may seriously interfere with the acquisition of skills for which this hemisphere is considered to be specialized. These skills include constructional abilities, affective behavior, and the control of speech prosody in both affective and nonaffective communication. Verbal abilities, including naming by visual confrontation, were average to superior in the majority of our sample (pp.467-468).

Follwing up this research, Voeller (1986) reported a right hemisphere deficit syndrome in 15 children (10 boys and 5 girls) aged 5 to 13 years which he suggests may be similar to alexithymia. The children all had neuropsychological profiles and neurological findings consistent with right hemisphere damage or dysfunction. <u>All but</u>

one of the children satisfied the diagnostic criteria for attention deficit disorder (ADD); seven of them had sustained pregnancy and birth complications (PBC's) ; and 4 of then had sustained postnatal neurological insults. While two (13%) of the children were left handed, seven showed a right hand preference before their first year which the authors stated was suggestive of an early left hemiperesis. Social withdrawal and isolation was characteristic of 8 of the children who also had difficulty discerning the nuances of social interaction. Half of the children had atypical prosody, and most had deficient eye contact. The group performed below "normal" on an affect recognition test. Five of the children were receiving some form of psychotherapy and their response to therapy was considered to be poor. Generally these findings suggest some similarities between right hemisphere deficit syndrome and characteristics of alexithymia. Especially interesting is the high incidence of attention deficit disorder in this group. Stroop interference was greatest among males in the high alexithymia group in the present study, that is, males with relatively higher alexithymia scores had difficulty attending to the salient aspects of a complex stimulus. This difficulty in sustaining attention may be suggestive of an attentional deficit. Taylor, Bagby, Ryan, and Parker (1990) found that in a sample of 117 (45 males and 72 females) university students, TAS scores correlated positively ($r=.46$, $p<.001$) with the "poor attentional control subscale" of the Short Imaginal Process Inventory, suggesting that alexithymia is associated with poor attentional control, consistent with the present findings.

The high rate of pregnancy and birth complications among this right hemisphere deficit syndrome group raises the possibility that alexithymia may be a result of pregnancy and birth complications that disrupt right hemisphere functioning (while speech disorders proper may be left hemisphere manifestations of the effects of PBC's). In addition to possible attention difficulties there are other similarities between ADD and alexithymia. Alexithymics have been described as impulsive; they are perceived as being less intelligent (when that is not necessarily the case as shown by Pierloot and Vinck (1977); both ADD subjects and alexithymics tend towards somatization; in general both are inattentive to their inner self (they may be construed as concrete externalizers) with a concordant lack of empathy, alexithymia has been described as being similar to psychopathic personality which has a long history of association with ADD. With ADD having been called minimal brain dysfunction, and alexithymia thought to possibly involve a constitutional deficit, there are possible common "organic" etiological explanations. There is a string of associations between ADD, alexithymia, non-right handedness that may have PBC's as a common link between them. As there is overlap between borderline and other personality disorders, ADD and alexithymia may be an overlap of two disorders in a spectrum of disorders (including epilepsy, speech problems, schizophrenia) that inolve a subtle brain dysfunction secondary to brain injury or PBC's.

Greater Stroop interference has also been reported among individuals with learning disabilities, conditions more prevalent among males and which also may be PBC sequalae. Lazarus, Ludwig and Aberson (1984) compared Stroop performance of 31 male and 14 female learning disabled (LD) 4th and 5th grade students with the Stroop performance of 22 male and 28 female non LD students. Both male and female LD students exhibited greater Stroop interference than non LD students, while LD males had more interference than LD females.

Among adolescents the prevalence of ADD (with hyperactivity) has a sex ratio of males to females ranging from 3-9:1 (Lezak, 1989). Lysak (1989) studied some effects of a stimulant (methylphenidate or Ritalin) on frontal lobe functioning in a sample of 27 male ADHD "conduct disordered" adolescents and found that her sample had lower (but not significantly lower) mean fluency scores (mean=25.37, SD=6.04 vs.mean=28.80, SD=8.3) and higher mean Stroop color word interference scores (56.73, SD=6.28) than quasi normal controls (mean=50.0, SD=10), and that both of these scores improved with the administration of Ritalin. Average Stroop interference scores decresead by up to 7.6 seconds (more than one standard deviation) with a .5mg per kilogram dose while an average of 8 more words were produced (about one standard deviation) with the FAS in the .3 mg/kg dose condition. Lysak's findings with Ritalin are in agreement with findings that caffeine improves verbal fluency (Franks, Hagedorn, Hensley, Hensley, & Starmer, 1975; Rideout & Hitchcock, 1985; Rideout & Grzywacz, 1988, cited in Rideout & Winchester, 1990).

Lyzak's results suggest that Ritalin improves mental flexability (as measured by the FAS test) and short-term attention span (measured with the Digit Symbol WAIS-R subtest) in addition to improved performance on direct measures of frontal lobe functioning (the Wisconsin Card Sorting Test). Lezak (1980) reviews evidence that frontal lobe damage is associated with 5 areas of behavioral disturbance: "(1.) Problems in starting appear in decreased spontaneity [associated with fluency differences] ...(2.) difficulties in making mental or behavioral shifts...(3) problems in stopping... (4) deficient self-awareness...(5) a concrete attitude..." (pp. 81-82), with the latter characteristics generally consistent with the alexithymic presentation. Thus, the "syndrome" of alexithymia may represent personality characteristics of people with diminished frontal lobe functioning. With the understanding of the frontal lobes, and their relation to the "highest" forms of behavior (e.g., concepts of "self" and consciousness) thought to be neuropsychology's most difficult problem, the construct validation of the problem of alexithymia is linked to more accepted and established problems in neuropsychology.

Lysak's (1989) finding that word fluency, frontal lobe, and Stroop performance improve in a sample of ADHD adolescents may have implications for the treatment of alexithymia. Smith and Johnson (1964) report that among depressed patients a positive relationship was found between improved Stroop CW performance and therapeutic improvement. Although this study is unavailable for further examination, the findings are interesting given that alexithymics are reported to be less able to benefit from psychodynamically oriented psychotherapy than non-alexithymic individuals. Given the sex differences in the cognitive correlates of alexithymia, stimulants could improve the attentional capacity and fluency of some male alexithymics. Thus, male alexithymics may experience beneficial effects of stimulants such as caffeine, cocaine, and amphetamines. Weil (1980) suggests that people dependent on caffeine get no positive effects, only the relief of negative symptoms such as "...the dissipation of mental cloudiness in the morning" (p.19). Caffeine is commonly associated with enhanced mental alertness, vigilance, and flow of thought (Ritchie, 1975):

> Caffeine stimulates all portions of the cortex. Its main action is to produce a more rapid and clearer flow of thought, and to allay drowsiness and fatigue. After taking caffeine one is capable of a greater sustained intellectual effort and a more perfect association of ideas. There is also a keener appreciation of sensory stimuli and reaction time is appreciably diminished (p.368).

High doses of caffeine, however, impair Stroop and verbal performance (Foreman, Barraclough, Moore, Mehta, & Madon, 1989; Gilliand, 1980). Alcohol also impairs Stroop performance, especially among females (Gustafson & Kallmen, 1990). While one could suggest that the ingestion of low doses of caffeine and other stimulants enhance attentional and verbal fluency abilities, and thus may be seen as a "treatment" for alexithymia, it seems more likely that the higher prevalence of substance abuse and alcoholism among alexithymics may reflect an attempt at self medication for the removal of the negative alexithymic characteristics. Taylor et al. (1990) referring to Khantzian (1985) and Lane and Schwartz (1987) state that:

> It has been hypothesized that substance dependent individuals use drugs or alcohol in an attempt to medicate themselves for certain unpleasant emotional states, which are experienced as unmanageable or overwhelming because of a limited cognitive capacity to differentiate and modulate affects (p.1228).

Cole and Bakan (1985) suggested that alexithymic characteristics may be similar to negative symptoms seen in schizophrenics and that these characteristics may result from the "displacement" of cognitive abilities by the limited capacity information processing system. This set of findings are may contribute to the understanding of some psychological mechanisms involved in various forms of addiction.

To summarize, for males Stroop interference scores were marginally higher in the high alexithymia group than the scores of the middle and low alexithymia groups. Three possible interpretations of this relationship are discussed. From the hemisphericity perspective, alexithymia may either be associated with increased anxiety, which is associated with disruption of function, or a synthetic-holistic-gestalt information processing style characteristic of a reliance on perceptual abilities of the right hemisphere. The difficulty with these explanations are that one suggests the disruption of right hemisphere functioning while the other suggests an overreliance on right hemispheric functions. Alternatively, the higher standard deviation of scores in high alexithymia group relative to the middle and low groups, may be suggestive of an association between alexithymia, diminished fluency and attentional resources. The pattern of greater variability of interference scores and verbal fluency scores within the high alexithymia group may suggest that this high alexithymia group may have some similaritites to adolescents with attention deficit disorder. As well there are some interesting parallels between alexithymia and attention deficit disorder in patients with "right hemisphere deficit syndrome". There is also the possibility that alexithymia represents the personality characteristics associated with diminished frontal lobe functioning. While these explanations are theoretically mutually exclusive and the support for each is generally equivocal given the data collected, they are heuristically useful in formulating more exacting hypotheses about the cognitive characteristics of alexithymia. These findings may also have implications for cognitive correlates of "stress responses" and the self-medication hypothesis of substance abuse.

Vocabulary and Alexithymia

For females the correlation between alexithymia and vocabulary scores was negative and significant: high alexithymia females had significantly lower vocabulary scores than low alexithymia females. This was further substantiated with a significant F on an ANOVA with vocabulary scores as the dependent variable and alexithymia groups as the independent variable. High alexithymia females had lower average vocabulary scores than low alexithymia females. There were no significant mean vocabulary differences between male alexithymia groups, nor were the correlations between alexithymia and vocabulary scores significant. The observed vocabulary differences seen among females are generally consistent with findings by Pierloot and Vinck (1977) who found that, in a group of patients (sex differences were not reported) referred for psychotherapy, alexithymia scores were significantly negatively correlated with WAIS-R vocabulary scores. This finding is also generally consistent with Loiselle and Dawson (1988) and Sriram et al. (1987) and split-brain researchers who report diminished word usage among alexithymics relative to non-alexithymics. Findings that high alexithymia females had lower vocabulary, and emotional vocabulary scores than low alexithymia females suggests that females in the high alexithymia group have a smaller lexicon with which to express both their feelings and their thoughts. While Lezak (1980) suggests that the Vocabulary subtest is the single best measure of verbal and general mental ability, Groth-Marnat (1984) suggests Vocabulary is the single best indicator of general intelligence:

> ... a test of accumulated verbal learning, and represents an individual's ability to express a wide range of ideas with ease and flexibility. It may also involve one's richness of ideas, long term memory, concept formation and language development (p.72).

The marginally significant mean vocabulary differences between females grouped according to degree of alexithymia and the significant negative correlation between alexithymia scores and vocabulary scores may represent a tendency for alexithymia, in females, to be associated with compromised expressive abilites and/or diminshed language aquisition. While a distinction between the influence of primary (deficit-trait) or secondary (defensive-situational) factors on vocabulary and general intellectual development cannot be made with the present data, there are a number of other possible explanations for the lower vocabulary scores among females with high alexithymia scores. Psychological trauma may influence both vocabulary and emotional development. Sifneos (1988) suggests

> a massive psychological trauma occuring at a critical period of infant development may not only influence the verbal expression of feelings but also may have lasting effect on the whole way in which feelings are dealt with...(p.290).

Difficulties in the parent-child relationship may also lead to disruption of cognitive development. Tronic (1989), in a review of the reciprocal interactions and emotional communication between infants and adults and the development of emotional regulation, suggests that abnormal interaction/communication can potentially lead to impaired cognitive development:

> The infant extablishes a self-directed style of regulatory behavior (i.e., turning away, escaping, becoming perceptually unavailable) to control negative affect and its disruptive effects on goal-directed behavior. Indeed, regulation of negative affect becomes the infant's primary goal and preempts other possible goals. This self-directed style of regulatory behavior precludes the infant's involvement with objects, potentially compromising cognitive development, and distorts the infants interactions with other people (p.117).

While there are many possible explanations for lower verbal abilities, the results suggest diminished language development may characterize female alexithymics. With females higher alexithymia scores were also associated with lower emotional vocabulary scores. This suggests that a relatively smaller lexicon of emotional words is available to the female alexithymic. The implications of this finding may include the presentation style of female alexithymics. Female alexithymics may present as being less intelligent or language deficient relative to non-alexithymic females. Cole (1984) found that, especially for females, alexithymia correlated strongly with a number of pain outcome measures independently of severity of physical injury, suggesting that female alexithymics may be treated differently by the medical profession because of their "stoic", non-hysterical, relatively uncommunicative presentation. The findings of decreased verbal abilities among females scoring high in alexithymia may also have implications for understanding the cognitive characteristics of individuals prone to violence. Comparing highly aggressive physically abused children with less aggressive physically abused children, Burke, Crenshaw, Green, Schlosser and Strcchia-Rivera (1989) found that reading and expressive language deficits were significantly more prevalent among the highly aggressive children. Keltikangas-Jarvinen's (1982) found of a high "incidence' of alexithymia among violent offenders. Diminished language abilities may be a factor associated with a greater propensity for violence, consistent with the impulsive, action oriented "style" of the alexithymic.

Lezak (1980) suggests that early socialization experiences influence vocabulary development more than school experiences and thus vocabulary scores more likely reflect the subject's socioeconomic and cultural origins than academic motivation. While the data is from subjects screened for English being a second language, or a language learned concurrently with another, there exists a possibility that cultural differences may have contributed some variance to vocabulary scores given that race or religion was not recorded. However, the plausibility of this explanation is diminished by the fact that males underwent the same "screening process" and one could reasonably expect that differences in cultural backgrounds or socioeconomic status would have relatively similar prevalence among the male sample and this would have been reflected in vocabulary differences, which were not found among males. Also, the experimenter was blind to alexithymia scores until after the vocabulary scores were calculated thus minimizing the possibility of experimenter bias. Thus, the possibility that the differences in vocabulary scores were due to SES or cultural differences is unlikely.

Similarities and Alexithymia

There was little systematic relationship between alexithymia and Similarities scores for males or females (though the relationships were in the predicted direction as high alexithymics had slightly lower similarities scores). There was little support for the hypothesis forwarded by Apfel and Sifneos (1979) that the alexithymic 'cognitive style', characterized by the presence of concrete rather than abstract thinking, is similar to the "pensee operatoire" cognitive style conceptualized by M'Uzan (1963). While the Similarities subtest of the WAIS-R is an accepted measure of verbal concept formation or "abstract thinking", it did not "capture" this aspect of the alexithymic cognitive style. This may be explained by the finding that the "concrete thinking" oriented questions on the TAS load on factor 3 in a factor analysis of the TAS (Taylor et al., 1985). Thus, relative to factor one which consists of items pertaining to the ability to identify and describe feelings and bodily sensations, and factor two with items reflecting the ability to verbalize feelings to others, the concrete thinking aspect of alexithymia may be a weaker phenomenon accounting for less variance in TAS scores. If the questions that load strongest on factor 3 were scored separately from the overall TAS scores, a relationship between Similarities scores and this subset of questions would likely be found. Also, if a more "clinical" population was used, a stronger relationship beteen Similarities and alexithymia scores may be found.

Verbal Fluency and Alexithymia

Other than the variability that fluency scores contributed to Stroop interference scores, no general differences were found regarding verbal fluency and alexithymia: alexithymia scores were not significantly correlated with word fluency scores despite the expectable significant correlation between fluency scores and vocabulary scores. The lack of differences in word fluency among the male and female alexithymia groups suggests alexithymia is not generally associated with a slowing of thought organization and expressive abilites. However, the finding that in the high male alexithymia group there was a tendency for higher Stroop interference scores to be associated with lower fluency scores suggests that verbal fluency difficulties may be characteristic of some alexithymic individuals. While the FAS test does not specifically tap emotional words, many subjects reported distress with this general word production task. The test seems to measure people's ability to produce words in a stressful "on the spot" situation where the experience and expression of emotions could reasonably be expected.

Sex Differences in Verbal Abilities

For females there was a relationship between alexithymia scores and scores on measures of verbal intelligence with higher alexithymia scores being associated with lower vocabulary and emotional vocabulary scores, while for males no vocabulary differences were found between the groups. An adequate explanation for these sex differences is elusive. Females are generally thought to be superior on tests of verbal ability (Maccoby & Jacklin, 1974) such as verbal fluency (Benton & Hamsher, 1977; Bennett, Seashore & Wasman, 1974), spelling (Bennett et al., 1974), and verbal learning (Ivison, 1977). This difference is more pronounced in childhood and puberty (McGee, 1979; Nyborg, 1983) and continues into old age (Cohen & Wilkie, 1979). Males, on the other hand, have a generally higher incidence of language difficulties: developmental dyslexia, infantile autism, reading retardation, developmental aphasia and stuttering (Flor-Henry, 1978b).It is unclear why alexithymia would be associated with diminished vocabulary among females and not males, given that males are more likely to have language disorders Perhaps the greater bilateral representation of language abilities among females makes them more vulnerable to language disruptions when a "functional commissurotomy" takes place, while males are more vulnerable to disruption of their attentional resources (as measured by the Stroop) under similar "functional commissurotomy" conditions.

Sexual Dimorphism of Alexithymia

Despite there being no significant sex differences in TAS alexithymia scores in the present study or in other studies using the TAS (Taylor et al., 1988), there appears to be a sexual dimorphism of cognitive characteristics associated with alexithymia. The results of the present study suggest that the disrupted cognitive processes in the alexithymia "phenomenon" may differ according to sex. Perhaps some male alexithymics have attentional difficulties that diminish their ability to discriminate between feelings while female alexithymics may have difficulty with concept formation-verbal expression processes. With females alexithymia may be secondary to a language-intelligence deficit, wheras with males alexithymia may be secondary to a general difficulty with the perception of any type of complex stimulus. As well, higher anxiety among males scoring high in alexithymia may have contributed to their relatively poorer Stroop performance, while anxiety may not play an important role in Stroop performance or alexithymia for females.

Color Naming and Alexithymia

There was a consistent sex difference in color naming abilites, with females showing superiority. Some of the implications of this were reviewed in the discussion of sex differences in Stroop performance. The relationship between color naming and alexithymia was quite similar between males and females, although it was not significant for males. I will now discuss some of the early research on color naming, which revealed consistent female superiority, and then I will discuss neuropsychological syndromes that include color naming difficulties, followed by a discussion of the implications that the color naming - alexithymia relationship may have for the processing of emotions .

Cattell (1886) was among the first to report that color naming takes longer than reading the names of color words, and suggested that automaticity explained this difference:

> the association between the color word and its name has been repeated so often that it has become automatic, wheras in the case of colors a voluntary effort is required (p.65).

Ligon (1932) studied color naming among grades 1 to 9 and found that girls were superior to boys in color naming in all grades. This sex differences held only for color naming and not word reading. Ligon suggested that a 'color naming special factor' rather than verbal ability accounted for the female superiority. Dubois (1939) reported results consistent with Ligon's hypothesis and found that the female superiority in naming patches of colors was greater when subjects were asked to point to matching colors on a response card rather than speaking the names. He suggested that his results show sex differences in color encoding speed, and that this difference is best explained by a "color naming special factor" that is independent of language abilities.

Sex differences in color naming were also found by Majeres (1977) who used stimulus lists varying the percentage of colors. He progressively decreased the proportion of colors by substituting color names under the premise that this would decrease the amount of color encoding and increase the amount of word coding required. Females were faster than males under the color-tapping condition. There were non-significant differences under the color-name-tapping condition with women being faster providing some support for Dubois's hypothesis. However, Dubois's hypothesis that the sex difference was due to superiority in color encoding received no support from results from varied stimulus list conditions (proportions of colors in stimulus lists was not associated with differences in the size of the sex differences). Practice effects did not account for these findings as females were significantly quicker on all trial blocks. It was suggested that these results may have resulted from women tapping quicker than males. This hypothesis was tested by measuring speed of finger tapping: females tended to be slower than males. This is consistent with findings by numerous other researchers that males are superior on finger tapping tests (e.g. Filskov & Catanese, 1986). Majeres (1977) tested the perceptual speed hypothesis, that color naming sex differences may be due to differences in visual scanning or attentional shift abilities, by administering a visual search task and found no significant sex differences. Generally, differences in reaction times, finger tapping, attentional shift, or verbal abilities do not fully explain the color naming sex difference. The difference may occur in the encoding of color (Dubois, 1939; Majeres, 1977). While there may be an overall female superiority in color encoding independent of verbal abilities, the results of the present study suggest that a "color naming special factor" does have some variance contributed by verbal fluency for both males and females in a verbal color naming task. Neuropsychological studies of color naming also suggest that differences in verbal abilites contribute to color naming difficulties.

<u>Neuropsychological Studies of Color Naming Difficulties</u>

In his review of studies on the relationship between color naming and verbal abilities Benton (1985) suggests that:

> The remarkable frequency with which aphasic patients fail the nonverbal task of matching colors to line drawings is often interpreted as implying that verbal mediational processes must underly the matching performance (p.166).

DeRenzi and Spinnler (1967) reported that 42% of a sample of aphasic patients failed a combined test of color naming and identifying colors (names were supplied) while only 10% of non-aphasic patients with right hemisphere deficits failed this test. There was a moderate correlation (r=.48) between test performance and assessed severity of the aphasic disorder. De Renzi, Faglioni, Scotti, & Spinnler (1972) reported a strong relationship between impaired performance on a nonverbal coloring task and aphasic disorder. Of the 18 poorest performances in a sample of 166 patients with unilateral brain disease (60 of whom were aphasic), 17 were made by aphasic patients. They suggested that this functional impairment was due to a "general disorder in conceptualisation". Impaired reading comprehension was correlated with defective color-object matching according to Varney (1982) and is an expression of a visual information processing disorder.

Benton (1985) gives an example of a specific visuoverbal color disability: 'alexic' patients do poorly on color naming tasks while having relatively intact ability to name objects and pictures. He suggests the association between incorrect color verbalization with acquired alexia (without agraphia) is highly frequent and is often included in the syndrome of symptoms of pure alexia (word blindness, acquired dyslexia, or acquired inability to comprehend written language as a sequalae of brain damage; Friedman & Albert, 1985) and right hemianopia (an ocular disorder marked by the loss of vision in half of the normal left visual field). Thus, there may be some similarities between alexithymia and alexia. The findings of the present study, and those from neuropsychological studies support the hypothesis that at least one language ability (fluency) appears to contribute variance to color naming abilities. The distinction between analog and digital information processing provides a possible theoretical basis for the role that language plays in color naming, and possibly, the naming of emotions.

Color and Affect: Digital vs. Analog Processing

There is a long standing hypotheses regarding a relationship between color and affect. Early research on the relationship between color preference and affect (Pressey, 1928) tested the hypothesis that response to color was a useful source of information for personality description. This led to the inclusion of color as a variable in the

Rorschach (Rorschach, 1942), the Luscher Color Test (Luscher & Scott, 1969), and in the Color Pyramid Test (Schaie & Heiss (1964). The Luscher Color test continues to be available to the public and used in research despite having poor theoretical support. Holmes, Wurtz, Waln, Dungan & Joseph (1984) found no consistent relationships between color preference and MMPI scores and suggest the Barnum effect is likely the only reason why the test has had some acceptance and perceived accuracy, i.e. general statements are made that would describe almost anyone. Also using the Luscher test Holmes, Fouty, Wurtz, & Burdick (1985) contend there is no consistent relationship between color preference and psychiatric disorder. While in an early review of Rorschach literature on color and affect Schachtel (1943) suggested that red "induced" striking, exciting, explosive and passionate affect; yellow induced cheerfulness and gentle stimulation; orange induced feelings of warmth and delight; and blue and green, with the avoidance of red, suggested people were controlling their affects, this early research was criticized on methodological grounds by Fortier (1953) and Keehn (1953). Thus, despite the generally accepted observation that colors are somehow related to emotions, there appears to be no consistent relationship between specific colors and specific emotions. A general relationship between color and affect is hypothesized to exist as indicated by the use of colored Rorschach cards as determinants to measure emotionality in its relationship to form (which is associated with degree of emotional control, organization, and expression of emotions).

Acklin and Alexander (1988) found the Rorschach to be a useful tool to assess alexithymia. They measured Rorschach responses in four psychosomatic groups (33 pain patients, 31 patients with gastrointestinal disorders, 29 dermatology patients, and

35 headache patients) and compared them to the responses of 600 non-patients. It was hypothesized that the alexithymic's lack of symbolic mentation or fantasy would be associated with a lower sum of overall responses to the cards and lower Rorschach human movement percept responses while the restricted affective responses of alexithymics would be represented by lower weighted Sum C (color) responses and poorly adapted affect would be manifested by a lower number of FC (Form-Color) responses. The alexithymic's tendency to exhibit concrete cognition would be manifest by fewer Blend responses, while perceptual stereotypy would be seen by a higher frequency of Lambda responses. All of the psychosomatic groups had responses consistent with these hypotheses with the exception of the GI and headache patients who did not exhibit significantly fewer Blends than nonpatients. In addition to showing that the Rorschach is a useful tool in assessing alexithymia, this study gives support to the connection between fewer color responses and diminished affective experience among alexithymics. A Rorschach study that measured the aforementioned Rorshach indices of a sample of subjects that had been tested for alexithymia using the TAS would add to the validity of their use.

Are there sex differences in the emotional salience of the colors used in the Stroop stimuli to account for the differences observed? Izawa and Silver (1989) report highly reliable sex differences in ranked reaction times to a total of eight colors. For females yellow was associated with the quickest average reaction time (626.88 milliseconds) followed by red, orange, black brown, blue, purple, and green the slowest (707.63 ms.). For males, yellow was also the quickest (772.88 ms) followed by red, black, blue, purple, brown, green, and orange the slowest (908.13 ms). While the between group differences show that females were consistently quicker in responding to all the colors, the within group differences (in terms of the colors used in the present study) indicate that blue was ranked higher for males with green, slowest for females, second slowest for males. It seems unlikely that these within group differences are significantly different enough to account for color naming differences between males and females given the large between group differences (the quickest RT for males was slower than the slowest RT for females).

A cognitive difference has been associated with alexithymia: the correlation between color naming scores and alexithymia scores was positive and significant for all subjects combined and females, while for males the correlation was slightly larger than that for females though it was not significant (likely due to the smaller sample of males). The factor accounting for most of the variance (12.3%) in a factor analysis of the Toronto Alexithymia Scale refers to items that refer to the ability to identify and describe feelings and to distinguish between feelings and bodily sensations. The ability to discriminate and differentiate stimuli (colors, thoughts, or visceral sensations) is necessary to produce an appropriate verbal label for a color or emotion. When looking at the color spectrum there is lack of distinct or "digital" boundaries between the colors: color hues are continuous, or analogue. Emotions can also be seen as analogue or existing on a continuum with a minimum of distinct boundaries between them (e.g., feelings are often blends of feeling states). The concept of "ambivalence" suggests being "mixed" or "torn" in one's affective experience and there is often external and internal pressure to "make up one's mind". With reference to Bakan's (1971) suggestions that two of the functional differences between the hemispheres are that the left is specialized for digital processing while the right is specialized for analogue processing, and that women have superior hemispheric integration of these, and other functions, Wilden (1980) describes the implications of digital vs. analogue information processing:

> It is almost impossible to translate the rich semantics of the analog into any digital form for communication to another organism. This is true both of the most trivial sensations (biting your tongue, for example) and the most enviable situations (being in love). It is impossible to precisely describe such events except by recourse to un-namable common experience (a continuum). But this imprecision carries with it a fundamental and probably essential ambiguity...The digital, on the other hand, because it is concerned with boundaries and because it dependes upon arbitrary combination, has all the syntax to be precise and may be entirely unambiguous. Thus what the analogue gains in semantics it loses in syntactics, and what the digital gains in syntactics it loses in semantics (p.163)...This is in essence the prime distinction between the function of the digital and that of the analog. The digital mode of language is denotative: it may talk about anything and does so in the language of objects, facts, events, and the like. Its linguistic function is primarily the sharing of namable information...its overall function is the transmission or sharing or reproduction of pattern and structures (information in the technical sense). The analogue on the other hand talks only about relationships. In human communication there are often serious problems of translation between the two (p.164)...In human

> communication, translation from analog to digital often involves a gain in information (organization) but a loss in meaning. Translation from the digital to the analog (as in the psychosomatic symptom) usually involves a loss of information and a gain in meaning (p.168)... Analog differences are differences of magnitude, frequency, distribution, pattern, organization and the like. Digital differences are those such as can be coded into DISTINCTIONS and OPPOSITIONS, and for this, there must be discrete elements with well-defined boundaries. In this sense, the sounds of speech are analog; phonology and the alphabet are digital. In the same way, the continuous spectrum of qualitative, analog differences ranging from black to white in the color spectrum may be digitalized by the boundaries of a color wheel...(p.169).

Thus, the naming of color seems to involve the imposition of a fairly arbirtrary boundary on analog stimuli, and a resulting imprecision or loss of information. This may serve as a metaphor for the process of trying to put analog information (emotions) into digital form (denotation, labelling, verbalizing). Differences in color naming ability between the male and female alexithymia groups suggests the exisitence of a cognitive ability that has some variance in common with alexithymia.

Conclusion

Despite the lack of sex differences in alexithymia scores there appears to be a sexual dimorphism in correlates of alexithymia. High alexithymia females appear to have diminished verbal intelligence while high alexithymia males demonstrate a relatively greater Stroop effect, or diminished ability to allocate attention to the salient aspect of a complex stimulus. This suggests there is not a single underlying factor that adequately explains alexithymia, and that at least a three factor (sex, attentional and self-control mechanisms, verbal abilities) model of alexithymia is necessary. As well, anxiety appears to be a variable with important sex differences that are important for both alexithymia and Stroop performance. The interference introduced by the presence of words regardless of emotional valence suggests the existence of a "standard" Stroop effect rather than an emotional Stroop effect. This hypothesis could be easily tested by administering the "standard" Stroop test used in clinical practice (Golden, 1978) to individuals with high and low alexithymia scores. The present findings may be interpreted at least two ways: (1) High alexithymia males may have higher anxiety which in turn negatively impacts on Stroop performance; (2) High alexithymia males may have a more synthetic or holistic cognitive style as opposed to an "analytic" style, characterized by an inability to analyze or break a complex stimulus down to its component parts (color and word). These views are consistent with other findings from hemisphericity studies on alexithymia (Cole & Bakan, 1985) and anxiety (Cole, 1982), and Stroop performance (Bakan & Shotland, 1969) and a hemispheric activation study of sex differences in Stroop performance and anxiety (Newman, 1990); (3) There are some similarities between alexithymia and right hemisphere deficit syndromes which include difficulties with attention and emotional expression. While there is little empirical support in the present study for an association between alexithymia and right hemisphere deficit syndrome or attention deficit disorder, or diminished frontal lobe functioning, there are some interesting parallels between these syndromes and alexithymia. Although theoretically inconsistent, these explanations have considerable heuristic value and warrant further research on each.

The results of this study may also have implications for the interpretation of studies utilizing Stroop stimuli to access or measure "salient" emotions in alexithymics. The stimuli used in the present study did not take into account individual differences in word frequency. Subsequent studies could compare the Stroop interference associated with depression related words among samples of alexithymic and non-alexithymic depressed patients. Alternatively, one could compare the salience of alcoholism related words among samples of alexithymic and non-alexithymic alcoholics. Finally, to further investigate the sex differences in correlates of alexithymia despite the lack of sex differences in alexithymia scores, a factor analytic study of the Toronto Alexithymia Scale taking sex into account may yeild different factor loadings of items measuring components of alexithymia.

While the results of the present study do not provide much support for the hypothesis that there are differences in the cognitive representation of affect among alexithymics, there are some indications that there may be differences in the efficiency of cognitive processes that have a secondary impact on conscious experience or computation (digitalization) of emotions. The disruption of affect among male alexithymics may be secondary to either the effects of anxiety or to the disruption of general attentional processes among males (or a combination of the two factors) while the disruption of affect among female alexithymics may be secondary to compromised verbal intelligence. Thus, high alexithymia males may do poorly on tests of right hemisphere and frontal lobe functioning while high alexithymia females may do relatively poorly on a variety of verbal tests (e.g., naming, verbal memory, verbal learning, and verbal reasoning). Additionally, measures of interhemispheric communication may show that a "functional commissurotomy" is associated with poorer cognitive performance for both males and females. The testing of these hypotheses may help explain the sexual dimorphism of cognitive correlates of alexithymia.

REFERENCES

Abramczyk, R.R., Jordan, D.E., & Hegel, M. (1983). "Reverse" Stroop effect in the performance of schizophrenics. Perceptual and Motor Skills, 56, 99-106.

Abse, D. (1974). Hysterical conversion and dissociative syndromes of the hysterical character, in Arieti, S. & Brody, S. (Eds.) American Handbook of Psychiatry (Vol. 3). New York: Basic Books.

Acklin, M.W. & Alexander, G. (1988). Alexithymia and somatization: A Rorschach study of four psychosomatic groups. The Journal of Nervous and Mental Disease, 176, 343-350.

Aherns, S., & Deffner, G. (1986). Empirical study of alexithymia: Methodology and results. American Journal of Psychotherapy, XL, 430-447.

Ahern, G.L. & Schwartz, G.E. (1985). Differential lateralization for positive and negative emotion in the human brain: EEG spectral analysis. Neuropsychologia, 23, 745-755.

Alexander, F. (1943). Fundamental concepts of psychosomatic research: Psychogenesis, conversion, specificity. Psychosomatic Medicine, 5, 205-210.

Apfel, J., & Sifneos, P. (1979). Alexithymia: Concept and measurement. Psychotherapy and Psychosomatics, 32, 180-190.

Anastasi, A. (1958). Differential psychology (3rd ed.). New York: MacMillan.

Bagby, M., Taylor, G., & Atkinson, L. (1988). Alexithymia: A comparative study of three self-report measures. Journal of Psychosomatic Research, 32, 107-116.

Bagby, M., Taylor, G., & Ryan, D. (1986). The measurement of alexithymia: Psychometric properties of the Schalling-Sifneos personality scale. Comprehensive Psychiatry, 27, 287-294.

Bagby, M., Taylor, G., & Ryan, D. (1986b). Toronto Alexithymia Scale: Relationship with personality and psychopathology measures. Psychotherapy and Psychosomatics, 45, 207-215.

Bakan, P. (1969). Hypnotizability, laterality of eye movement and functional brain asymmetry. Perceptual and Motor Skills, 28, 927-932.

Bakan, P. (1971). The eyes have it. Psychology Today, 4, 64-67, 96.

Bakan, P. & Shotland, R.L. (1969). Lateral eye movement, reading speed, and visual attention. Psychonomic Science, 15, 93-94.

Bear, D.M. (1983). Hemispheric specialization and the neurology of emotion. Archives of Neurology, 40, 195-202.

Bennett, G.K., Seashore, H.G., & Wasman, A.G. (1974). Manual of the Differential Aptitude Tests: Forms S and T. (5th ed.). New York: Psychological Corporation.

Bentall, R.P. & Kaney, S. (1989). Content specific information processing and persecutory delusions: An investigation using the emotional Stroop test. British Journal of Medical Psychology, 62, 355-364.

Bentall, R.P. & Thompson, M. (1990). Emotional Stroop performance and the manic defence. British Journal of Clinical Psychology, 29, 235-237.

Benton, A. (1985). Visuoperceptual, visuospatial, and visuoconstructive disorders. In K.M. Heilman & E. Valenstein (Eds.) Clinical Neuropsychology (2nd Ed.) New York: Oxford University Press.

Benton, A.L. & Hamsher, K. (1977). Multilingual Aphasia Examination. Iowa City: University of Iowa.

Benton, A.L., Hamsher, K. de S., Varney, N.R. & Spreen, O. (1983). Contributions to Neuropsychological Assessment. New York: Oxford University Press.

Blackshaw, S. & Bowen, R.C. (1987). A case of atypical psychosis associated with alexithymia and a left fronto-temporal lesion: possible correlations. Canadian Journal of Psychiatry, 32, 688-692.

Bogen, J.E. (1969). The other side of the brain. II. An appositional mind. Bulletin of the Los Angeles Neurological Society, 34, 135-162.

Bower, G.H. & Cohen, R.R. (1982). Emotional influences in memory and thinking: Data and theory. In Affect and Social Cognition. S. Fiske and M. Clark (Eds.) Hillsdale: Erlbaum.

Borens, R., Grosse-Schultz, E., Jaensch, W., & Kortemme, K.H. (1977). Is "alexithymia" but a social phenomenon? Psychotherapy and Psychosomatics, 28, 193-198.

Broverman, D.M. (1962). Behavioral correlates of cognitive style. Progress report, U.S.P.H. Grants M-5773 and M-896 (cited in Jensen & Rohwer, 1966).

Brown, W. (1915). Practice in associating color names with colors. Psychological Review, 22, 45-55.

Bruner, J. & Postman, L. (1947). Emotional selectivity in perception and reaction. Journal of Personality, 16, 69.

Bryden, M.P. & Ley, R.G. (1982). Right hemispheric involvement in the perception and expression of emotion in normal humans. In K. Heilman & D. Satz (Eds.). The neuropsychology of emotion. New York: Academic Press.

Buchanan, D., Waterhouse, G., & West, S. (1980). A proposed neuropsychological basis of alexithymia. Psychotherapy and Psychosomatics, 34, 248-255.

Burke, A.E., Crenshaw, D.A., Green, J., Schlosser, M.A., & Strocchia-Rivera, L. (1989). Influence of verbal ability on the expression of aggression in physically abused children. Journal of the American Academy of Child and Adolescent Psychiatry, 28, 215-218.

Callaway, E. (1959). The influence of amobarbital (amylobarbitone) and methamphetamine on the focus of attention. Journal of Mental Science, 105, 382-392 (cited in Jensen & Rohwer (1966).

Cancelliere, A.E.B. & Kertesz, A. (1990). Lesion localization in acquired deficits of emotional expression and comprehension. Brain and Cognition, 13, 133-147.

Cattell, J. McK. (1886). The time it takes to see and name objects. Mind, 11, 63-65.

Channon, S., Hemsley, D., & de Silva, P. (1988). Selective processing of food words in anorexia nervosa. British Journal of Clinical Psychology, 27, 259-260.

Cicone, M., Wapner, W., & Gardner, H. (1980). Sensitivity to emotional expressions and situations in organic patients. Cortex, 16, 145-148.

Cohen, D. & Wilkie, F. (1979). Sex-related differences in cognition among the elderly. In M.A. Witing and A.C. Peterson (Eds.), Sex related differences in cognitive functioning. New York: Academic Press.

Cole, G. (1982). Conjugate lateral eye movements, alexithymia, anxiety, autonomic nervous system balance, and body consciousness. B.A. Thesis, Simon Fraser University.

Cole, G. (1984). The relationships between alexithymia, the Minnesota Multiphasic Personality Inventory, and recovery time in pain patients. unpublished M.A. thesis, Simon Fraser University.

Cole, G. & Bakan, P. (1985). Alexithymia, hemisphericity, and conjugate lateral eye movements. Psychotherapy and Psychosomatics, 44, 139-143.

Davidoff, J. (1976). Hemispheric sensitivity differences in the perception of color. Quarterly Journal of Experimental Psychology, 28, 387-394.

Davidson, R.J., & Schwartz, G.E. (1976). Patterns of cerebral lateralization during cardiac biofeedback versus the self-regulation of emotion: Sex differences. Psychophysiology, 13, 62-68.

Dawkins, K., & Furnham, A. (1989). The colour naming of emotional words. British Journal of Psychology, 80, 383-389.

De Lacoste-Utamsing, C. & Holloway, R.L. (1982). Sexual dimorphism in the human corpus callosum. Science, 216, 1431-1432.

De Renzi, E., Colombo, A., Faglioni, P., & Gilbertoni, H. (1982). Conjugate gaze paresis in stroke patients with unilateral damage: An unexpected instance of hemispheric asymmetry. Archives of Neurology, 39, 482-486.

De Renzi, E. & Spinnler, H. (1967). Impaired performance on color tasks in patients with hemipsheric damage. Cortex, 3, 194-217.

De Renzi, E., Faglioni, P., Scotti, G., & Spinnler, H. (1972). Impairment of color sorting behavior after hemispheric damage: an experimental study with the Holmgren skein test. Cortex, 8, 147-163.

Deutsch, H. (1942). Some forms of emotional disturbance and their relationship to schizophrenia. Psychoanalytic Quarterly, 11, 301-321.

Dimond, S.J. & Beaumont, J.G. (1974). Experimental studies of hemisphere function in tbe human brain. In Dimond, S.J. & Beaumont, J.G. (Eds.) Hemispheric function in the human brain. New York: John Wiley.

Dixon, N.F. (1971). Subliminal Perception: The Nature of a Controversy. London: McGraw-Hill.

Dubois, P.H. (1939). The sex difference on the color-naming test. American Journal of Psychology, 52, 380-382.

Dunbar, K., & MacLeod, C.M. (1984). A horse race of a different color: Stroop interference patterns with transformed words. Journal of Experimental Psychology: Human Perception and Performance, 10, 622-639.

Duncan-Johnson, C.C. & Kopell, B.S. (1981). The Stroop effect: brain potentials localize the source of interference. Science, 214, 938-940.

Dyer, F.N. (1973). The Stroop phenomenon and its use in the study of perceptual, cognitive, and response processes. Memory and Cognition, 1, 106-120.

Erdelyi, M.H. (1974). A new look at the new look: Perceptual defense and vigilance. Psychological Review, 81, 1-25.

Estes, W.K. (1974). Learning theory and intelligence. American Psychologist, 29, 740-749.

Fairweather, H. (1976). Sex differences in cognition. Cognition, 4, 231-280.

Fernandez, A., Sriram, T.G., Rajkumar, S. & Chandrasekar, A.N. (1989). Alexithymia in rhematoid arthritis: a controlled study. Psychotherapy and Psychosomatics, 51, 45-50.

Filskov, S.B. & Caranese, R.A. (1986). Effects of sex and handedness on neuropsychological testing. In S.B Filskov and Catanese (Eds.) Handbook of Clinical Neuropsychology (Vol.2), New York: John Wiley & Sons.

Finn, P.F., Martin, J. & Pihl, R.O. (1987). Alexithymia in males at high genetic risk for alcoholism. Psychotherapy and Psychosomatics, 47, 18-21.

Fisch, R.Z. (1989). Alexithymia, masked depression, and loss in a holocaust survivor. British Journal of Psychiatry, 154, 708-710.

Flannery, J. (1977). Alexithymia I: The communication of physical symptoms. Psychotherapy and Psychosomatics, 28, 133-140.

Flor-Henry, P. (1978b). Gender, hemispheric specialization and psychopathology. Social Sciences & Medicine, 12b, 155-162.

Fodor, J. (1983). The Modularity of Mind. Cambridge: MIT/Bradford.

Foreman, N., Barraclough, S., Moore, C., Mehta, A. & Madon, M. (1989). High doses of caffeine impair performance of a numerical version of the Stroop task in men. Pharmacology, Biochemistry, and Behavior, 32, 399-403.

Fortier, R.H. (1953). The response to color and ego functions. Psychological Bulletin, 50, 41-63.

Frankel, F., Apfel-Savitz, R., Nemiah, J., & Sifneos, P. (1977). The relationship between hypnotizability and alexithymia. Psychotherapy and Psychosomatics, 28, 172-178.

Franks, H.M., Haegedorn, H., Hensley, V.R., Hensley, W.J. & Starmer, G.A. (1975). The effects of caffeine on human performance, alone and in combination with ethanol. Psychopharmacologia, 45, 177-181.

Freud, A. (1966). The ego and the mechanisms of defense. New York: International Universities Press.

Freyberger, H. (1977). Supportive psychotherapeutic techniques in primary and secondary alexithymia. Psychotherapy and Psychosomatics, 28, 337-342.

Fricchione, G. & Howanitz, E. (1985). Aprosodia and alexithymia - a case report. Psychotherapy and Psychosomatics, 43, 156-160.

Friedman, R.B. & Albert, M.L. (1985). Alexia. In K.M. Heilman & E. Valenstein (Eds.) Clinical Neuropsychology (2nd Ed.) New York: Oxford University Press.

Gage, B.C., & Egan, K.J. (1984). The effect of alexithymia on morbidity in hypertensives. Psychotherapy and Psychosomatics, 41, 136-144.

Gainotti, G. (1972). Emotional behavior and hemispheric side of the lesion. Cortex, 8, 41-55.

Garai, J.E. & Scheinfeld, A. (1968). Sex differences in mental and behavioral traits. Genetic Psychology Monographs, 77, 169-299.

Gazzaniga, M.S., Ledoux, J.E., & Wilson, D.H. (1977). Language, praxis, and the right hemisphere: Clues to some mechanisms of consciousness. Neurology, 27, 1144-1147.

Geschwind, N. (1967). The varieties of naming errors. Cortex, 3, 97-112.

Giles, M., & Cairns, E. (1989). Colour naming oif violence-related words in Northern Ireland. British Journal of Clinical Psychology, 28, 87-88.

Gilliland, K. (1980). The interactive effect of introversion extraversion with caffeine induced arousal on verbal performance. Journal of Research on Personality, 14, 482-492.

Glaser, W.R. & Dolt, M.O. (1977). A functional model to localize the conflict underlying the Stroop phenomenon. Psychological Research, 39, 287-310.

Glaser, M.O. & Glaser, W.R. (1982). Time course analysis of the Stroop phenomenon. Journal of Experimental Psychology: Human Perception and Performance, 8, 875-894.

Golden, C.J. (1974). Effect of differing number of colors on the Stroop Color and Word Test. Perceptual and Motor Skills, 39, 550.

✗ Golden, C.J. (1974b). Sex differences in performance on the Stroop Color and Word Test. Perecptual and Motor Skills, 39, 1067-1070.

Golden, C.J. (1978). Stroop Color and Word Test: A manual for clinical and experimental uses. Chicago: Stoelting.

Goldstein, K. (1948). Language and Language Disturbances. New York: Grune and Stratton.

Gorelick, P.B. & Ross, E.D. (1987). The aprosodias: further functional-anatomical evidence for the organization of affective language in the right hemisphere. Journal of Neurology, Neurosurgery, & Psychiatry, 50, 553-560.

Gotlib, I. H. & McCann, C.D. (1984). Construct accessibility and depression: An examination of cognitive and affective factors. Journal of Personality and Social Psychology, 47, 427-439.

Groth-Marnat, G. (1984). Handbook of Psychological Assessment. New York: Van Nostrand Reinhold Co.

Guilford, J.P. (1967). The nature of human intelligence. New York: McGraw-Hill.

Gur, R.E. & Gur, R.C. (1975). Defense mechanisms, psychosomatic symptomatology and conjugate lateral eye movements. Journal of Consulting and Clinical Psychology, 43, 416-420.

Gustafson, R. & Kallmen, H. (1990). Effects of alcohol on prolonged cognitive performance measured with Stroop's color word test. Psychological Reports, 67, 643-650.

Haviland, M.G., Shaw, D.G., Mac Murray, J.P., & Cummings, M.A. (1988). Validation of the Toronto Alexithymia Scale with substance abusers. Psychotherapy and Psychosomatics, 50, 81-87.

Hecaen, H., Ajuriaguerra, J.D., & Massonet, J. (1951). Les troubles visuo constructiffs pars lesions parieto-occipitales droites. Roles des perturbations vestibulaires. L'Encephale, 1, 122-179.

Heiberg, A. & Heiberg, A. (1977). Alexithymia: An inherited trait? Psychotherapy and Psychosomatics, 28, 221-225.

Heiberg, A. & Heiberg, A. (1978). A possible genetic contribution to the alexithymia trait. Psychotherapy and Psychosomatics, 30, 205-210.

Heilman, K.M. & Van den Abel, T. (1979). Right hemipsheric dominance for mediating cerebral activation. Neuropsychologia, 17, 315-321.

Holmes, C.B., Wurtz, P.J., Waln, R.F., Dungan, D.S. & Joseph, C.A. (1984). Relationship between the Luscher Color Test and the MMPI. Journal of Clinical Psychology, 40, 126-128.

Holmes, C.B., Fouty, H.E., Wurtz, P.J. & Burdick, B.M. (1985). The relationship between color preference and psychiatric disorders. Journal of Clinical Psychology, 41, 746-749.

Hoppe, K. (1977). Split brains and psychoanalysis. Psychoanalytic Quarterly, 46, 220-244.

Hoppe, K. & Bogen, J. (1977). Alexithymia in twelve commissurotomized patients. Psychotherapy and Psychosomatics, 38, 148-155.

Horton, P.C., Gewirtz, H., & Kreutter, K.J. (1989). Alexithymia and solace. Psychotherapy and Psychosomatics, 51, 91-95.

Ivison, D.J. (1977). The Wechsler Memory Scale: Preliminary findings toward an Australian standardization. Australian Psychologist, 12, 303-312.

Izawa, C. & Silver, N.C. (1988). Response variations to Stroop colour-word stimuli. Genetic, Social, and General Psychology Monographs, 114, 211-255.

Jaeger, W. (1972). Genetics of congenital colour deficiencies. In D. Jameson & L.M. Hurvich (Eds.), Visual Psychophysics (Vol. VII/4). Berlin: Springer-Verlag.

Jensen, A.R. (1965). Scoring the Stroop Test. Acta Psychologia, 24, 398-408.

Jensen, A.R. & Rohwer, W.D. (1966). The Stroop Color-Word Test: A review. Acta Psychologia, 25, 36-93.

Joanette, Y., Goulet, P. & Hannequin, D. (1990). Right hemisphere and verbal communication. New York: Springer-Verlag.

Katkin, E.S. (1985). Blood sweat and tears: Individual differences in autonomic self-perception. Psychophysiology, 22, 125-137.

Keehn, J.D. (1953). Rorschach validation III: an examination of the affective value of colour as a determinant in the Rorschach test. Journal of Mental Science, 99, 410-438.

Keltikangas-Jarvinen, L. (1982). Alexithymia in violent offenders. Journal of Personality Assessment, 46, 462-465.

Kertesz, A., Polk, M., Howell, J. & Black, S.E. (1987). Cerebral dominance, sex, and callosal size in MRI. Neurology, 37, 1385-1388.

Kihlstrom, J.F. (1987). The cognitive unconscious. Science, 237, 1445-1452.

Kimura, D. & Harshman, R. (1984). Sex differences in brain organization for verbal and non-verbal functions. Progress in Brain Research, 61, 423-441.

Kleiger, J.H. & Jones, N.F. (1980). Characteristics of alexithymic patients in a chronic respiratory illness population. Journal of Nervous and Mental Disease, 165, 465-470.

Krystal, H. (1979). Alexithymia and psychotherapy. American Journal of Psychotherapy, 33, 17-31.

Kucera, H. & Francis, W.N. (1967). Computation analysis of present-day American English. Providence: Brown University Press.

Kunst-Wilson, W.R. & Zajonc, R.B. (1980). Affective discrimination of stimuli that cannot be recognized. Science, 207, 557-558.

Lake, D.A., & Bryden, M.P. (1976). Handedness and sex differences in hemispheric asymmetry. Brain and Language, 8, 266-282.

Lane, R.D. & Schwartz, G.E. (1987). Levels of emotional awareness: A cognitive-developmental theory and its application to psychopathology. American Journal of Psychiatry, 144, 133-143.

Lazarus, P.J., Ludwig, R.P. & Aberson, B. (1984). Stroop Color-Word Test: A screening measure of selective attention to differentiate LD from non LD children. Psychology in the Schools, 21, 53-60.

Lee, G.P., Loring, D.W., & Meader, K.J. (1990). Hemispheric specialization of emotional expression: a reexamination of results from intracarotid administration of sodium amobarbital. Brain and Cognition, 12, 267-280.

Legorreta, G., Bull, R.H., Kiely, M.C. (1988). Alexithymia and symbolic function in the obese. Psychotherapy and Psychosomatics, 50, 88-94.

Lesser, I., Ford, C., & Friedman, C. (1979). Alexithymia in somatizing patients. General Hospital Psychiatry, 1, 256-261.

Lesser, I., & Lesser, B. (1983). Alexithymia: Examining the development of a psychological concept. American Journal of Psychiatry, 140, 1305-1308.

Levy, J. (1978). Lateral differences in the human brain in cognition and behavioral control. In P.A. Buser & A. Rougel-Buser (Eds.), Cerebral correlates of conscious experience (pp.285-298). Amsterdam: Elsevier-North Holland Biomedical Press.

Ley, R.G., & Bryden, M. (1979). Hemispheric differences in processing emotions and faces. Brain and Language, 7, 127-138.

Lezak, M. D. (1983). Neuropsychological Assessment (2nd Ed.). New York: Oxford University Press.

Ligon, E.M. (1932). A genetic study of colour naming and word reading. American Journal of Psychology, 44, 103-122.

Lindholm, T., Lehtinen, V., Hyyppa, M., & Puukka, P. (1990). Alexithymic features in relation to the dexamethasone suppression test in a Finnish population sample. American Journal of Psychiatry, 147, 1216-1219.

Loiselle, C.G., & Dawson, C. (1988). Toronto alexithymia scale: Relationships with measures of patient self-disclosure and private self-consciousness. Psychotherapy and Psychosomatics, 50, 109-116

Lolas, F., de la Parra, G., Aronsohn, S., & Collin, C. (1980). On the measurement of alexithymic behavior. Psychotherapy and Psychosomatics, 33, 139-146.

Luria, A.R. (1980). Higher Cortical Functions in Man. New York: Basic Books.

Luscher, M. & Scott, I. (1969). The Luscher Color Test. New York: Random House.

Lysak, H.M. (1989). The effects of Ritalin (methylphenidate) on self-regulatory processes of hyperactive young offenders. Unpublished Doctoral Thesis, Simon Fraser University.

Maccoby, E.E. (1966). The development of sex differences. Stanford: Stanford University Press.

Maccoby, R.J. & Jacklin, C.N. (1974). The psychology of sex differences. Stanford: Stanford University press.

Majeres, R.J. (1977). Sex differences in clerical speed: Perceptual encoding vs. verbal encoding. Memory & Cognition, 5, 468-476.

Mandler, G. (1984). Mind and Body: Psychology of Emotion and Stress. New York: Norton.

Martin, J.B., & Pihl, R.O. (1985). The stress-alexithymia hypothesis: theoretical and empirical considerations. Psychotherapy and Psychosomatics, 43, 169-176.

Martin, J.B. & Pihl, R.O. (1986). Influence of alexithymic characteristics on physiological and subjective stress responses in normal individuals. Psychotherapy and Psychosomatics, 45, 66-77.

Martin, J.B., Pihl, R.O., Young, S.N., Ervin, F.R., & Tourjman, S.V. (1986). Prediction of alexithymic characteristics from physiological, personality, and subjective measures. Psychotherapy and Psychosomatics, 45, 133-140.

Martin, N.J. & Franzen, M.D. (1989). The effect of anxiety on neuropsychological function. International Journal of Clinical Neuropsychology, 11, 1-8.

Marty, P. & M'Uzan, M. (1963). La pensee operatoire. Revue Francais Psychoanalysis, 27, 1345.

Mathews, A., & MacLeod (1985). Selective processing of threat cues in anxiety states. Behavior Research and Therapy, 23, 563-569.

Matlin, M.W. (1988). Sensation and Perception (2nd Ed.) Allyn and Bacon: Boston.

McDonald, P.W. & Prkachin, K.M. (1990). The expression and perception of facial emotion in alexithymia: a pilot study. Psychosomatic Medicine, 52, 199-210.

McDougall, J. (1974). The psychosoma and the psychoanalytic process. International Review of Psychoanalysis, 1, 437-459.

McDougall, J. (1982). Alexithymia: A psychoanalytic viewpoint. Psychotherapy and Psychosomatics, 38, 81-90.

McGee, M.G. (1979). Human spatial abilities: Psychometric studies and environmental, genetic, hormonal and neurological influences. Psychological Bulletin, 86, 889-918.

McGinnies, E. (1949). Emotionality and perceptual defence. Psychological Review, 56, 244-251.

McGlone, J. (1978). Sex differences in functional brain asymmetry. Cortex, 14, 122-128.

Mendelson, G. (1982). Alexithymia and chronic pain: Prevalence, correlates, and treatment results. Psychotherapy and Psychosomatics, 37, 154-164.

Merriam, A.E. & Wyszynski, B. (1990). Letter to the editor. American Journal of Psychiatry, 147, 955-956.

Miller, G.A. (1962). Psychology: The science of mental life. New York: Harper and Row.

Miller, L. (1986-87). Is alexithymia a disconnection syndrome? A neuropsychological perspective. International Journal of Psychiatry in Medicine, 16, 199-209.

Mogg, K. & Marden, B. (1990). Processing of emotional information in anxious subjects. British Journal of Clinical Psychology, 29, 227-229.

Moir, A. & Jessell, D. (1989). Brain Sex. London: Michael Joseph.

Nemiah, J. (1975). Denial revisited: Reflections on psychosomatic theory. Psychotherapy and Psychosomatics, 26, 140-147.

Nemiah, J. (1977). Alexithymia: Theoretical considerations. Psychotherapy and Psychosomatics, 28, 199-206.

Nemiah, J. (1984). The unconscious and psychopathology. In The Unconscious Reconsidered. K.S. Bowers & D. Meichenbaum (Eds.) New York: John Wiley and Sons.

Nemiah, J., Freyberger, H., & Sifneos, P. (1976). Alexithymia: A view of the psychosomatic process. Hill, O. (ed.), Modern Trends in Psychsomatic Medicine, Vol. 3, London: Buttorworths.

Newman, J.P. (1981). Induced anxiety and Stroop Color-Word Test performance: Hemispheric processing implications. International Journal of Neuroscience, 12, 63-66.

Newman, J.P. (1990). Effects of characterological anxiety and situational arousal on the solving of a color-word interference task: Hemispheric processing implications. International Journal of Neuroscience, 52, 1-9.

Nyborg, H. (1983). Spatial ability in men and women: Review and a new theory. Advances in Behavioral Research and Therapy, 5, 89-140.

Overbeck, G. (1977). How to operationalize alexithymic phenomenon: some findings from speech analysis and the Giesen Test (GT). Psychotherapy and Psychosomatics, 28, 106-117.

Papciak, A.S., Feuerstein, M., & Spiegel, J.A. (1985). Stress reactivity in alexithymia: Decoupling of physiological and cognitive processes. Journal of Stress, 11, 135-142.

Parker, J.D.A., Taylor, G.J., & Bagby, R.M. (1989). The alexithymia construct: relationship with sociodemographic variables and intelligence. Comprehensive Psychiatry, 30, 434-441.

Pennal, B.E. (1977). Human cerebral asymmetry in color discrimination. Neuropsychologia, 15, 563-568.

Peretti, P.O. (1971). Effects of noncompetitive, competitive instructions, and performance in a color-word interference task. Journal of Psychology, 79, 67-70.

Pierloot, R. & Vinck, J. (1977). A pragmatic approach to the concept of alexithymia. Psychotherapy and Psychosomatics, 28, 156-166.

Posner, M.I. & Snyder, C.R.R. (1975). Attention and cognitive control. In Solso, R.L. (ed) Information Processing and Cognition: The Loyola Symposium, Hillsdale: Erlbaum.

Pressey, S.L. (1921). The influence of color upon mental and motor efficiency. American Journal of Psychology, 32, 326-356.

Rabavilas, A.D. (1987). Electrodermal activity in low and high alexithymia neurotic patients. Psychotherapy and Psychosomatics, 47, 101-104.

Ray, C. (1979). Examination stress and performance on a color-word interference test. Perceptual and Motor Skills, 49, 400-402.

Rideout, B. & Grzywacz, M. (1988). Individual differences and the reveral of caffeine's effects by L-tryptophan. Paper presented at the Eastern Psychological Association, Buffalo NY.

Rideout, B. & Hitchcock, D. (1985). Reversal of caffeine-induced performance changes by L-tryptophan. Paper presented at the Eastern Psychological Association, Boston, MA.

Rideout, B. & Winchester, L. (1990). Effects on verbal fluency associated with sex, practice, and stimulus letter. Perceptual and Motor Skills, 71, 656-658.

Ritchie, J.M. (1975). Central nervous system stimulants: the xanathines. In Goodman, L.S. & Gilman, A. (Eds.). The pharmocological basis of therapeutics. 5th ed. New York: MacMillan, 367-378.

Rodenhauser, P., Khamis, H.J. & Faryna, A. (1986). Alexithymia and handedness: A pilot study. Psychotherapy and Psychsomatics, 45, 169-173.

Rorschach, H. (1942). Psychodiagnistics: a diagnostic test based on perception. New York: Grune and Stratton.

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

Ross, E.D. (1984). The right hemisphere's role in language, affective behavior and emotion. Trends in Neurosciences, 7, 342-346.

Ross, E.D. (1988). Prosody and brain lateralization. Archives of Neurology, 45, 338-339.

Ross, E.D., & Mesulam, M.M. (1979). Dominant language functions of the right hemisphere? Prosody and emotional gesturing. Archives of Neurology, 36, 144-148.

Rossi, G.F., & Rosadini, G. (1967). Experimental analysis of cerebral dominance in man. In F.L. Darley (Ed.). Brain mechanisms underlying speech and language. New York: Grune & Stratton.

Rubin, D.C. & Friendly, M. (1986). Predicting which words get recalled: Measures of free recall, availability, goodness, emotionality, and pronuounceability for 925 nouns. Memory and Cognition, 14, 79-94.

Ruesch, J. (1948). The infantile personality: The core problem of psychosomatic medicine. Psychosomatic Medicine, 10, 134-144.

Sackeim, H.A., Greenberg, M.S., Weiman, A.L., Gur, R.C., Hungerbuhler, J.P. & Geschwind, N. (1982). Hemispheric asymmetry in the expression of positive and negative emotions: Neurologic evidence. Archives of Neurology, 39, 210-218.

Sarmany, I. (1977). Different performance in Stroop's Interference Test from the aspect of personality and sex. Studia Psychologica, 19, 60-67.

Schachtel, E.G. (1943). On color and affect. Psychiatry, 6, 393-409.

Schaie, K.W. & Heiss, R. (1964). Color and personality: a manual for the color pyramid test. Stuttgart: Hans Huber Publishers.

Schwartz, G.E., Davidson, R.J., & Maer, F. (1975). Right hemisphere lateralization for emotion in the human brain: Interactions with cognition. Science, 190, 286-288.

Segalowitz, S.J. (1983). Two sides of the brain: Brain lateralization explored. New Jersey: Prentice-Hall Inc.

Seward, J.P. & Seward, G.H. (1980). Sex differences: mental and tempermental. Lexington: D.C. Heath.

Shapiro, D. (1965). Neurotic Styles. New York: Basic Books.

Sherman, J.A. (1978). Sex related cognitive differences. Springfield: Charles C. Thomas.

Shipko, S. (1982). Alexithymia and somatization. Psychotherapy and Psychosomatics, 37, 193-201.

Shipko, S. (1982). Further reflections on psychosomatic theory: alexithymia and hemispheric specialization. Psychotherapy and Psychosomatics, 37, 83-86.

Shipko, S., Alveraz, W., & Noviello, N. (1983). Towards a teleological model of alexithymia: Alexithymia and post-traumatic stress disorder. Psychotherapy and Psychosomatics, 39, 122-126.

Sifneos, P. (1967). Clinical observations on some patients suffering from a variety of psychsomatic diseases. Acta Med. Psychosom., 13, 339.

Sifneos, P. (1973). The prevalence of "alexithymic" characteristics in psychosomatic patients. Psychotherapy and Psychosomatics, 22, 255-262.

Sifneos, P. (1975). Problems of psychotherapy with patients with alexithymic characteristics and physical disease. Psychotherapy and Psychosomatics, 26, 65-70.

Sifneos, P. (1988). Alexithymia and its relationship to hemispheric specialization, affect, and creativity. Psychiatric Clinics of North America, 11, 287-292.

Sifneos, P.E., Apfel-Savitz, R., Frankel, F.H. (1977). The phenomenon of alexithymia. Psychotherapy and Psychosomatics, 28, 47-57.

Silberman, E.K. & Weingartner, H. (1986). Hemispheric lateralization of functions related to emotion. Brain and Cognition, 5, 322-353.

Smith, G.J.W., & Johnson, G. (1964). Experimental description of a group of psychiatric patients before and after therapy by means of MCT (the meta-contrast technique) and CWT (the serial color-word test). Psychological Research Bulletin, Lund University, Sweden, 4, no. 7. (cited in Jensen & Rohwer, 1966).

Smokler, I.A. & Shevrin, H. (1979). Cerebral lateralization and personality style. Archives of General Psychiatry, 36, 949-954.

Sovcilova, E. & Bronis, M. (1989). Some further findings regarding Stroop interference test. Studia Psychologica, 31, 223-229.

Sperry, R.W. (1968). Hemisphere deconnection and unity in conscious awareness. American Psychologist, 23, 723-733.

Sperry, R.W. (1982). Some effects of disconnecting the cerebral hemispheres. Science, 217, 1223-1226.

Sperry, R.W. & Gazzaniga, M.S. (1967). Language following surgical disconnection of the hemispheres. In C.H. Millikan & F.L. Darley (Eds.), Brain mechanisms underlying speech and language (pp.108-121). New York: Grune and Stratton.

Springer, S.P. & Deutsch, G. (1989). Left Brain, Right Brain. New York: W.H. Freeman & Co.

Sriram, T.G., Chaturvedi, S.K., Gopinath, P.S., & Shammugam, V. (1987). Controlled study of alexithymic characteristics in patients with psychogenic pain disorder. Psychotherapy and Psychosomatics, 47, 11-17.

Stroop, J.R. (1935). Studies of interference in serial verbal reactions. Journal of Experimental Psychology, 18, 643-662.

Szatamari, P., Offord, D.R., & Boyle, M.H. (1989). Ontario child health study: Prevalence of attention deficit disorder with hyperactivity. Journal of Child Psychology and Psychiatry, 302, 219-230.

Taylor, G.J. (1977). Alexithymia and countertransference. Psychotherapy and Psychosomatics, 28, 141-147.

Taylor, G.J. (1987). Psychosomatic medicine and contemporary psychoanalysis. Madison: International Universities Press.

Taylor, G.J. & Bagby, M. (1988). Measurement of alexithymia: Recommendations for clinical practice and future research. In Hemispheric Specialization: Affect and Creativity. Psychiatric Clinics of North America, K.D. Hoppe (Ed.) Vol. 3, 351-365, Philadelphis: Saunders.

Taylor, G.J., Bagby, R.M., Ryan, D.P., & Parker, J.D. (1990). Validation of the alexithymia construct: a measurement-based approach. Canadian Journal of Psychiatry, 35, 290-297.

Taylor, G.J., Bagby, M., Ryan, D., Parker, J., Doody, K. & Keefe, P. (1988). Criteria validity of the Toronto Alexithymia Scale. Psychosomatic Medicine, 50, 500-509.

Taylor, G.J., Doody, K., & Newman, A. (1981). Alexithymic characteristics in patients with inflammatory bowel disease. Canadian Journal of Psychiatry, 26, 470-474.

Taylor, G.J., Parker, J.D.A., Bagby, R.M. (1990). A preliminary investigation of alexithymia in men with psychoactive substance dependence. American Journal of Psychiatry, 147, 1228-1230.

Taylor, G., Ryan, D., & Bagby, M. (1985). Toward the development of a new self-report alexithymia scale. Psychotherapy and Psychosomatics, 44, 191-199.

TenHoughten, W.D., Hoppe, K.D., Bogen, J.E., & Walter, D.O. (1985a). Alexithymia and the split brain. I. Lexical-level content analysis. Psychotherapy and Psychosomatics, 43, 202-208.

TenHoughten, W.D., Hoppe, K.D., Bogen, J.E., & Walter, D.O. (1985b). Alexithymia and the split brain. II. Sentential-level content analysis. Psychotherapy and Psychosomatics, 44, 1-5.

TenHoughten, W.D., Hoppe, K.D., Bogen, J.E., & Walter, D.O. (1985c). Alexithymia and the split brain. III. Global-level content analysis of fantasy and symbolization. Psychotherapy and Psychosomatics, 44, 89-94.

TenHoughten, W.D., Hoppe, K.D., Bogen, J.E., & Walter, D.O. (1985d). Alexithymia and the split brain. IV. Gottschalk-Gleser content analysis, an overview. Psychotherapy and Psychosomatics, 44, 113-121.

TenHoughten, W.D., Hoppe, K.D., Bogen, J.E., & Walter, D.O. (1986). Alexithymia: An experimental study of cerebral commissurotomy patients and normal control subjects. American Journal of Psychiatry, 143, 312-316.

TenHoughten, W.D., Walter, D.O., Hoppe, K.D., & Bogen, J.E. (1987). Alexithymia and the split brain. V. EEG alpha-band interhemispheric coherence analysis. Psychotherapy and Psychosomatics, 47, 1-10.

Terzian, H. (1964). Behavioral and EEG effects of intracarotid sodium amytal injections. Acta Neurochirugia, 12, 230-240.

Thome, A. (1990). Alexithymia and acquired immune deficiency syndrome. Psychotherapy and Psychosomatics, 54, 40-43.

Thomson, G.H. (1951). The factorial analysis of human ability. Boston: Houghton Mifflin Co.

Thurstone, L.L. & Mellinger, J.J. (1953). The Stroop Test. Chapel Hill N.C.: The Psychometric Laboratory, University of North Carolina, No. 3. (cited in Jensen & Rohwer, 1966).

Todarello, O., La Peasa, M.W., Zaka, S., Martino, V. & Lattanzio, E. (1989). Alexithymia and breast cancer: Survey of 200 women undergoing mammography. Psychotherapy and Psychosomatics, 51, 51-55.

Tokar, D.M., Matheson, N.K., Haude, R.H. (1989). Lateralization differences for color-naming and color-matching in men and women. Perceptual and Motor Skills, 69, 651-656.

Treisman, A.M. (1969). Strategies and models of selective attention. Psychological Review, 76, 282-299.

Tronick, E.Z. (1989). Emotions and emotional communication in infants. American Psychologist, 44, 112-119.

Tucker, D. (1981). Lateral brain function, emotion, and conceptualization. Psychological Bulletin, 89, 19-46.

Tucker, D., Antes, J., Stenslie, C., & Barnhardt, T. (1978). Anxiety and lateral cerebral function. Journal of Abnormal Psychology, 87, 380-383.

Tucker, D., Roth, R., Arnson, B., & Buckingham, V. (1977). Right hemisphere activation during stress. Neuropsychologia, 15, 697-700.

Tulen, J.H., Moleman, P., Steenis, H.G. Van & Boomsma, F. (1989). Pharmcology, Biochemistry & Behavior, 32, 9-15.

Van Nuys, D.W. (1979/80). Lateral eye movements and dream recall. Journal of Altered States of Consciousness, 5, 147-152.

Varney, N.R. (1982). Colour association and "colour amnesia" in aphasia. Journal of Neurology, Neurosurgery, and Psychiatry, 45, 248-252.

Voeller, K.K.S. (1986). Right hemisphere deficit syndrome in children. American Journal of Psychiatry, 143, 1004-1009.

Watts, F.N., McKenna, F.P., Sharrock, R., & Trezise, L. (1986). Colour naming of phobia related words. British Journal of Psychology, 77, 97-108.

Wechsler, D. (1981). WAIS-R Manual. New York: Psychological Corporation.

Weil, A. (1980). The marriage of the sun and the moon: A quest for unity in consciousness. Boston: Houghton Mifflin Co.

Weintraub, S. & Mesulam, M.M. (1983). Developmental learning disabilities of the right hemisphere: Emotional, interpersonal, and cognitive components. Archives of Neurology, 40, 463-468.

Weintraub, S., Mesulam, M.M., & Kramer, (1981). Disturbances in prosody. Archives of Neurology, 38, 742-744.

Wilden, A. (1980). System and structure: essays in communication and exchange (2nd ed.). New York: Tavistock Publications.

Williams, E. (1977). The effects of amount of information in the Stroop color word test. Perception & Psychophysics, 22, 463-470.

Williams, J.M.G., & Broadbent, K. (1986). Distraction by emotional stimuli: Use of a Stroop task with suicide attempters. British Journal of Clinical Psychology, 25, 101-110.

Williams, J.M.G., & Nulty, D.D. (1986). Construct accessibility, depression and the emotional stroop task: Transient mood or stable structure? Personality and Individual Differences, 7, 485-491.

Wilson, A. & Malatesta, C. (1990). Affect and the compulsion to repeat: Freud's repetition compulsion revisited. Psychoanalysis and Contemporary Thought, 12, 265-312.

Wise, T.N., Jani, N.N., Kass, E., Sonnenschein, K., Mann, L.S. (1988). Alexithymia:Relationship to severity of medical illness and depression. Psychotherapy and Psychosomatics, 50, 68-71.

Wise, T.N., Mann, L.S., & Hill, B. (1990). Alexithymia and depressed mood in the psychiatric patient. Psychotherapy and Psychosomatics, 54, 26-31.

Wise, T.N., Mann, L.S., Hryvniak, M., Mitchell, J.D., & Hill, B. (1990). The relationship between alexithymia and abnormal illness behavior. Psychotherapy and Psychosomatics, 54, 18-25.

Witelson, S.F. (1976). Sex and the single hemisphere: right hemisphere specialization for spatial processing. Science, 193, 425-427.

Witelson, S.F. (1985). The brain connection: the corpus callosum is larger in left handers. Science, 229, 665-668.

Yalom, I.D. (1989). Love's Executioner. New York: Basic Books.

Zaidel, E. (1976). Auditory vocabulary of the right-hemisphere following brain bisection or hemidecordation. Cortex, 12, 191-211.

Zaidel, E. (1978c). Lexical organization in the right hemisphere. In: P.A. Buser & A. Rougel-Buser (Eds.), Cerebral correlates of conscious experience (pp.177-197). Amstersam: Elsevier-North-Holland Biomedical Press.

Zajonc, R.B. (1980). Feeling and thinking: Preferences need no inferences. American Psychologist, 35, 151-175.

Zeitlin, S.B., Lane, R.D., O'Leary, D.S. & Schrift, M.J. (1989). Interhemispheric transfer deficit and alexithymia. American Journal of Psychiatry, 146, 1434-1439.

Zeitlin, S.B., Lane, R.D., O'Leary, D.S. & Schrift, M.J. (1990) Letter to the editor. American Journal of Psychiatry, 147, 956.

APPENDICES

APPENDICES

Raw data from subjects excluded from data analysis

Possible color weakness data

Age	Voc	Evo	Sim	Flu	Col	Neu	Pos	Neg	Alx
19	45	1	16	8.7	72	72	71	66	61
Age	Voc	Evo	Sim	Flu	Col	Neu	Pos	Neg	Alx
19	46	3	23	12.3	68.3	69.94	64.54	61.67	62

Male English first language means and standard deviations (n=62).

	Age	Voc	Evo	Sim	Flu	Col	Neu	Pos	Neg	Alx
Av.	19.9	51.1	1.9	21.0	12.7	61.6	67.3	66.1	64.6	61.6
S.D.	4.4	6.5	1.2	3.1	4.4	9.6	10.7	12.5	12.8	10.8

Male English as second language means and standard deviations (n=11).

	Age	Voc	Evo	Sim	Flu	Col	Neu	Pos	Neg	Alx
Av.	19.8	41.1	1.7	19.5	11.7	61.8	68.0	67.4	64.5	61.9
S.D.	6.9	16.7	0.7	7.1	3.9	23.1	27.4	26.0	28.9	21.2

Female English first language means and standard deviations (n=128).

	Age	Voc	Evo	Sim	Flu	Col	Neu	Pos	Neg	Alx
Av.	20.1	50.5	2.4	21.3	12.9	57.6	64.1	63.4	61.3	60.7
S.D.	4.3	7.0	1.2	2.6	2.9	8.4	9.8	11.2	10.4	10.5

Female English second language means and standard deviations (n=22).

	Age	Voc	Evo	Sim	Flu	Col	Neu	Pos	Neg	Alx
Av.	19.8	48.5	1.9	20.6	12.3	63.0	72.0	70.1	69.0	65.5
S.D.	3.2	7.8	1.1	2.9	3.9	11.4	17.8	19.9	20.2	10.3

Right handed Male Means (n=54)

	Age	Voc	Evo	Sim	Flu	Col	Neu	Pos	Neg	Alx
Av.	19.7	51.1	1.9	21.1	13.1	62.2	67.8	66.9	65.4	61.8
S.D.	3.6	6.7	1.3	3.0	3.3	9.6	10.7	12.5	13.1	11.0

Left Handed Male Means(n=7)

	Age	Voc	Evo	Sim	Flu	Col	Neu	Pos	Neg	Alx
Av.	21.7	51.3	1.9	20.1	13.3	57.6	62.3	60.2	58.3	60.4
S.D.	7.9	4.1	0.8	3.3	3.4	8.7	10.3	9.9	8.1	9.1

Right handed Female Means (n=125)

	Age	Voc	Evo	Sim	Flu	Col	Neu	Pos	Neg	Alx
Av.	20.2	50.4	2.4	21.3	12.9	57.7	64.1	63.4	61.3	60.8
S.D.	4.3	6.9	1.2	2.7	2.9	8.4	9.9	11.3	10.5	10.5

Left Handed Female Means (n=4)

	Age	Voc	Evo	Sim	Flu	Col	Neu	Pos	Neg	Alx
Av.	19.5	53.3	3.0	22.5	14.3	54.1	63.2	65.4	60.6	52.0
S.D.	1.7	6.7	1.2	2.4	3.5	2.3	2.3	5.0	5.9	7.4

Outlier

Age	Voc	Evo	Sim	Flu	Col	Neu	Pos	Neg	Alx
43	67	4	24	11.7	81.9	100.4	124.9	117.2	48

Summary Statistics

The following tables represent the summary statistics of all the variables: SD=standard deviation; SE=standard error; Up=upper 95% confidence interval limit; Low=lower 95% confidence interval limit; Med=median; skew=skewness; kurt=kurtosis.

Summary Statistics All Ss

	Age	Voc	Emv	V-C	Sim	Flu	Col	Neu	Pos	Neg	Alx
Mean	19.89	50.50	2.49	48.02	21.21	12.79	4.07	2.76	2.74	2.71	61.29
SD	3.77	6.81	1.49	5.88	2.77	2.99	.15	.12	.14	.14	10.60
SE	.28	.51	.11	.44	.21	.22	.01	.01	.01	.01	.79
Up	20.45	51.51	2.71	48.89	21.62	13.23	4.09	2.78	2.76	2.74	62.86
Low	19.34	49.49	2.27	47.15	20.80	12.34	4.04	2.74	2.72	2.69	59.72
Med	19.00	51.00	2.00	49.00	22.00	12.70	4.06	2.76	2.74	2.70	62.00
Skew	3.70	-.15	.31	-.34	-.89	.16	.15	.17	.47	.32	.02
Kurt	16.63	-.44	-.48	-.32	.80	-.58	.14	-.15	.16	.32	-.09

Female Summary Statistics (n=124)

	Age	Voc	Emv	V-E	Sim	Flu	Col	Neu	Pos	Neg	Alx
Mean	19.98	50.24	2.61	47.65	21.25	12.84	4.04	2.75	2.73	2.70	61.09
SD	3.84	6.86	1.39	5.96	2.65	2.84	.14	.12	.13	.13	10.46
SE	.34	.62	.12	.54	.24	.26	.01	.01	.01	.01	.94
Up	20.67	51.46	2.86	48.70	21.72	13.35	4.07	2.77	2.76	2.72	62.95
Low	19.30	49.02	2.37	46.59	20.79	12.34	4.02	2.73	2.71	2.68	59.23
Med	19.00	51.00	3.00	48.00	22.00	12.70	4.03	2.75	2.71	2.68	60.00
Skew	3.20	-.29	.11	-.43	-.89	.15	.04	.08	.37	.06	.23
Kurt	12.30	-.43	-.63	-.21	1.09	-.87	-.32	-.25	-.08	.21	-.02

Male Summary Statistics (n=54)

	Age	Voc	Emv	V-E	Sim	Flu	Col	Neu	Pos	Neg	Alx
Mean	19.69	51.09	2.20	48.89	21.11	12.66	4.12	2.79	2.77	2.75	61.76
SD	3.64	6.70	1.68	5.67	3.04	3.34	.15	.12	.15	.16	11.01
SE	.50	.91	.23	.77	.41	.45	.02	.02	.02	.02	1.50
Up	20.68	52.92	2.66	50.44	21.94	13.57	4.16	2.82	2.81	2.79	64.76
Low	18.69	49.26	1.75	47.34	20.28	11.75	4.08	2.76	2.73	2.70	58.75
Med	19.00	51.00	2.00	49.00	22.00	12.85	4.09	2.78	2.77	2.73	63.50
Skew	4.95	.21	.72	-.05	-.82	.21	.27	.31	.45	.35	-.42
Kurt	28.38	-.77	-.15	-1.03	.12	-.41	.58	-.31	-.01	-.33	-.23

Psychology Experiment Information
and Ethics Consent Form

You are being asked to participate in a research project designed to examine relationships between the verbal expression of emotions and general verbal abilites. Your participation will initially consist of completing a questionnaire examining the verbal expression of emotions and other personality dimensions. After this questionaire is scored, a random selection of subjects will be called for vocabulary testing and a word fluency test.

Your participation in this study is voluntary and you can withdraw from the research at any time. Your responses will be kept entirely confidential, and your identity could never be inferred from the experimental results. You will not experience any psychological or physical discomfort during the experiment. If you wish I can make the results of this experiment, after it is complete, known to you.

The University and those conducting this research subscribe to the ethical conduct of research and to the protection of the interests, comfort, and safety of subjects at all times. This form and the information that it contains are given to you for your own protection and full understanding of what your participation will entail.

I understand that I may withdraw my participation in this experiment at any time. I also understand that I may register any complaint I might have with Gordon Cole, M.A., chief researcher, or with Dr. Roger Blackman, the chairman of the Psychology Department at SFU.

Please print your name and telephone number below, then sign your name signifying that you understand the information provided to you, and that you are willing to participate in further aspects of the study.

Print Name ________________ Phone Number(s)__________________

Signature ___________________ ___________________

Best time you can be reached at home_____________