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AN INVESTIGATION OF RELATIONSHIPS AMONG IMAGERY OF FEELING STATES, IMAGERY OF NEUTROPHILS/IgA AND IMMUNE RESPONSIVITY AS MEASURED BY BLOOD NEUTROPHIL FUNCTION AND SECRETORY IgA LEVELS

presented by

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of the requirements for

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By

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ABSTRACT

AN INVESTIGATION OF RELATONSHIPS AMONG IMAGERY OF FEELING STATES, IMAGERY OF NEUTROPHILS/IgA AND IMMUNE RESPONSIVITY AS MEASURED BY BLOOD NEUTROPHIL FUNCTION AND SECRETORY IgA LEVELS

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The purpose of the study was to investigate the influence of happy and sad emotions (experienced through mental imagery) on immune responsivity as measured by changes in responsivity of neutrophils (white blood cells) and changes in secretory IgA (an antibody found in saliva) levels. Two types of emotional imagery were used to elicit the Treatment Conditions in the study. In the first part of the study, the emotional imagery was used to establish an emotional state and then examine the Indirect Effect this state had on immune responsivity. In the second phase of the study, the imagery focused on the neutrophil cells and secretory IgA themselves responding in a "happy" or "sad" manner. Thus, the second imagery process, was an effort to manipulate Direct central nervous system influence on neutrophil/IgA activity.

The eighteen subjects (nine men and nine women) for the experiment were paid volunteers who were comfortable experiencing strong emotional states. Participants were screened for age, life events, depression, and daily habits that could influence immune responsivity.

Each subject experienced five different imagery conditions: a Neutral Condition where the subject sat quietly for twenty minutes, an Indirect Happy Condition, an Indirect Sad Condition, a Direct Happy Condition and a Direct Sad Condition.

Each Treatment Condition included: submission of blood and saliva samples, twenty minutes of imagery, and the submission of a second set

of blood and saliva samples.

The dependent measures for the study were White Blood Cell Count, Percentage of White Blood Cells that were neutrophils, Adhesion of Neutrophils, Stimulated Adhesion of neutrophils and IgA levels in saliva. The dependent measures were analyzed using difference scores (post-pre measures) in a Sex by Treatment, multivariate analysis of variance for repeated measures, with planned comparisons.

Additional multivariate analyses of similar form were used to clarify the relationships between the Treatment Conditions for the one statistically significant comparison: White Blood Count-Neutral versus Other Treatments ($\underline{P}$ .05 level). The additonal analyses yielded statistically significant comparisons at the .05 level for: White Blood Count - Neutral versus Indirect Conditions, Neutral versus Sad Conditions, and a Sex by Treatment interaction for the Neutral versus Sad comparison.

DEDICATION

I dedicate this research to my parents who have always wished the best in life for me and given their best effort to provide opportunities for my growth.

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CHAPTER I

THE PROBLEM

Introduction

The relationship between the mind and the body has been of interest to persons in diverse fields for many years. Philosophers, religious leaders, physicians, and psychologists have all wrestled with the questions of whether these concepts of body and mind represent different entities and, if they are different, how they interact. In the 1940s the field of psychosomatic medicine combined two of the disciplines mentioned above in an effort to investigate the interrelationship of the mind (emotional conflicts) and the body (disease states) (Bakal, 1979). More recently, the theories of psychosomatic medicine have been broadened to include disease prevention and health promoton. Within the last ten years, related fields such as behavioral medicine and health psychology have also emerged and, like psychosomatic medicine, are concerned with disease/health issues. The development of these fields reflect a general interest in society, both by lay people and professionals, to understand how activities of the mind can influence general well being.

One of the important issues to consider in looking at the influence of the mind on the body has been the reassessment of those body systems historically labeled "autonomous" or "involuntary". For

example, the advent of biofeedback demonstrated that many bodily systems thought to be autonomous can be influenced by Central Nervous System (CNS) activity if an individual has the appropriate information about that system (Shearn, 1962; Frazier, 1966; Engel, 1972; Blanchard & Young, 1974).

The immune system is one of the body mechanisms that has been viewed as autonomous from CNS influence. However, a new field called psychoneuroimmunology has begun to challenge this assumption. Some studies in psychoneuroimmunology have shown, for instance, conditioned immunosuppression (Ader, 1981), immunosuppression related to emotional stress (Bartrop, Luckhurst, Lazarus, Kiloh & Penny, 1977), and direct CNS influence on immune function (Black, Humphrey, & Niven, 1963; Hall, 1982; Minning, 1982; Schneider, Smith & Witcher, 1984). The establishment of these CNS links to the immune system is significant in exploring etiology, prevention, and treatment of various diseases including: cancer, autoimmune diseases, and infectious diseases (Ader, 1981).

Need for The Study

As stated above, the theories of psychosomatic medicine and related fields such as behavioral medicine and health psychology, have broadened into more comprehensive conceptualizations. Several of these theories have included stress models (Lipowski, 1976; Stone, 1979) which have looked at specific physiologic response patterns to stress (Mason, 1975; Selye, 1974) and correlated life stressors with disease onset (Holmes & Rahe, 1967; Sarason, Johnson & Siegal, 1978). These

investigations, however, have not fully answered the question of how life stressors and the concurrent physiologic responses eventuate in disease or health (Ader, 1981; Rogers, Dubey & Reich, 1979).

The relationship between the CNS system in the form of emotions and the immune system has increasingly been seen as a link in explaining disease development, abatement, and prevention. Although, there is growing evidence both in animal and human research to support CNS influence on the immune system, the specific role of feeling states as a CNS process influencing immune capabilities is not as well documented.

Bartrop (et. al., 1977) has shown depressed T-cell functioning in persons bereaving the loss of someone they were close to emotionally. Linn, Linn and Gensen (1982) also studied people experiencing beareavement but additionally assessed their levels of depression and showed a greater decrease in immune response for the highly depressed group. Another study by Kronfol, Silva, Greden, Dembinski and Carroll (1982) also showed a difference in immune response between depressed and non-depressed groups.

While the above studies have looked at the influence of some mood states, no studies have examined the influence of specific feelings such as happiness, sadness, anger or fear.

Purpose of the Study

This study adds to the literature of psychoneuroimmunology by investigating the influence of happy and sad feelings (as experienced through mental imagery) on immune responsivity as measured by changes

in responsivity of neutrophils (white blood cells) and changes in secretory IgA (an antibody found in saliva) levels. Two types of emotional imagery were used to elicit the Treatment Conditions in the study. In the first set of Treatment Conditions, the emotional imagery was used to establish an emotional state and then examine the Indirect Effect this state had on immune responsivity. In the second set of Treatment Conditions, the imagery focused on the neutrophils cells and secretory IgA themselves responding in a "happy" or "sad" manner. Thus, the second imagery process was an effort to manipulate Direct CNS influence on neutrophil/IgA activity.

By using both the emotional state imagery and the neutrophil/IgA imagery, not only was the general question of CNS influence addressed but also the differential effect of Direct versus Indirect emotional imagery.

Research Questions

The primary questions for the study were as follows:

1) Will a 20 minute emotional imagery state of happiness or sadness (Indirect Effect) effect immune responsivity as measured by changes in neutrophil function and secretary IgA levels in saliva?

2) Will a 20 minute imagery process in which an individual focuses on the neutrophil cells and saliva secretory IgA responding in a happy or sad emotional manner (Direct Effect) effect immune responsivity as measured by changes in neutrophil function and secretory IgA levels in saliva?

3) Will there be a difference between the effects of the imagery states of happiness and sadness (Direct and Indirect combined) on the neutrophil function and secretory IgA levels in saliva?

4) Will there be a difference between the effects of the Direct Effect imagery states and the Indirect states on the neutrophil

and secretory IgA levels in saliva?

5) Will there be a difference between the effects of emotional imagery on the immune system of men and the effects of emotional imagery on the immune system of women as measured by changes in blood neutrophil function and secretary IgA levels in saliva?

Basic Immunology

For the purpose of background information the following review of basic immunological terms and concepts is presented.

The immune system's primary role is one of maintaining body homeostasis and health by discriminating between self and non self as well as pathnogenic and host relationships. Bellanti (1978) provides the following definition of immunity: "all those physiologic mechanisms that endow the animal with the capacity to recognize materials as foreign to itself and to neutralize, eliminate, or metabolize them with or without injury to it's own tissues." Thus the system acts in three major capacities: defense against external microorganisms, maintenance of homeostasis by removing old or damaged cells, and surveillance in recognition and control of abnormal cell development such as cancer cells.

The above functions of the immunologic system can follow two types of responses (Bellanti, 1978). A "non-specific" immune response may occur which involves an inflammation or phagocytosis, or both. Inflammation is characterized by swelling, heat, redness, and pain. The body function of inflammation, however, is homeostatic and its intent is to protect or restore the threatened body area. Phagocytosis is a many phase process by which cells of the immune system destroy

foreign organisms or diseased cells. Once activated phagocytic cells recognize the material to be removed, move toward that cell (chemotaxis), attach, ingest, and then digest the foreign substance.

The actions of neutrophils are an example of non specific action. Neutrophils are a type of leukocyte (white blood cell). Neutrophils are the most prevalent leukocyte in the body and represent 60 to 70 percent of the total leukocyte population in the peripheral blood supply. The neutrophils primary function is phagocytosis described above. By digesting bacteria and body debris neutrophils protect the individual from infection.

The typical life of the neutrophil includes its development from bone marrow cells, a circulation period of 8 - 12 hours, and an entry into body tissue where it will die after a few hours (Bellanti, 1978; Wilkinson, 1974).

In order to respond to bacteria three changes can occur with neutrophils: the total number of neutrophils available to the circulating blood can increase, the neutrophils can become sticky (adherent) and they can change shape becoming convoluted and elongated. These changes allow the cell to perform phagocytosis as described above. Smith, Hollers, Patrick and Hassett (1979) have developed reliable measures of the three functions just described. It has also been shown through formal and informal observations (Smith, 1979; Schneider & Smith, 1979) that neutrophils are responsive to emotional stress and mental imagery.

The second type of immune response is "specific". The specific responses can be differentiated from the non-specific by three

qualities: specificity, heterogeneity and memory. Specificity refers to the fact that this type of responsivity can determine in a refined manner the material that began the response (antigen). The "specific" mechanisms respond in a very selective way thereby helping to maintain homeostasis, since the immune actions destroy the antigen, but do not affect a broad range of cells in the body.

The second quality, heterogeneity, refers to the diversity of cell types and their products that are used in the immune system to specifically match and counteract the foreign substances present. While a given response of the immune system is specific, the capability of the system as a whole is diverse and flexible.

The third quality of the specific responses is memory. This is the capability of the immune system to respond to a greater degree when re-exposed to the same immunogen. The non-specific responses, in contrast, are a general response pattern and merely repeat the same response when the immunogen is reintroduced.

The nonspecific responses have a set number of cell types to utilize whereas the specific responses can introduce new cell configurations to respond to a new antigen.

The mechanisms for accomplishing the various responses of the immune system have been divided into two broad components: humoral or antibody-mediated reactions and the cell-mediated immune reactions. Historically these two components represented competing theories proposed by Ehrlich (humoral) and Metchnikoff (cellular), but were later recognized as interdependent mechanisms of the total immune process (Bellanti, 1978).

The humoral responses are a result of antigen stimulation of B lymphocyte cells (associated with bone marrow). When stimulated these B lymphocytes change into a plasma configuration and produce a group of proteins (antibodies) known as immunoglobulins. Immunoglobulins such as IgG, IgM, IgA, and IgE act as antibodies against toxic antigens and bacterial antigens as well as being involved in transfusion reactions and autoimmune reactions (Rogers et al., 1979).

IgG makes up 50-70% of the blood serum antibodies and is active against toxins, viruses and some forms of bacteria. IgM is a smaller percentage of the serum configuration (5-10%) and deals with other forms of bacteria. IgE has been shown to play a vital role in hyper-sensitivity of allergic reactions.

IgA is found in body areas that secrete mucous such as the nasal passages, gastrointestinal tracts or in saliva. IgA "may function by covering parts of the surface of pathogens and thus inhibiting their adherence to surface musocal cells and, hence, their entry into the body," (Bowry, 1977). IgA can also destroy the pathogen after it has successfully entered the mucosa (Tomasi, 1976). Evidence reveals that IgA is influential in preventing viral infections both respectively (Rossen, Butler, Waldmann, Alford, Hornick, Togo & Kasel, 1979) and prospectively (Yodat & Silvian, 1977).

The other broad component of the immune system, the cell-mediated responses, involves T lymphocytes which are under the influence of the Thymus. T lymphocytes respond to specific antigens and release lymphokines which are nonantibody substances and therefore circulatory antibodies are not directly involved with cell-mediated immunity. The

lymphokines instead act on other cells that result in inflammatory processes.

While T lymphocytes do not directly produce antibodies or plasma cells a set of T cells may play a role in influencing B lymphocytes. These cells, known as helper T cells and supressor T cells, act to inhance or restrict humoral responses.

The presence of helper and supressor T cells highlights the fact that even though the humoral and cellular mechanisms are separate components they are interrelated. To complicate matters further there are variations in immune capability resulting from such factors as genetics, environment, anatomy, age, sex, race, time of day and time of year (Bellanti, 1978; Rogers et al., 1979).

The entire immune system is genetically controlled or programmed. This is illustrated by the fact that various animal species are responsive or non-responsive to the same antigen. Also, differences in responsivity to antigens can be bred into various laboratory animal species (Bellanti, 1978).

Genetics in the form of sex differences and race is another controlling variable. Grundbacher (1974) states that females have 20% more IgM than males and blacks have more IgG than whites. Changes in immune competence also take place in women when they are pregnant. This immunosupression is thought to act as as protection of the fetus, which in one sense, is a foreign substance (Purilo, Hallgren, & Yunis, 1972).

The environment in which a given individual grows up may also impact the immune system due to increased exposure to pathogens or the

influence of poor nutrition on body function. Also, interactions with the environment can result in anatomical damage to the skin through burns or cuts that leave the individual more vulernable to external microbes.

Age plays a critical role in immune function at least for the young and the elderly. Hummoral immunity takes several years to develop and some immuglobulins such as IgA continue to increase into adulthood (Buckley & Dorsey, 1970). Aging represents a general decline in several areas of immune responsivity (Makinodan & Yunis, 1977). These changes may account in part for increases in autoimmune diseases and cancer in the elderly (Rogers et al., 1979).

There is also evidence to show that there are daily fluctuations in plasma cell levels, immunoglobulin levels, lymphocyte levels, and various immunologic responsitivies (Smolensky, 1977). Diurnal variation in natural killer cell activity has also been found (Rogers et al., 1979).

Summary and Overview

A brief historical progression of psychosomatic medicine was presented in this chapter to establish the long standing interest of various professionals in mind-body relationships. The field of psychoneuroimmunology was described as an outgrowth of this interest in body-mind relationships and examines the links between the CNS and the immune system. Studies in psychoneuroimmunology have shown conditioned immunosuppression and direct CNS influence on immune responses. Additionally, studies were cited that suggest CNS activity in the form

of emotional states such as bereavement or depression influence immune responsivity. Given the implications of CNS influence on the immune system for disease development and treatment, it was argued that the impact of more specific feelings (such as happiness, sadness, anger or fear) should be addressed.

The present study was intended to specifically look at CNS influence on the immune system in the form of happy and sad feelings as experienced through mental imagery. In the first set of Treatment Condition the Indirect influence of the feeling states on the immune system was examined by having the subjects be naive regarding the bodily systems being monitored. During the second set of Treatment Conditions a Direct influence was measured by having the subjects visualize neutrophil cells and IgA of the immune system being "happy" and "sad."

Having established the need, purpose, and research questions in Chapter I, the remainder of the study will be presented in the following format: a literature review of Central Nervous System activity and general physiologic consequences, Central Nervous System activity and immune system responses, emotions as a Central Nervous System influence on physiology, and imagery and emotional arousal will be presented in Chapter II; the design of the study including sampling and research procedures, methods of measuring dependent variables, statement of the specific hypotheses, and types of data analyses will be stated in Chapter III; the results of the data analyses will be reported in Chapter IV; and the conclusions and implications for further research will be explained in Chapter V.

CHAPTER II

REVIEW OF LITERATURE

The following topical areas are presented to further establish the context for investigating the influence of emotions on immune system responsivity: Central Nervous System Activity and General Physiological Consequences as reflected in psychosomatic literature; Central Nervous System Activity and Immune System Responses including the development of psychoneuroimmunology, establishment of neuroendocrine-immune relationships and review of direct Central Nervous System influences on the immune system; Emotions as a Central Nervous System Influence on Physiology both as a general physiologic patterning and specifically as an influence on the immune system; and Imagery and Emotional Arousal to establish the usefulness of imagery for this investigation.

Central Nervous System Activity and General Physiological Consequences

Western philosophic orientation has led to an emphasis on looking at parts of organisms and systems rather than the whole and the interaction of the parts. Particularly, the Cartesian dualism of mind and matter has had a significant impact on our way of thinking, leading to the division of knowledge into disciplines such as psychology and medicine. Psychology has emerged as a field primarily concerned with

the mind and the behaviors resulting from the mind's activities, while medicine has focused on the physiology of the body and the treatment of disease (Pelletier, 1977).

A softening of this mind - body dualism was found in the development of psychosomatic medicine. Psychosomatic medicine had its origins in psychoanalysis. The term itself comes from the Greek words psyche, which means soul or mind, and soma, which means body (Keefe & Blumenthal, 1982). Therefore psychosomatic medicine was an attempt to examine the mind-body relationship.

Dunbar (1943) was one of the first investigators to gain notoriety in the area of psychosomatic medicine. Dunbar examined personality traits and behaviors of people with a given disease. She was able to establish consistent patterns across some diseases. Hypertensives, for instance, were described as being very self controlled, demanding of perfection, and often shy.

Alexander (1950) followed Dunbar and also looked for psychological correlates to disease but was most interested in explaining body symptoms by means of psychic conflict paradigms. Axexander's model followed a specificity approach which stated that certain internal conflicts would eventuate in a specific disease state such as peptic ulcers, hypertension, ulcerative colitis, skin disorders, or respiratory disorders. Alexander believed that the conflicts the persons experienced were also experienced by persons who did not have the disease, but that certain conflicts were specific to a certain type of disease developing.

Graham, Lundy, Benjamin, Kabler, Lewis, Kunish, and Graham (1962)

paralleled the notions of Dunbar (1943) and Alexander (1950) but more specifically examined the relationship of individuals' attitudes and particular diseases. All three of the above investigators are considered specific theorists since they demonstrated correlations of psychological factors (personality, internal conflict, attitudes, etc.) with specific types of disease.

The psychosomatic orientation eventually moved away from the "specificity" notion and began to examine nonspecific theories of disease onset. The nonspecific approach is more concerned with finding factors that influence diseases in general, rather than linking psychological factors with a specific disease. Holmes and Rahe (1967) who suggested that too many life change events such as changing jobs, loss of loved one, moving, etc., are correlated with disease onset are an example of researchers following a nonspecific model. Since Holmes and Rahe's (1967) original study, other researchers have ellaborated the life events theme. One of the main concerns in the later studies has been how the person interprets the life events they experience (Sarason et al., 1978). Totman (1982) believes that "It must be considered well established that life events which threaten health do so primarily on account of their social meaning to the individual." In other words, the cognitive interpretation of the event appears to mediate the emotional response and following physiologic outcome. Engel (1967), Schmale (1958), and Schmale and Iker (1966) have proposed a "giving up - given up complex" that illustrates the principle of individual interpretation of life events. The giving up - given up complex is a response to personal loss where the individual comes to

have a general feeling of grief and helplessness that the researchers believe leads to a biological susceptibility to illness.

Other researchers such as Selye (1974) have been more interested in the biological consequences of the above mentioned stressors. Selye argues that the body has a "generalized adaptation syndrome" which is its response to any perceived threat. According to Selye many types of stressors can elicit the same physiologic reaction which if frequent or sustained long enough can lead to disease conditions. Mason (1975) has criticized Seyle's concept stating that the general non-specific model should be applied at "higher level physiological integrative mechanisms" such as the brain, rather than at "lower level psysiological or biochemical mechanisms". He argues Selye's hypothalamus-pituitory-adrenal cortical response system is responding to emotional stimuli rather than the first level physiologic stimuli. Thus, he is saying that physical stimuli may not stimulate the hypothalamus-pituitary-adrenal cortical system unless an emotional component is present. The physical stimuli may cause many interactions at the lower physiologic level but the general adaptation syndrome is primarily a result of behavioral or emotional stimuli rather than physical stimuli, therefore, there is a general response to emotional-cognitive stressors but not to physical stress alone.

As the above research suggest, psychosomatic medicine has moved from a narrowly focused, specific conflict/single disease model to more comprehensive perspectives. Lipowski (1976) presents a formulation where environmental stressors create emotional responses that are influenced by cognitive appraisals, which, in turn, are a product of

the persons unique mind set developed through their lifetime. The emotional states have physiological arousal patterns which have a functional quality but may also have an influence on disease development depending on intensity and duration. Thus, Lipowski presents a view which considers the interaction of social, cognitive and physiological systems. Stone (1979) notes, however, that Lipowski's formulation still has a major focus on emotions as the mediation of physiological response patterns.

In summary, the mind-body issue has been an area of controversy and an impetus for many theories related to disease and health. Theoretical formulations regarding the role of the mind in disease onset or health promotion have become more complex, but still view the individual's experience of emotion as an important ingredient in any formulation. While the assumption that feelings have influence on disease and health is well accepted, the mechanisms of how feelings effect disease and health is not fully understood.

Central Nervous System Activity and Immune System Responses

The role of the immune system is thought to be a critical link in further understanding of disease/health processes. A growing body of literature has developed examining how the central nervous system (and emotions as a CNS process) can influence the immune system. The following three sections will cite literature related to Psychoneuroimmunology in general, Neuroendocrine-Immune Relationships, and direct CNS Influences on the Immune System. The literature cited

will establish the context for looking at emotions as a more specific type of CNS influence on the immune system.

Psychoneuroimmunology

The immune system's ability to fight foreign substances, remove damaged cells and to control mutant cells (Bellanti, 1978) are all integral to the maintenance of health. Thus if there are central nervous system influences on immune responsivity, these could serve as a partial explanation of health/disease dynamics.

As Robert A. Good in the forward to Ader's (1981) book Psychoneuroimmunology, states:

> Immunologists are often asked whether the state of mind can influence the body's defenses. Can positive attitude, a constructive frame of mind, grief, depression, or anxiety alter ability to resist infections, allergies, autoimmunities, or even cancer? Such questions leave me with a feeling of inadequacy because I know deep down that such influences exist, but I am unable to tell how they work, nor can I in any scientific way prescribe how to harness these influences, predict or control them. Thus they cannot usually be addressed in scientific perspective. In the face of this inadequacy, most immunologists are naturally uneasy and usually plead not to be bothered with such things. (p. xvii)

Good goes on to cite several studies that support the idea of CNS influence on the immune process and concludes that:

> The scientific results reviewed and presented in the pages of this book leave no doubt that the brain can influence many immunologic processes. The question that remains is how these three major networks--the nervous system, the endrocrine system, and the immunologic system-- interact and, how, by understanding these interactions in precise quantitative terms, we can learn to predict and control them.

Rogers, Dunbey, and Reich (1979) in their review of psychic influences on immunity and disease susceptibility see the immune system as "a further critical link in the psychosomatic process and disease susceptibility." (p. 148). Thus the study of psychoneuroimmunology provides another extension of the mind-body integration in psychosomatic medicine. As Ader (1981) puts it:

> It is, after all, our own intellectual limitations that have led to the proliferation of scientific disciplines that have no necessary relationship to a full understanding of adaptive processes, and the study of immune processes as an integrated part of the organisms psychobiological adaptation to its environment represents a constructive dissolution of such arbitrary boundaries.

One of the apparent ways the immune system aids in the oganism's adaptive process is through the immune system's inter-relationships with the neuroendocrine system.

Neuroendocrine-Immune Relationships

The endocrine system appears to have a significant effect on both the development and functioning of the immune system. In fact, in review articles by Amkraut and Solomon (1975) and Besedovsky and Sorkin (1977) the neuroendocrine system is presented as one model for explaining the link between CNS activity and fluctuations in immune capability.

The daily variations in the immune system activity seem to parallel the daily variations that have already been established for the endocrine system suggesting that these changes function together.

The data supporting the interdependence of the neuroendocrine and immune systems developmentally is even more pronounced than their

apparent mutual daily fluctuations (Rogers et al., 1979). An example of the developmental interaction can be illustrated by removing the thymus (part of the immune system) in new born mice. The result of early thymus removal included lessened cellular immunity, alterations in sexual development, and adrenal hypertrophy. The converse effect of the endocrine system on the thymus was documented by Selye (1955) when he described increased thymic involution as a concurrent event with increased corticosteroid levels and adrenal hypertrophy.

A change in steroid level such as with the corticosteroids does not, however, always result in an immunosuppressive effect. Ambrose (1970) has shown that certain levels of corticosteroids are necessary for normal functioning of the immune system. Within certain boundaries an increase in steroids may enhance the functioning of the immune system. The effect of steroids and other hormones such as thyroid hormone, insulin, growth hormone, and sex hormones are, therefore, bi-directional and dependent on the concentration of the hormone in the system (Fabris, 1977).

The growing understanding of cellular confirgurations in both the immune and neuroendocrine systems also lends support to the theory that the two systems can and do interact. Lymphocytes have been shown to have receptor sites for a variety of hormones including: insulin, histamine, E prostaglandins, acetylcholine, and B-adrenergic catecholamines. The presence of hormonal reception sights not only show the link between the endocrine system and the immune system but also build a potential pathway from the CNS to the immune system. As cell configurations are more clearly delineated it will become possible

to develop more theories regarding the interaction sequences between cells that may result in changes in immunologic functions.

Although the specific mechanisms are not clearly understood, Pierpaoli and Maestroni (1978) report just such an interaction that was caused by the administration of a combination of several drugs. These drugs were known to interfere with typical neuroendrocine responses that, in turn, resulted in a suppression of the expected immune response to an antigen.

Another example of the interaction of the neuroendocrine system and the immune system is found in the work of Besedovsky, Sorkin, Felix, and Haas (cited in Ader, 1981). In this study, immunized rats were exposed to antigens. At the same time that the antibody reaction of the immune system was taking place the experimentors noted an increase in serum hydrocortisone and thyroxine levels of the endocrine system. The researchers also documented a concurrent increase in the electrical activity of the ventral medial hypothalamus of the rat. This activity in the hypothalamus suggests a possible afferent pathway from the immune activity, which was peripherally initiated, to the hypothalamus.

Besedovsky (cited in Melnechuk, 1983) has also presented data that local immune responses may be able, in turn, to effect the brain. When stimulated by a mitogen, lymphocytes release substances called lymphokines. Besedovsky injected lymphokines into laboratory animals and found a decrease in noradrenaline activity of the hypothalamus. The lymphokine injection also increased corticosterone and ACTH levels (associated with stress) in the blood but had no effect for a second

set of animals where the pituitary gland had been removed. Thus Besedovsky has demonstrated a hypothalmic-pituitary-hormonal-immune-hypothamalic circuit.

CNS Influences on the Immune System

Having reviewed some of the immune system's relationships to the neuroendocrine system, it is now possible to examine some of the evidence that more specifically suggests a CNS influence of the immune system.

Hypnosis was one of the earliest areas to demonstrate the relationship of the CNS and the immune system. Both Barber (1978) and Hall (1982) have written extensive reviews of literature that link hypnotic procedures with bodily responses that are mediated by the immune system. Barber cites studies that have shown blocks in allergic skin responses, reproduction of skin inflamation that the subject had previously experienced, cure of warts and ameilioration of congenital ichthyosiform erythrodermia (a skin disease causing scaling). Hall (1982) lists some of the same studies by categories of allergic responses, reactions to Mantoux skin tests, dermatological conditions, warts, and his own work trying to directly effect T and B cells in the immune system.

Much of the early work with hypnosis was of a case study nature. Clarkson (cited in Hall, 1982) was able to hypnotize a young woman who had an allergic reaction to an intradermal injection allergy test. Under hypnosis there was no reaction to the innoculation. On another occasion when hypnosis was not used the skin reaction reappeared.

Zeller was unable to replicate Clarkson's findings but may not have had as highly hypnotizable subjects as Clarkson. Zeller also used a different antigen than Clarkson for his skin tests which may also account for the lack of significant findings (Hall, 1982).

Mason and Black (1958) were able to virtually eliminate the asthmatic attacks of a woman who responded to pollen with chronic respiratory distress. Bowers and Kelly (1979) reviewed the Mason and Black (1958) case and stated:

> . . .not only were the asthmatic reactions to the pollen eliminated, the patient's immediate-type hypersensitivity skin reaction to injected antigens was also eliminated, despite the fact that no suggestions had been given to this effect. Even more impressive was the fact that when Black introduced the patient's serum into his own arm and subsequently exposed himself to the appropriate allegen, he displayed the characteristic hypersensitive skin response. (Black had previously proven to be non-allergic to the pollen.) In other words, the patient was somehow inhibiting an allergic reaction to pollen despite the demonstrated presence of what we now know to be IgE antibodies in her serum.

Another series of studies done by Black (et al., 1963) also demonstrated an alteration of immediate hypersensitivty responses of the immune system. Black and his colleagues used the Mantoux tuberculin skin test and tissue biopsies as their outcome measures. Five subjects were used in the study. Four of the five subjects had positive Mantoux reactions prior to a twelve day series of hypnotic inductions with the suggestion that they would no longer have positive test results. After the suggestion period none of the subjects showed positive Mantoux tests. The biopsies however did show increased lymphocytic activity. The researchers concluded that the hypnotic process most likely inhibited the Mantoux response by decreasing

vascular activity in the form of the capillary system. Thus the hypnosis was able to influence the swelling and inflamation response but there was still a clear cellular response to the test (Hall, 1982).

In follow up studies Black (1963a, 1963b) was able to show that the earlier results were not the result of repeated injections and therefore the development of hyposensitivity. Black and Friedman (1965) also discounted increases in plasma cortisol levels (an immune suppressant) as a possible explanation for the change in Mantoux response.

Another clinical application of hypnosis and immune function cited by Hall (1982) was the work of Kaneko and Takaishi (1963) who were able to treat urticaria, a skin disease mediated by IgE. Kaneko and Takaishi not only removed the response for a number of their subjects they also increased the response in four volunteers by suggesting situations of personal conflict or increase in heat. The volunteers believed that these two conditions (conflict or heat) would increase their urticaria and the hypnotic suggestion of conflict or heat did result in increase in urticaria symptoms.

The removal of warts has also been documented through the use of hypnosis. Warts are thought to be the result of viruses and may be associated with deficiencies of T cells. Sinclair-Gieben and Chalmers (1959) were able to lessen warts on one side of a subject's body while leaving the same number of warts on the other side of the subject's body until the hypnotic suggestion specifically inferred the second side would become wart free.

A more recent study of hypnotic influence was done by Hall, Longo,

and Dixon (1981). In this study subjects were asked under hypnosis to imagine their white cells being strong and powerful. Three blood samples were taken: a prehypnotic baseline measure, a sample one hour after hypnosis, and another sample one week later, after a second hypnotic session. Subjects were then divided by age (median split was 50 years old) for one statistical analysis and in a second analysis were divided by hypnotizability scores. The younger group showed a higher general immune functioning (in vitro mitogen analysis) as would be expected since the immune response tends to lessen with age. An additional finding was the fact that the younger group had a higher increase the second week than the older group, thus showing a practice effect for the younger group. A third finding was the correlation between high hypnotizability and increase in lymphocyte count one hour after hypnosis.

Another line of research supporting CNS influence on the immune system is work in the area of conditioned immunologic responses.

One of the most striking series of experiments linking the CNS and the immune system was initiated by Ader and Cohen (1975). Ader's investigation used a classical conditioning paradigm. An aversion to sacharin water was conditioned in rats by pairing it with an injection of cyclophophamide which causes the rats to have an upset stomach. The pairing resulted in a learned aversion in just one trial. The experimentors then assessed the extinguishment pattern of the behavior, but after a period of time some of the rats died. This led them to theorize that the rats had not only been conditioned to have an aversion to the saccharin water but that they had also learned an

immunosuppression response. The basis for this theory was the fact that the cyclophosphamide in addition to making the animals sick had a short term immunosuppressive effect. Since the animals were exposed to the conditioned stimulus (the saccharin water) repeatedly (during the extinguishment phase) it might be possible that the immunosuppressive effect was reinitiated as well as the aversive behavior.

Ader and Cohen set out to test their theory by using three groups of rats: conditioned rats, unconditioned rats, and control rats. All three groups were taught to drink their entire supply of water for a day in 15 minutes. Then various pairings were made with saccharin water, regular water, cyclophosphamide injections, and saline injections, to see if a conditioned immune suppression would be found. It was found that the conditioned rats did, in fact, develop an immunosuppression while the control group showed a normal immune responsivity. The unconditioned group's immune capability was almost as responsive as the control group but had a slight depression due to the recent injection of cyclophosphamide.

As cited in Ader (1981), Ader and Cohen's results have been replicated in their laboratory using variations in the research design (Ader, Cohen, & Grota, 1979; Bovbjerg, Cohen & Ader, 1980; Cohen, Ader, Green, & Bovbjerg, 1979) and by others (Rogers et al., 1979; Wayner et al., 1978).

At the time of the 1975 experiment Ader and Cohen were:

> Unaware that attempts to condition immune responses had been initiated by Russian investigators 50 years ago (Metal'nikov and Chorine, 1926). We were also unaware of some of the early clinical observations cited by Smith and Salinger (1933): Osler, for example, described the case of a patient who experienced an asthmatic attack when

> presented with an artificial rose, and Hill (1930) observed that a picture of a hay field could evoke a hay fever attack in very sensitive subjects. Additional clinical and experimental examples are provided by Dekker et al. (1957) and by Ottenberg et al., (1958).

An additional example of conditioned immune response was presented by Gorezynski at the Neuroimmunomodulation Conference held at the University of Kentucky in 1983 (Melnechuk, 1983). Melnechuk reports that Gorczynski was able to condition mice to respond immunologically to sham skin grafts. The mice were first exposed to skin grafts from unrelated mice. These original graphs served as the unconditioned stimulus since they initiated a rejection process of T-killer cells. During the second phase of the experiment the skin graphs were paired with sham graphs. The sham graphs were then able to cause an increase in immune response.

Another series of experiments linking the CNS and the immune system was initiated by Schneider and Smith (1979) who were joined by Minning (1982) and Whitcher (Schneider, Smith, & Whitcher, 1984) in subsequent investigations. These yet to be published observations have focused on the use of imagery to bring about changes in neutrophil functions in humans.

In one of the early observations (Schneider & Smith, 1979) the subject experienced an exercise condition of ten minutes and a relaxation imagery process focusing on neutrophil activity. Pre and post measures were taken for both conditions and change scores were computed. The exercise period resulted in an increase in count while adherence of the cells remained the same. The relaxation-imagery process produced a drop in blood count and an increase in adherence.

To further test the potential influence of thought processes on neutrophil functions an experiment was initiated where subjects experienced an imagery process and a control session (Minning, 1982). During the imagery process the subjects pictured their neutrophils becoming more active, more adhesive, more numerous, changing shape, sticking to the blood vessel wall and migrating to the surrounding tissue. The statistical data for count and adhesion were signifiant but the adhesion results were opposite of the expected direction.

In subsequent studies (Schneider, et al, 1984) the specific instructions for the imagery process were modified to change the response pattern of the neutrophils. These data have generally supported the hypotheses stated above, but one group did not yield statistically significant changes. Further analysis of the later group of subjects suggested that two of the subjects may not have followed the researcher's instructions and therefore significantly skewed the data.

In general, the researchers were able to show changes in neutrophil activity that correlated with imagery content both for the vividness of the imagery and the directionality of the immune response being imagined.

The Schneider and Smith studies were influenced by the writing of Simonton, Simonton, & Creighton (1978). The Simontons' work used imagery and a number of behavioral interventions with cancer patients who had advanced malignances.

As cited earlier in this paper, one of the functions of the

immune system is the recognition and destruction of mutant cells such as cancer. One of the theories regarding cancer onset suggests that a breakdown in this surveillance function of the immune system allows the cancerous cells to multiple to clinical proportions (Byers & Levin, 1976). This theory has been well supported by a number of animal studies (Amkraut & Solomon, 1972; LaBarba, 1970; and Solomon, 1969). The above notion of cancer etiology was also supported by Riley, Fitzmaurice, and Spackman (1981) who cite the "stress phenomena" as the common denominator in their experiments. They see the increase of plasma corticosterone as the primary agent in depressing immune functions due to its negative influence on various aspects of the immune system including the thymus, spleen, and lymph nodes.

A study by Bartrop, Luckhurst, Lazurus, Kiloh and Penny (1977) suggests that the surveillance model may have some application with humans as well as animals. Bartrop and his associates found that persons who were bereaving the loss of an intimate had depressed T-cell functioning when compared to matched controls. Fox (1981), however, points out that the surveillance theory has been discredited in part. Prehn (1974) is cited by Fox as arguing that the immune system sometimes stimulates cancer growth (e.g. an increase in suppressor cells) and in these situations a stressful experience for the individual with its concurrent immune suppression may be advantagious. Fox draws four conclusions from his review: first, that there is enough data to think that endogenous (defined as: "arising from internal states stemming directly from the influence on or by the psyche" p. 103) psychosocial factors effect the chances of a person getting cancer

but these effects can either be positive or negative; second, the influence of these psychosocial factors are probably fairly small; third, what psychosocial factors that do exist are likely to be specific to certain organ sites but are dependent on many variables for initiation; and fourth, the affects of these factors in contributing to cancer onset is a smaller percentage in humans than in animals.

In summary, it has been believed for many years the Central Nervous System does influence the immune system but until recently it has been difficult to formulate plausable explanations of how the CNS could influence the immune system. The field of psychoneuroimmunology has postulated links to the immune system by way of neuroendocrine pathways that are being delineated by current studies. Evidence has also been presented that demonstrates CNS influence on the immune system through hypnosis, conditioned learning and imagery.

Emotions as a Central Nervous System Influence on Physiology

Having reviewed general physiological consequences of CNS activity and established CNS influences on the Immune System, the following sections will examine emotions as a CNS influence on physiology. Emotions will first be discussed as a physiological patterning and secondly as a specific influence on the immune system.

Emotions and Physiological Patterning

Since the time of Darwin, arguments have been made that emotions have defined physiologic patterns. Darwin suggested that facial

expressions had consistent patterns and were the result of adaptive behavior patterns inherited from lower level animal forms.

James and his contemporary, Lange both believed that emotions were the cortex's experience, or perception, of patterns of visceral activity that the brain had orignially initiated. That is for James and Lange the brain's perception of a patterned visceral activity was the emotion, rather than the viseral activity being considered the result of an emotion (Strongman, 1978).

Cannon also saw emotions as having patterned physiologic character but argued against the sequence of events that James and Lange hypothesized. Cannon saw the body responding to emotions in a broad way defined largely by the autonomic nervous system (ANS) and most specifically the sympathetic arm of the ANS. Cannon labeled the sympathetic nervous system activity as the fight-flight response and its bodily contrast as "housekeeping" (parasympathetic activity). The fight-flight response was characterized by Cannon as including acceleration of the heart, contractions of arterioles, dialation of bronchioles, increase in sweating, increase in adrenaline and inhibition of digestive activities (Bakal, 1979).

Later researchers such as Hess and Selye both confirmed and elaborated Cannon's work. Looking across the work of Cannon, Hess, and Selye the common pathways for visceral expression of emotions appear to include the hypothalmus, pituitary, adrenal, and thymus glands (Knapp, 1983).

The degree to which the above organs respond appears to be dependent on the type of emotion being experienced. Knapp (1983) has

compared the basic emotions postulated by several theorists in a table form (See Table 1).

Recent research has been able to confirm discrete response patterns for some of the specific emotions in Table 1. Thompkins (1962) set forth a position that affects were amplifiers of drives (bodily states and needs) and that affects were primarily expressive in nature. Thompkins believed that "affect is primariy facial behavior." (1962, p. 205)

Knapp (1983) cites the work of Ekman, Friesen, and Ellsworth (1972), Izard (1971) and Demos (1982) as supporting Tomkins's postion that facial patterns do exist for basic affects. Ekman (et al., 1972) has done extensive research, across cultures, using motion pictures to record and analyze the presence of basic emotional patterns in facial expression. Izard (1971) and Demos (1982) have been able to demonstrate similar facial patterns in infants long before the children were able to verbally communicate.

Another method of analyzing facial patterns was employed by Sirota and Schwartz (1982) and also by Schwartz, Brown and Ahern (1980). Both studies utilized electromyographic (EMG) responses of various facial muscles including zygomatic, corrugator, masseter and frontalis, as measures of emotional states.

Sirota and Schwartz (1982) examined the differences in facial activity for feeling states of elation, depression and a neutral condition. The feeling states were initiated using self-referent statements and imagined scenes. Subjects who reported change in mood

Table 1
Basic Emotions: Five Views

Tomkins (1962, 1970)	Shand (1914)	Plutchik (1962, 1980)	Dahl & Stengel (1978)	Knapp 1981)
Excitement		Anticipation		Excitement
Surprise*	Curiosity*	Surprise	Surprise	
Joy	Joy	Joy	Joy	Elation+
		Acceptance	Contentment	Euphoria
			Love	Lust
Anger	Anger	Anger	Anger	Anger
Fear	Fear	Fear	Fear	Fear
			Anxiety	
Distress+	Sorrow	Sorrow	Depression+	Sorrow
Disgust	Disgust	Disgust		Disgust
Shame				Shame
Contempt				
				Torpor

*Solid underlining for identity of terms
+Dotted underlining for near identity of terms

also had changes in facial muscles. Feelings of elation resulted in increased zygomatic activity while depression caused increases in corrugator activity.

The study by Schwartz (et al., 1980) also used an imagery technique to elicit feelings of happiness, sadness, anger and fear rather than the more general mood states of the Sirota and Schwartz (1982) study. Schwartz (et al., 1980) were able not only to show physiologic response to the feeling states but were also able to distinguish men from women on several measures. Women showed greater EMG arousal during imagery, reported stronger subjective experience of emotions and had higher within-subject correlations between subjective experience of emotions and facial EMG levels.

In addition to the above studies that have used facial activity as a dependent measure, there have also been studies that have distinguished basic feeling on the basis of viseral response. Schwartz (et al., 1981) discusses the work of Ax (1953), and Schachter (1957) who were able to demonstrate different physiological patterns for fear and anger.

Ax placed subjects in settings where they thought they may experience harm (fear) or where they were exposed to abusive interactions (anger) and then measured fourteen different physiological indices including cardiovascular activity. Ax found differential patterns between fear and anger on seven of the fourteen measures he used.

Similarly, Schachter (1957) was able to distinguish fear and anger when he studied physiologic responses of hypertensives and

normotensives. When looked at together the studies suggested that fear is more mediated by epinephrine and anger is more influenced by norepinephrine. Thus the heart rate and systolic blood pressure increase in a similar manner for both anger and fear but the diastolic pressure increases more during anger. Fear tends to increase peripheral dialation of arteries while anger produces more of a vasoconstriction in muscle groups.

Schwartz (et. al., 1981) extended the work on emotions and cardiovascular response when he studied the effects of happiness, sadness, anger and fear following imagery and exercise. In this study Schwartz and his colleagues again used mental imagery to induce feelings but looked at those feelings both while the subject was in a sitting position and while the subject was physically active. Dependent measures for the study included systolic and diastolic blood pressure and heart rate. Anger showed the most distinct increase in cardiovascular activity and was the slowest to recover baseline systolic pressure after exercise. The heart rate and systolic blood pressure for sadness was virtually the same for the resting condition and the active condition. Sadness appeared to negate the typical cardiovascular responses associated with exercise.

Emotions and the Immune System

There has been a very limited number of studies done to date investigating the effect of specific feeling states on the immune system. A few recent studies have focused on the emotional states of bereavement and also on depression.

Bartrop and his colleagues (1977) have shown depressed T-cell functioning in persons bereaving the loss of someone they were close to emotionally. Linn (et al., 1982) also studied people experiencing bereavement but additionally assessed their levels of depression. When divided into high and low depression groups the more highly depressed group showed lessened immune response both to in-vivo (delayed hypersensitivity tests) and in vitro (lymphocyte response to phytohemagglutinin). A third study by Kronfol (et al., 1982) compared the in vitro lymphocytic response of melancholic psychiatric patients, non-melancholic psychiatric controls, and normal controls. The melancholic group showed a marked decrease in lymphocytic response in comparison to both control groups.

The present study represents the first effort to examine the influence of specific feelings on the immune system.

Imagery and Emotional Arousal

Mental imagery was chosen for this study as a method to induce feelings. The following review supports the use of imagery as an effective means to elicit emotions and their physiologic manifestations.

Holt in his 1964 article, "Imagery: The Return of the Ostracized", defined image as a "generic term for all conscious subjective presentations of a quasi - sensory but nonperceptual character" (p. 255). Later in the same article Holt (1964) describes the striking manifestation of mental images found by Penfield and Jasper (1954):

> In the course of attempts to find and cut out the pathological focus of temporal-lobe epilepsies, Penfield (Penfield & Jasper, 1954) developed a technique of opening the skull under local anesthesia and then stimulating the exposed cortex by electrodes. One such patient exclaimed, "I just heard one of my children speaking. She added that. . . she could hear the neighborhood noises as well. . . She was asked whether it seemed to be a memory and she replied, "Oh no, it seemed more real than that." She thought she was looking into the yard and saw as well as heard the boy (p. 137).

After regularly encountering this kind of thing with scores of patients, Penfield and Jasper concluded:

> There are in the temporal cortex innumerable neurone patterns which constitute records of memory. The electrode causes the patient to have a psychical experience, like the memory of some past event, and he can describe it as he lies upon the operating table. The hullucination thus produced may be auditory or visual, or both, but is neither a single sound nor a frozen picture. . .such hullucinations, or memories or dreams continue to unfold slowly while the electrode is held in place. They are terminated suddenly when the electrode is withdrawn. This is a startling discovery. It brings psychical phenomena into the field of physiology. It should have profound significance also in the field of psychology provided we can interpret the facts properly (p. 259).

As Penfield and Jasper have suggested the use of imagery has had profound significance on psychology. Lang (1978) and Lang, Kozak, Miller, Levin, McLean (1980), for instance, have used various mental imagery instructions to gain changes in physiological parameters that are associated with emotional reactions. In fact, Lang argues in his bio-informational theory of emotional imagery that a mental image is ". . .a conceptual network, controlling somatovisceral patterns and constituting a prototype for overt behavioral expression." (p. 495).

Numerous studies have illustrated Lang's notion that mental images have physiologic manifestations. Sheikh and Jordan (1983) cite the

following examples of imagery elliciting general physiologic change. Simpson and Paivio (1966) noted changes in pupil dialation with imagery; May and Johnson (1973) demonstrated changes in heart rate with images intended to create arousal; Yaremko and Butler (1975) showed parallel physiologic response between the actual experience of a shock or a tone and the imaging of the same events.

While the examples just cited are general physiologic consequences of imagery that was not specifically emotional in content, Sheikh and Jordan (1983) go on to point out that images are usually accompanied by emotional responses (Klinger, 1980) and articles by Rheyer and Smeltzer (1968), Shapiro (1970) and Sheikh and Panagiotou (1975) are also cited to support the notion that imagery can uncover, ellaborate or generate very intense emotional reactions.

Thus it is argued that imagery can cause physiologic consequences that are consistent with the content of the image, including emotions. Schwartz (1979, 1980a, 1980b, 1981) as already stated, has used mental imagery as a method to induce feeling states such as happiness, sadness, anger and fear. He has verified Lang's notion regarding emotional imagery by showing differential physical responses to the above feeling states on measures of heart rate, blood pressure and EMG facial readings.

Weerts and Roberts (1976) also used imagery as a means to replicate the work of Ax (1953) and were able to show distinct physiologic patterns for anger and fear.

In summary, imagery has been shown to be an effective method for

influencing many physiologic parameters. It has also been shown that imagery with emotional content results in physiologic change and further that imagery of specific feeling states can result in differential physiologic patterns. It is likely that persons may vary in their ability to image, but there is no current evidence to suggest that the physiologic response patterns that do occur are significantly different than what would occur in actual experience (Schwartz et al., 1981).

CHAPTER III

RESEARCH DESIGN AND PROCEDURES

Subjects

The sample for the study was drawn from a population of healthy Caucasian men and women who have had some type of acting experience or who said they were comfortable experiencing strong emotional states in an unfamiliar setting and in the presence of an observer. Further, the subjects were willing to follow the measurement procedures for the study which included giving saliva samples and submitting to standard venipuncture procedures for drawing blood samples. Although the subjects did not have to be totally comfortable with these procedures, anyone who found these processes distasteful or quite anxiety provoking was excluded from the study. Three persons, who had stated initial interest in the study, decided not to participate in the experiment after they were given a more detailed explanation of the commitments involved with participation in the study.

The eighteen subjects (nine men and nine women) were paid volunteers with an age range from 19 years old to 45 years of age, with a mean age of 24 years (See Table 2). Subjects were recruited from acting classes at Michigan State Univesity, community theatre groups of Lansing, Michigan, and two subjects from a graduate class in loss and grief at Michigan State University. Eleven subjects were students, one

Table 2
Demographic Information

Sex	Age	Education	Occupation
M*	19	College Sophomore	Student
M	20	College Sophomore	Student
M	20	College Sophomore	Student
M	21	College Junior	Student/Salesman
M	21	College Junior	Student
M	21	2 years college	Waiter/Actor
M	25	3 years college	General Manager
M	26	Master's degree	Bookkeeper/Actor
M	35	High school	Actor/mortgage
F	18	College Freshman	Student
F	19	College Sophomore	Waitress/Student
F	22	College Junior	Student
F	25	Bachelor of Arts	Student/Actress
F	26	Associates Degree	Waitress
F	30	College Senior	Student/Secretary
F	31	Ph.D. Candidate	Student/Administration
F	34	Bachelor of Science	Student/Waitress
F	45	Doctor of Philosophy	Psychologist

*M = Male
F = Female

subject was a psychologist, and the remaining subjects listed their occupation as acting but retained other jobs to support themselves financially.

The study included both men and women since various studies have suggested gender differences in how people experience imagery. These differences include stronger reported affective responses, greater changes in facial-EMG readings (Schwartz et al., 1980), and greater lateralization of facial muscle activity for "negative" than for "positive" emotions (Schwarts et al., 1979) for women. Frankenhauser (1975) reports sex differences in the excretion to catecholamines which may in turn influence the immune system's responsivity (McClelland et al., 1980, Rogers et al., 1979). While normative data regarding baseline readings for various immunological measures is limited, at least one study (Grudbacher, 1974) reported females having 20% more IgA than males and blacks having more IgA than whites. Sex was therefore used as an independent variable to clarify its gender influences on immune system responsivity. Race was not included as an independent variable due to resource limitations.

Age was also considered an important factor in the selection of subjects. Rogers (et al., 1979) cites studies that show considerable change in immunologic systems in the very young and the elderly. Although there continues to be changes in the immune system from twenties through middle age, these changes are less dramatic than those found in childhood or the changes found with senior citizens. Therefore no subjects were recruited from life stages such as puberty or menopause that have very distinct hormonal activity.

Subjects who volunteered to participate were interviewed using the attached "Demographic and Background Information" form (see Appendix B). This interview was used as a screening process to exclude those individuals whose interpersonal stress, physical illness, or ingestion of chemical substances may have affected their immune system and, therefore, may have confounded the experimental results.

The Beck Depression Inventory (Beck & Beamesderfer, 1974) (See Appendix D) and the Life Experiences Survey (See Appendix E) by Sarason, Johnson and Siegel (1978) were also used as screening devices. A description of the Beck Depression Inventory and the Life Experiences Inventory is given in the Measures section of this chapter. If a subject had significantly high scores on either of these instruments she/he was excluded from the study.

Beck and Beamesderfer (1974) have suggested a rating system for the clinical use of the Beck Depression Inventory (BDI):

0 - 4 No depression

5 - 7 Mild depression

8 - 15 Moderate depression

16+ Severe depression

Anyone scoring more than eight on the BDI was excluded from the study.

Negative change score for the Life Experiences Survey (LES) were also used as a screening device. Anyone whose negative change score was one and one-half standard deviations from the appropriate mean for their sex (Sarason et al., 1978) was excluded from the study.

These criteria were used since both depression and a high level of stress (as measured by the Life Experiences Inventory) may

significantly alter baseline physiology of the indivdiaul (Bartrop et al., 1977; Cohen, 1979). Additionally, screening persons who were quite depressed eliminated the possibility of exacerbating the depressed mood through experiencing the various feeling states during the study.

Subjects were limited to individuals with acting experience, or those who said they were comfortable generating affective states, because it was assumed they were less inhibited in experiencing their feelings. While this did create a sample bias, it seemed most important for the study to demonstrate that a relationship might exist between affective states and immune function rather than seeking broad generalizability.

One person was dropped from the study because of involvement in a detoxification program for alchohol abuse. The subject had not reported this problem during the pretreatment interview. The subject was dropped after two sessions. Since the next female subject had not been started in her treatment sequence she was assigned the same treatment order as the lost subject thereby retaining the original random assignment order.

In summary, all eighteen subjects were recruited from theatre groups or university classes. The subjects stated that they were comfortable experiencing emotions intensely and were willing to follow the study procedures. Subjects were screened for age, life events, emotional states, and daily habits that could influence immune responsivity. The recruitment process and preparation of subjects for participation in the study is elaborated in the following procedure

section.

Procedures

Daily variations in white blood cell activity and secretory IgA levels were controlled for by taking samples at the same time of day for all subjects. Seasonal variations in white blood cell activity and secretory IgA levels were controlled for by having the experimental conditions for each individual subject performed in as short a time as was practical. The time period for the study was from April through July 1983. Given the laboratory resources available, scheduling conflicts and illness of subjects there was some variance in the time required to complete an individual sequence of treatments. Table 3 lists the period of time to complete the experiment for each subject. Seventeen weeks was the longest period of time for a subject to complete the experimental conditions. The shortest period of time for a subject was three weeks and the average length of involvement was seven and a half weeks.

The recruitment process for subjects was partially described in the Subjects section of this chapter and is outlined in Table 4. Prior to obtaining the Demographic and Background Information, the purposes and procedures of the study were reviewed with the subject. The subject was shown the inventories for the study, the Consent Form (see Appendix C) was reviewed, and the subject was given an opportunity to ask questions. After the consent form had been signed, the investigator interviewed the subject using the Demographic and Background Information Form. The subject filled out the Beck

Table 3
Length of Time For Individual Subjects
to Complete the Survey

Men		Women	
Subject #	Weeks	Subject #	Weeks
1	8	1	17
2	12	2	7
3	7	3	6
4	8	4	4
5	6	5	6
6	9	6	8
7	15	7	4
8	6	8	3
9	4	9	3
Average Time	8	Average Time	6
Longest Time	15	Longest Time	17
Shortest Time	4	Shortest Time	3

Average Length of Time for all subjects: 7 Weeks

Table 4
Recruitment Process

Announcement of the study at theatre groups and university class.
Individual appointments with volunteers.
Review of the purpose of the study and the commitments expected from the volunteers.
Opportunity for questions from the volunteer.
Signing of the consent form.
Demographic and background interview.
Subject completed the Beck Depression Inventory and the Life Experiences Survey.
Discussion of the procedures for the first session of the study.
Development of the imagery hierarchy.

Depression Inventory and the Life Experiences Survey at his/her own pace.

After the subject completed the consent form, demographic data and screening inventories, the specific procedures for the next session were discussed. The subject was asked to develop a hierarchy of emotional scenes (real or invented) for happiness, sadness, and anger feeling states. The angry feeling state was never used directly in the treatment sessions but was presented as a possible feeling to be imaged. It was hoped that always having two possible feeling states for a given session would preclude the subject starting to experience a given feeling state before the session had actually started.

The subject was also asked to place his/her scenes in an order from those that mildly evoked the given feeling to those that very

strongly elicted that feeling. It was emphasized that the subject could keep the content of her/his images private so she/he could feel free to use whatever images that were most helpful in evoking the feeling. The subject was told not to be concerned about sharing this material unless she/he so chose.

The subject was encouraged to write down notes that might help visualize the scenes in detail and with as much clarity as possible. The subject was asked to be especially mindful of body posture, actions and sensations. The scenes were to be used as a vehicle to experience the specific feeling as fully as possible, therefore, the hierarchy did not have to be used in a rigid manner but rather as an aid in heightening the given feeling.

Each subject in the study went through five separate conditions (See Figure 1): a Neutral session in which she/he sat quietly for twenty minutes (Neutral Condition); an emotional imagery state of happiness (Indirect Condition); an emotional imagery state of sadness (Indirect Condition); a neutrophil/IgA imagery of happiness (Direct Condition); a neutrophil/IgA imagery of sadness (Direct Condition). The first three conditions listed above were presented in a random order during consecutive sessions at approximately weekly intervals. After the first three conditions, the subjects participated in an education experience (described later in this study)and then the remaining two conditions were presented in random order during the following weeks.

Groups	Order of Treatment (Indirect)	Order of Treatment (Direct)	Neutral	Indirect Happy	Indirect Sad	Direct Happy	Direct Sad
MALE	SNH*	HS	3	3	3	2	2
		SH				1	1
	NHS	HS	3	3	3	1	1
		SH				2	2
	HSN	HS	3	3	3	1	1
		SH				2	2
FEMALE	SNH	HS	3	3	3	2	2
		SH				1	1
	NSH	HS	3	3	3	1	1
		SH				2	2
	HSN	HS	3	3	3	1	1
		SH				2	2

*S = Sad
N = Neutral
H = Happy

Figure 1. Design Graph

Table 5
Procedures for Individual Sessions

Reviewing with the subject the procedures for the session.
Samples of blood and saliva were submitted.
Relaxation-focusing instructions were read.
Twenty minutes of imagery.
Second set of blood and saliva samples were submitted.
Debriefing of the session with the subject.

education experience (described later in this study) and then the remaining two conditions were presented in random order during the following weeks.

Each individual session followed the same basic format: introduction, samples of blood and saliva were taken, relaxation-focusing instructions, imagery period, second set of samples taken, and debriefing (See Table 5).

When the subject arrived for the session she/he was seated in a comfortable chair with the observer to her/his side, out of the subject's line of sight. The procedures for the session were reviewed including the fact that the material used in the imagery could remain private. The subject was informed that after the imagery she/he would be asked to rate the vividness of the imagery (on a scale of 1-10) and how strongly he/she felt the given emotion (on a scale of 1-10). The subject would be asked if there were any things that seemed to help intensify the feeling state. The subject was then told she/he would be given an opportunity to talk with the investigator about her/his

experience of the session if she/he so chose. The inquiry about the subject's imagery process was used to provide anecdotal data regarding the subjects' involvement with the process, to encourage full participation in the exercise, and to provide data for designing future research.

After the above introduction the first set of blood and saliva samples were taken. The subject was given the following relaxation-focusing instructions:

> Close your eyes and take a few moments to let your body relax. It may help you to start at your feet, move up through your body visualizing each part of your body feeling comfortable (pause). Also let your mind relax by putting aside your everyday concerns for a few minutes and just focusing your attention on the activities here.
>
> In a moment I want you to begin experiencing (appropriate feeling for that session). You do not have to follow a rigid method. The goal is simply to experience _____ as fully as possible by the end of twenty minutes in whatever manner works best for you. You may want to begin with scenes or experiences that mildly evoke the feeling of _____ and move to stronger images of _____ or at times you may just focus on the feeling of _____ itself. Whatever approach or combination of methods you use let yourself go - get into the feeling of _____ as completely as you can. Be especially aware of the bodily sensations that add to your experience of _____.
>
> Now I want you to begin feeling _____. I will remain in the room to let you know when each 5 minute period of time has past and to encourage you from time to time to remain focused on feeling _____.

At the end of twenty minutes the second set of samples were taken. The debriefing period followed, including the subjects rating of the session and an opportunity to talk about the experience as a whole.

Each individual session followed the format described above. The time period between sessions varied according to the subject's personal

schedule and the availability of the laboratory resources to assess the blood measures. After the subject completed three individual sessions (Neutral, Indirect Happy, Indirect Sad) the dependent variables were described to the subject. The methods for assessing the dependent measures were described in a similar, but less detailed, manner as is found in the Measures section of this chapter. The general body functions of neutrophils and secretory IgA were explained. The subjects were told about the structure of the neutrophils, the development of neutrophils from bone marrow, and how the cells function. The neutrophil functions described included adhesion, chemotaxis, and phagocytosis. The salivary structures of the mouth were described and IgA was presented as a product of immunologic cells that surround the saliva ducts. The activities of the neutrophil cells and IgA were described in a neutral manner so that the various functions were known only as possible changes, but were not labeled as good, bad, healthy, unhealthy, etc..

The neutrophil imagery sessions followed the same format as the feeling state imagery except the relaxation - focusing instructions read such that the subject's neutrophils and IgA cells felt the appropriate emotion:

> Close your eyes and take a few moments to let your body relax. It may help you to start at your feet, move up through your body visualizing each part of your body feeling comfortable (pause). Also let your mind relax by putting aside your everyday concerns for a few minutes and just focusing your attention on the activities here.
>
> In a moment I want you to begin experiencing your neutrophil and IgA feeling (<u>appropriate feeling for that session</u>). You do not have to follow a rigid method. The goal is simply to have your cells experience _____ as fully as possible by the end of twenty minutes in

whatever manner works best for you. You may want to begin with scenes or experiences that mildly evoke the feeling of _____ and move to stronger images of _____ or at times you may just focus on the feeling of _____ itself. Whatever approach or combination of methods you use let yourself go - let your neutrophil and IgA feel as _____ as you can. Be especially aware of the bodily sensations that add to your Neutrophil and IgA experiencing _____.

Now I want you to begin having your neutrophils and IgA feel _____. I will remain in the room to let you know when each 5 minute period of time has past and to encourage you from time to time to remain focused on having your neutrophils and IgA feel _____.

Additionally, the debriefing process was expanded. The subject was asked to draw a representation of the images that were used and a recording was made while the subject described as much of the imagery process as she/he was comfortable sharing. The remaining aspects of the debriefing were the same as in the indirect treatment conditions. The drawings and recordings were gathered both to encourage subject participation and to be used for designing future research.

One male subject was asked to repeat his last treatment session because he began feeling ill during the session and his premeasure for white blood count was very high relative to his other premeasures and in comparison to the group premeasures. The high blood count verified the subject's own sense of growing ill and was therefore considered an inappropriate measure of immune responsivity.

Measures

The measures for this study included neutrophil function, secretory IgA levels in saliva and psychological screening measures.

Neutrophil Function Measures

A general description of the blood neutrophil measures for this study was taken from Minning (1982) and the specific procedures are stated in direct quotations from studies by Smith, Hollers, Patrick and Hassett (1979) and Smith and Hollers (1980).

Blood samples of approximately 10-15 centimeters (cc) were taken from the subjects on five separate days and processed in the following manner (Minning, 1982):

> Ten milimeters (ml) were anticoagulated with heparin, two ml were anticoagulated with EDTA and three ml were allowed to clot in a glass tube. A portion of the serum was stored at -70°C for possible future use. Three neutrophil measures were observed: white blood cell count (WBC), adherence (Ad), and shape change (SC).

White Blood Cell Count

> White blood cells are produced in the bone marrow and are found circulating in the blood stream (circulating pool) or attached to the blood vessel walls (marginal pool). Under ordinary circumstances, approximately 50 percent are circulating and 50 percent are marginal. Changes in white blood cell count are caused by cells shifting from the circulating to the marginal pool and vice versa. Only those cells that are circulating are measured by venipuncture.
>
> A 25 microlitre sample of blood was diluted in white blood cell diluting fluid. The white blood cells were then counted on a Coulter counter. They were counted in triplicate to account for variability. The number of cells were multiplied by 1000 which gives the number of white blood cells per milimeter of blood.

Adherence

> Adherence was determined by the ability of cells to stick to protein-coated surfaces. After the neutrophils were isolated, they were injected into a glass chamber and allowed to settle for 500 seconds. The apparatus for measuring adherence is two gaskets and two cover glasses. The chamber is filled with Hanks balanced salt solution

(which contains all salts necessary for cell function and approaches a balanced physiologic condition), and the cells are injected into the chamber. Gravity causes the cells to settle. The chamber is flipped over. After 500 seconds, some cells detach, and some cells stick to the upper glass cover. Percent unstimulated adherence represents the percent of isolated neutrophils that remain attached to the glass cover.

$$\frac{\text{adherent}}{\text{total}} \times 100 = \text{percent adherence}$$

Minning (1982) goes on to describe the measurement process for stimulated adherence which is the same as the general adherence test but introduces a known stimulator of neutrophil cells.

Stimulated Adherence

The same procedure was repeated for neutrophils that were stimulated by f-Met-Phe (fMP), a synthetic substance and a chemotactic factor produced by Sigma Chemcial Company. F-M-P, which binds to a fairly specific receptor site on the cell, activates shape change and adherence in the cell. If neutrophils are dysfunctional, their percent adherence will not increase when treated with fMp. Percent stimulated adherence represents the percent of neutrophils treated with fMP that remain attached to the glass cover.

The specific procedures for blood neutrophil measurement are described in the following quotations (Smith, et al., 1979; Smith & Hollers 1980):

Isolation of human neutrophils. Leukocyte-rich plasma was prepared by dextran sedimentation of erythrocytes. The leukocytes were washed one time in Hanks' balanced salt solution (HBSS) to remove the plasma and then separated by centrifugation on Ficoll (Pharmacia Fine Chemicals Inc., Piscataway, N.J.)-Hypaque (Winthrop Laboratories, New York) cushions (8). The leukocytes used in the following experiments were > 98% granulocytes, of which $\cong$ 95% were neutrophils. No platelets were seen in the preparations, and the erythrocyte (RBC) to peripheral blood neutrophils (PMN) ratio was consistently < 2:1. The PNM viability was > 98% as determined by eosin exclusion.

> The PMN were resuspended at 10^7/ml in HBSS and immediately placed at 4^oC. PMN to be evaluated by the techniques described below were drawn from this pool for up to 5 h. No change attributable to incubation at 4^oC for 5 h could be detected in any of the parameters of PMN behavior tested. (Smith, et al. 1979)
>
> Assessment of neutrophil adhesiveness. Culture chambers were constructed using gaskets for Sykes-Moore chambers and two 25-mm round coverglasses. These were clamped together between two specially milled brass plates. The plates contained injection ports and did not interfere with examinations of either coverglass under oil-immersion phase-contrast microscopy. (Smith & Hollers, 1980)
>
> This allowed observations of cells settling onto the glass surface. Between 350 and 500 s after injecting cells into the chamber, cell counts were made in five randomly selected x 50 fields, and the cells were classified as rounded (spherical) or motile (bipolar shape). The chambers were then inverted for 400's. The number of cells remaining attached to the glass were assessed by counting five x 50 fields.

In this study four indexes of neutrophil activity were measured: the white blood cell count, the percentage of the white blood cells that were neutrophils, neutrophil adhesiveness, and stimulated neutrophil adhesiveness. The shape change measure mentioned in the quotation of Minning (1980) was not used.

Percentage of Neutrophils

The percentage of white blood cells that were neutrophils was determined by examining dried blood smears under a standard microscope. The smears had been treated with Wright's stain so that the various cells could be distinguished. Two separate counts were done for each measurement choosing random areas of the slides. Cells were counted differentially (neutrophil verses all other white blood cells) until a total of fifty cells were counted and then a second count to fifty was

done. The two counts were combined and the total number of neutrophil cells were then considered a representative percentage.

Neutrophils were chosen as a dependent measure in this study for three reasons: first, they are very responsive cells that have been shown to react to stress (Smith, 1979) and imaging processes (Schneider & Smith, 1979; Minning 1982; Schneider, et al., 1984); secondly, neutrophils have a major role in fighting bacteria that can lead to disease states (Smith, et al., 1972); and thirdly, the measurement procedures described above have been shown to be highly reliable through repeated samplings (Smith & Hollers, 1979; Smith et al., 1980).

Secretory IgA Measure

The method for measuring secretory IgA levels in the saliva samples was similar to that used by McClelland (1980):

> The saliva was frozen until it could be assayed for IgA using the single radial immunodiffusion method. Thawed saliva specimens were deposited in 5 u cylindrical wells cut in an agar plate impregnated with monospecific goal antihuman IgA. As the saliva diffuses in the agar over a 24-hour period, the antiserum forms a disc-shapped immune precipitate with the IgA protein for which it is specific, while other proteins diffuse freely. The diameter of the precipitin ring thus formed is proportional to the concentration of IgA in the sample. Concentration values for unknowns are read from a standard curve of precipitin ring diameters vs. known reference concentrations of human serum IgA plotted on semilogarithmic paper. Each agar plate used is checked for possible deterioriation with a reference concentration of IgA. The technique used has been described by Mancini, Carbonara and Heremans,(20) modified by Fahey and McKelvey, (21) and made available commerically as the Dade Dataplate immunodiffusion system for quantitation of low levels of serum IgA.

The same measurement method as described above was used in this study but the test plates were acquired from Helena Laboratories.

The immunoglobulin A level in saliva was chosen as a dependent measure for several reasons. IgA in mucous areas protects the individual from pathogenic implantation and can eliminate the pathogen even if it has successfully entered the mucosa (Tomasi, 1976). These protective functions have been shown both retrospectively (Rossen, et al., 1979) and prospectively (Yodat & Silvian, 1977) to be influential in preventing viral infections. Secondly, secretory IgA represents another measure of immune responsivity that is quite independent of neutrophil function and the sampling procedure is simple and unobtrusive. Finally, the reliability of the measure is well documented (Mancini et al.,1965; Fahey & McKelvey, 1965).

Psychological Screening Measures

The two psychological screening measures for this study were the Beck Depression Inventory (BDI) and the Life Experiences Survey (LES).

The BDI is a self report instrument that examines physical, motivational, cognitive and emotional aspects of depression. The individual was asked to respond to twenty one items according to how that person had "been feeling the past week, including today!" (see Appendix D).

The BDI was chosen for this study because it is a relatively short inventory; is widely used both clinically and in research; and has been shown to be both reliable and valid. In one study, split-half reliability coefficient for depressed subjects was .86 and correlations with clinicians' ratings of depth of depression were .65 (Beck & Beamesderfer, 1974). The BDI was also found to correlate with the

Depression Scale of the Minnesota Multiphasic Personality Inventory (.75 initial and .69 final) (Nussbaum & Michaux, 1963).

As mentioned previously, Beck and Beamesderfer (1974) have developed a clinical rating system that ranges from no depression (0-4) to severe depression (16 or more). For the purposes of this study anyone with a score of eight or more was excluded from the study.

The second screening instrument used in the study was the LES. The LES is a 57-item self report inventory of life events. The LES lists events such as marriage, change in sleep habits, new job etc. (see Appendix E) and asks the individual to rate the impact of each event at the time the event occurred. Events can be rated positively, negatively, or no impact. The ratings yield positive, negative and total change scores.

Sarason (et al., 1978) reports test-retest reliability of .88 for the negative change score. The negative change scores were also shown to correlate with: trait anxiety .29 state anxiety .46 the BDI .24 and the locus of control scale .32. No consistent correlations were found for either positive change scores or total change scores.

The LES was chosen for this study because it has, in part, addressed prior criticisms of life change scales. By allowing both positive and negative assessment of life change it considers the individual's perception of the events as a variable. Since the negative change score has been shown to be both reliable and correlated to stress related dependent measures it was used as the screening scale for this study. Any subject whose negative change score fell one and one-half standard deviations from the mean, was excluded from this study.

Hypotheses

The primary purpose of the study was to investigate the Central Nervous System influence on the immune system in the form of happy and sad feelings as experienced through mental imagery states. In the first set of Treatment Conditions the Indirect influence of the feeling states on the immune system was examined by having the subjects be naive regarding the bodily systems being monitored. During the second set of Treatment Conditions a Direct Influence was measured by having the subjects visualize neutrophil cells and IgA of the immune system being "happy" and "sad". It was also of interest whether the immune systems of men and women responded differently to the feeling states.

Five hypotheses were formed to address the above research questions. Hypothesis I through IV were in the form of planned comparisons of means, specifically: Hypothesis I compares the Neutral Condition against all Other Treatment Conditions; Hypothesis II predicts that there will be a difference between the Happy Conditions and the Sad Conditions; Hypothesis III predicts differences between the Indirect Conditions and the Direct Conditions; and Hypothesis IV tests for the interaction between the Indirect/Direct Conditions and the Happy/Sad Conditions. Hypothesis V examines the issue of gender difference in response to the Treatment Conditions.

Hypothesis I:

The mean difference score for the Neutral Condition will be different than the average mean difference score for the other four Conditions (Indirect Happy, Indirect Sad, Direct Happy, and Direct Sad).

Specifically:

Hypothesis I (a): The mean difference score for the Neutral Condition for White Blood Cell Count will be different than the average mean difference score for the other four Conditions (Indirect Happy, Indirect Sad, Direct Happy, and Direct Sad) for White Blood Cell Count.

Hypothesis I (b): The mean difference score for the Neutral Condition for Neutrophil Percentage in the White Blood Cell Count will be different than the average mean difference score for the other four Conditions (Indirect Happy, Indirect Sad, Direct Happy, and Direct Sad) for Neutrophil Percentage in the White Blood Cell Count.

Hypothesis I (c): The mean difference score for the Neutral Condition for Unstimulated Neutrophil Adhesion will be different than the average mean difference score for the other four Conditions (Indirect Happy, Indirect Sad, Direct Happy, and Direct Sad) for Unstimulated Neutrophil Adhesion.

Hypothesis I (d): The mean difference score for the Neutral Condition for Stimulated Neutrophil Adhesion will be different than the average mean difference score for the other four Conditions (Indirect Happy, Indirect Sad, Direct Happy, and Direct Sad) for Stimulated Neutrophil Adhesion.

Hypothesis I (e): The mean difference score for the Neutral Condition for Secretory IgA will be different than the average mean difference score for the other four Conditions (Indirect Happy, Indirect Sad, Direct Happy, and Direct Sad) for Secretory IgA.

Hypothesis II:

The average mean difference score for the Happiness Imagery Conditions (Indirect and Direct) will be different than the average mean difference score for the Sadness Imagery Conditions (Indirect and Direct).

Specifically:

Hypothesis II (a): The average mean difference score for the Happiness Imagery Conditions (Indirect and Direct) for White Blood Cell Count will be different than the average mean difference score for Sadness Imagery Conditions (Indirect and Direct) for White Blood Cell Count.

Hypothesis II (b): The average mean difference score for the Happiness Imagery Conditions (Indirect and Direct) for Neutrophil Percentage in the White Blood Cell Count will be different than the average mean difference score for Sadness Imagery Conditions (Indirect and Direct) for Neutrophil Percentage in the White Blood Cell Count.

Hypothesis II (c): The average mean difference score for the Happiness Imagery Conditions (Indirect and Direct) for Unstimulated Neutrophil Adhesion will be different than the average mean difference score for Sadness Imagery Conditions (Indirect and Direct) for Unstimulated Neutrophil Adhesion.

Hypothesis II (d): The average mean difference score for the Happiness Imagery Conditions (Indirect and Direct) for Stimulated Neutrophil Adhesion will be different than the average mean difference score for Sadness Imagery Conditions (Indirect and Direct) for Stimulated Neutrophil Adhesion.

Hypothesis II (e): The average mean difference score for the Happiness Imagery Conditions (Indirect and Direct) for Secretory IgA will be different than the average mean difference score for Sadness Imagery Conditions (Indirect and Direct) for Secretory IgA.

Hypothesis III:

The average mean difference score for the Indirect Conditions (Happiness and Sadness) will be different than the average mean difference score for the Direct Conditions (Happiness and Sadness).

Specifically:

Hypothesis III (a): The average mean difference score for the Indirect Conditions (Happiness and Sadness) for White Blood Cell Count will be different than the average mean difference score for the Direct Conditions (Happiness and Sadness) for White Blood Cell Count.

Hypothesis III (b): The average mean difference score for the Indirect Conditions (Happiness and Sadness) for Neutrophil Percentage in the White Blood Cell Count will be

different than the average mean difference score for the Direct Conditions (Happiness and Sadness) for Neutrophil Percentage in the White Blood Cell Count.

Hypothesis III (c): The average mean difference score for the Indirect Conditions (Happiness and Sadness) for Unstimulated Neutrophil Adhesion will be different than the average mean difference score for the Direct Conditions (Happiness and Sadness) for Unstimulated Neutrophil Adhesion.

Hypothesis III (d): The average mean difference score for the Indirect Conditions (Happiness and Sadness) for Stimulated Neutrophil Adhesion will be different than the average mean difference score for the Direct Conditions (Happiness and Sadness) for Stimulated Neutrophil Adhesion.

Hypothesis III (e): The average mean difference score for the Indirect Conditions (Happiness and Sadness) for Secretory IgA will be different than the average mean difference score for the Direct Conditions (Happiness and Sadness) for Secretory IgA.

Hypothesis IV:

The average mean difference score for the Indirect Happy Condition and the Direct Sad Condition will be different than the average mean difference score for the Indirect Sad Condition and the Direct Happy Condition.

Specifically:

Hypothesis IV (a): The average mean difference score for the Indirect Happy Condition and the Direct Sad Condition for White Blood Cell Count will be different than the average mean difference score for the Indirect Sad Condition and the Direct Happy Condition for White Blood Cell Count.

Hypothesis IV (b): The average mean difference score for the Indirect Happy Condition and the Direct Sad Condition for Neutrophil Percentage in the White Blood Cell Count will be different than the average mean difference score for the Indirect Sad Condition and the Direct Happy Condition for Neutrophil Percentage in the White Blood Cell Count.

Hypothesis IV (c): The average mean difference score for the Indirect Happy Condition and the Direct Sad Condition for Unstimulated Neutrophil Adhesion will be different than the average mean difference score for the Indirect Sad

Condition and the Direct Happy Condition for Unstimulated Neutrophil Adhesion.

Hypothesis IV (d): The average mean difference score for the Indirect Happy Condition and the Direct Sad Condition for Stimulated Neutrophil Adhesion will be different than the average mean difference score for the Indirect Sad Condition and the Direct Happy Condition for Stimulated Neutrophil Adhesion.

Hypothesis IV (e): The average mean difference score for the Indirect Happy Condition and the Direct Sad Condition for Secretory IgA will be different than the average mean difference score for the Indirect Sad Condition and the Direct Happy Condition for Secretory IgA.

Hypothesis V:

The average mean difference score for men for the five Treatment Conditions will be different than the average mean difference score for women for the five Treatment Conditions.

Specifically:

Hypothesis V (a): The average mean difference score for men for the five Treatment Conditions for the White Blood Cell Count will be different than the average mean difference score for women for the five Treatment Conditions for the White Blood Cell Count.

Hypothesis V (b): The average mean difference score for men for the five Treatment Conditions for the Neutrophil Percentage in the White Blood Cell Count will be different than the average mean difference score for women for the five Treatment Conditions for the Neutrophil Percentage in the White Blood Cell Count.

Hypothesis V (c): The average mean difference score for men for the five Treatment Conditions for the Stimulated Neutrophil Adhesion will be different than the average mean difference score for women for the five Treatment Conditions for the Stimulated Neutrophil Adhesion.

Hypothesis V (d): The average mean difference score for men for the five Treatment Conditions for the Stimulated Neutrophil Adhesion will be different than the average mean difference score for women for the five Treatment Conditions for the Stimulated Neutrophil Adhesion.

Hypothesis V (e): The average mean difference score for men for the five Treatment Conditions for Secretory IgA will be different than the average mean difference score for women for the five Treatment Conditions Secretory the IgA.

Design and Statistical Analysis

Research Design

A pretest-posttest multivariate repeated measures design was used with each subject serving as her/his own control (See Figure 1). Subjects experienced five different conditions:

1. A Neutral Condition where the subject sat quietly for twenty minutes.
2. A Feeling State Imagery - Happiness (Indirect Happy) Condition.
3. A Feeling State Imagery - Sadness (Indirect Sad) Condition.
4. A Neutrophil/Secretory IgA Imagery - Happiness (Direct Happy) Condition.
5. A Neutrophil/Secretory IgA Imagery - Sadness (Direct Sad) Condition.

The subjects received the first three conditions (as listed above) in a counterbalanced order based on a latin square assignment. The latin square assignment was used as a means to control for order effects. There were six possible orders (three factorial) to present the Indirect Conditions (Neutral, Indirect Happy and Indirect Sad). If all six Indirect Orders were used and combined with the two possible Direct Orders (Happy-Sad or Sad-Happy) there would have been twelve orders for each sex to balance the design. Resource limitations precluded using twenty-four subjects in the study. Therefore, a three

by three latin square was used to randomly select three Indirect Orders that still retained the statistical properties of randomness and independence for the order of treatment.

The two remaining Treatment Conditions (Direct Happy and Direct Sad) were also presented in a randomly assigned counter balanced order.

The subjects were naive regarding the dependent measures during the Feeling State Imagery (Indirect Conditions) but were fully informed about the dependent measures for the Neutrophil/IgA Imagery Conditions (Direct Conditions).

The laboratory personnel were blind regarding the Treatment Condition being used during a given day. In turn, the primary experimentor was blind regarding the Treatment outcomes until the individual subject had completed all treatment conditions.

Statistical Test for Order Effects

Given the limitation of the number of subjects, the Order of Treatment was not examined as an independent variable. It was instead viewed as a possible extraneous variable that should be controlled. The latin square development of Orders of Treatment and the random assignment of subjects to the Orders of Treatment was intended to control for Order Effects. Multivariate analyses of variance for repeated measures were computed to determine if order effects occurred despite the assignment procedures.

Statistical Test for Sex and Treatment Main Effects

The tests for Order Effects as well as the tests for main effects

analyzed difference scores derived from the the pretest and posttest scores for the dependent measures (White Blood Cell Count, Percentage of Adhesion, Neutrophil, Stimulated Adhesion, and IgA level).

The main effects for the study were tested using a two way repeated measures multivariate analysis of variance with Sex and Imagery Treatment Conditions as the Independent Variables. The planned comparisons of means for Treatment Effects as stated in the Hypotheses were : Neutral Condition versus the Other Conditions, Happy Conditions versus Sad Conditons, Indirect Conditons versus Direct Conditions, and the interaction of Indirect/Direct Conditions and Happy/Sad Conditions. The Sex by Treatment analysis also included the main effects test of Sex.

Supplementary Analyses

Two supplemental analyses were used to clarify differences that were found between means for some of the Treatment Conditons. The supplemental analyses were also two way repeated measures multivariate analyses of variance with Sex and Treatment as the Independent Variables. The first supplemental analysis used the following planned comparisons: Neutral Condition versus the Indirect Conditions, Neutral Condition versus the Direct Conditions, Neutral Condition versus the Happy Conditions and Neutral Condition versus the Sad Conditions. The planned comparisons for the second supplemental analysis were: Neutral Condition versus Indirect Happy Condition, Neutral Condition versus Indirect Sad Condition, Neutral Condition versus Direct Happy Condition and Neutral Condition versus Direct Sad Condition.

CHAPTER IV

RESULTS

Introduction

The Independent variables for the study were Sex and Treatment Conditions (Neutral, Indirect Happy, Indirect Sad, Direct Happy and Direct Sad). The five dependent measures for the study were White Blood Count, percentage of Neutrophils in the White Blood Cell Count, Adhesion of Neutrophils, Stimulated Adhesion of Neutrophils, and IgA Levels in Saliva. In the case of the Stimulated Adhesion measure, approximately one fourth of the laboratory assays were not performed, therefore the Stimulated Adhesion data was not analyzed statistically.

The results other than the Stimulated Adhesion data are reported by the order in which the analyses were performed. First, a multivariate analysis for repeated measures was done to rule out possible effects of the Order of presentation of the Treatment Conditions on the outcome measurements. After Order Effects were assessed, multivariate analyses of repeated measures with planned comparisons were used to test for the Main Effects of Treatment Conditions and for the Main Effects of Sex. Finally a set of planned comparisons were performed to clarify the relationships of the Treatment Conditions in statistically significant comparisons.

Order by Treatment Analysis

Given the limitation of the number of subjects, the Order of Treatment was not examined as an independent variable. Order was instead viewed as a possible extraneous variable that should be controlled. The latin square development of Orders of Treatment and the random assignment of subjects to the Orders of Treatment was intended to control for Order Effects. A multivariate analysis for repeated measures was performed to confirm that the effects of Order of Treatment Conditions had been controlled.

The effects of the three Indirect Orders, two Direct Orders, as well as, the interaction of the Indirect Orders and Direct Orders were tested for each of the four dependent measures. As listed in Table 6 none of the F values were significant at the P .05 level. Therefore the Order in which Treatments (including the Neutral Condition) were presented did not significantly influence Treatment outcomes.

Sex by Treatment Analysis

After the Effects of Order were tested, the main effects for the study were tested using a multivariate analysis for repeated measures with planned comparisons. Treatment Conditions and Sex were the factors for the multivariate analysis.

Treatment Effects

The Effects of the Treatment Conditons were assessed by tests of Hypothesis I through Hypothesis IV. Hypothesis I compares the Neutral Condition against all the Other Conditions. Hypothesis II asks if

Table 6
Multivariate Analysis of Order Effects

Source of Variance	d.f.	Mean Square	Val. of F	Sig. of F
White Blood Count				
Indirect Order	2	404,078.71	0.57	.578
Direct Order	1	187,404.81	0.27	.615
Indirect Order by Direct Order	2	7,090.85	0.02	.990
Within	12	707,917.50		
Total	17			
Percentage of Neutrophils				
Indirect Order	2	122.31	1.67	.228
Direct Order	1	43.02	0.59	.458
Indirect Order by Direct Order	2	11.54	0.59	.458
Within	12	73.07		
Total	17			
Adhesion				
Indirect Order	2	561.34	2.01	.177
Direct Order	1	24.94	0.09	.770
Indirect Order by Direct Order	2	652.04	2.33	.139
Within	12	279.65		
Total	17			
IgA				
Indirect Order	2	2,365.34	0.06	.940
Direct Order	1	10,125.00	0.27	.616
Indirect Order by Direct Order	2	76,177.55	2.00	.178
Within	12	38,087.64		
Total	17			

there is a difference between the Happy Conditions and the Sad Conditions. Hypothesis III examines differences between the Indirect Conditions and the Direct Conditions. Hypothesis IV tests for the interaction between the Indirect/Direct Conditions and the Happy/Sad Conditions.

The results for the above Hypotheses are listed in Table 7 by dependent variable and by planned comparison. The specific results for each Hypothesis are listed below:

Hypothesis I:

> The mean difference score for the Neutral Condition will be different than the average mean difference score for the other four Conditions (Indirect Happy, Indirect Sad, Direct Happy, and Direct Sad).

Specifically:

> Hypothesis I (a): The mean difference score for the Neutral Condition for White Blood Cell Count will be different than the average mean difference score for the other four Conditions (Indirect Happy, Indirect Sad, Direct Happy, and Direct Sad) for White Blood Cell Count.

The significance of the F value for Hypothesis I(a) ($\underline{P}$ .008) was statistically significant at the $\underline{P}$ .05.

> Hypothesis I (b): The mean difference score for the Neutral Condition for Neutrophil Percentage in the White Blood Cell Count will be different than the average mean difference score for the other four Conditions (Indirect Happy, Indirect Sad, Direct Happy, and Direct Sad) for Neutrophil Percentage in the White Blood Cell Count.

The significance of the F value for Hypothesis I (b) ($\underline{P}$ .865) was not statistically significant at the $\underline{P}$ .05 level and therefore does not support Hypothesis I (c).

> Hypothesis I (c): The mean difference score for the Neutral Condition for Unstimulated Neutrophil Adhesion will be different than the average mean difference score for the

Table 7
Multivariate Analysis of Sex and Treatment Effects

Source of Variance	d.f.	Mean Square	Val. of F	Sig. of F
White Blood Cell Count				
Sex	1	112,430.68	0.19	.667
Treatment Contrasts:				
Neutral vs. Others	1	942,285.34	9.10	.008**
Happy vs Sad	1	10,082.00	0.02	.879
Indirect vs Direct	1	3,901.39	1.01	.934
Interaction Happy/Sad & Indirect/Direct	1	66,005.56	0.15	.708
Interactions:				
Sex and Neutral vs Others	1	274,785.88	2.65	.123
Sex and Happy vs Sad	1	10,464.22	0.02	.877
Sex and Indirect vs Direct	1	1,972,760.06	3.56	.077*
Sex and Interaction Happy/Sad & Indirect/Direct	1	14.22	0.00	.996
Within	8	584,770.20		
Total	17			
Percentage of Neutrophils				
Sex	1	20.54	0.28	.603
Treatment Contrasts:				
Neutral vs. Others	1	1.11	0.03	.865
Happy vs Sad	1	50.00	1.58	.227
Indirect vs Direct	1	10.89	0.16	.696
Interaction Happy/Sad & Indirect/Direct	1	0.00	0.00	1.000
Interactions:				
Sex and Neutral vs Others	1	4.90	0.13	.722
Sex and Happy vs Sad	1	2.72	0.09	.773
Sex and Indirect vs Direct	1	93.39	1.36	.261
Sex and Interaction Happy/Sad & Indirect/Direct	1	0.50	0.01	.936
Within	8	20.54		
Total	17			

Table 7--continued

Source of Variance	d.f.	Mean Square	Val. of F	Sig. of F
Adhesion				
Sex	1	170.84	0.48	.496
Treatment Contrasts:				
Neutral vs. Others	1	40.00	0.28	.601
Happy vs Sad	1	22.22	0.09	.772
Indirect vs Direct	1	32.00	0.13	.719
Interaction Happy/Sad & Indirect/Direct	1	0.89	0.00	.950
Interactions:				
Sex and Neutral vs Others	1	11.38	0.08	.779
Sex and Happy vs Sad	1	26.89	0.11	.750
Sex and Indirect vs Direct	1	355.56	1.49	.241
Sex and Interaction Happy/Sad & Indirect/Direct	1	37.56	0.17	.683
Within	8	352.29		
Total	17			
IgA				
Sex	1	598.04	0.02	.903
Treatment Contrasts:				
Neutral vs. Others	1	11,639.47	0.86	.368
Happy vs Sad	1	5,390.68	0.20	.663
Indirect vs Direct	1	53,956.13	2.05	.171
Interaction Happy/Sad & Indirect/Direct	1	23,871.13	0.70	.414
Interactions:				
Sex and Neutral vs Others	1	3,718.47	0.27	.608
Sex and Happy vs Sad	1	94,105.68	3.43	.082*
Sex and Indirect vs Direct	1	24,457.35	0.93	.349
Sex and Interaction Happy/Sad & Indirect/Direct	1	61,776.13	1.82	.196
Within	8	598.04		
Total	17			

* P .10
** P .05

other four Conditions (Indirect Happy, Indirect Sad, Direct Happy, and Direct Sad) for Unstimulated Neutrophil Adhesion.

The significance of the F value for Hypothesis I (c) (P .601) was not statistically significant at the P .05 level and therefore does not support Hypothesis I (c).

Hypothesis I (d): The mean difference score for the Neutral Condition for Stimulated Neutrophil Adhesion will be different than the average mean difference score for the other four Conditions (Indirect Happy, Indirect Sad, Direct Happy, and Direct Sad) for Stimulated Neutrophil Adhesion.

Due to the missing data Hypothesis I (d) was not tested.

Hypothesis I (e): The mean difference score for the Neutral Condition for Secretory IgA will be different than the average mean difference score for the other four Conditions (Indirect Happy, Indirect Sad, Direct Happy, and Direct Sad) for Secretory IgA.

The significance of the F value for Hypothesis I (e) (P .368) was not statistically significant at the P .05 level and therefore does not support Hypothesis I (e).

Hypothesis II:

The average mean difference score for the Happiness Imagery Conditions (Indirect and Direct) will be different than the average mean difference score for the Sadness Imagery Conditions (Indirect and Direct).

Specifically:

Hypothesis II (a): The average mean difference score for the Happiness Imagery Conditions (Indirect and Direct) for White Blood Cell Count will be different than the average mean difference score for Sadness Imagery Conditions (Indirect and Direct) for White Blood Cell Count.

The significance of the F value for Hypothesis II (a) (P .879) was not statistically significant at the P .05 level and therefore does not support Hypothesis I (a).

Hypothesis II (b): The average mean difference score for the Happiness Imagery Conditions (Indirect and Direct) for Neutrophil Percentage in the White Blood Cell Count will be different than the average mean difference score for Sadness Imagery Conditions (Indirect and Direct) for Neutrophil Percentage in the White Blood Cell Count.

The significance of the F value for Hypothesis II (b) (P .227) was not statistically significant at the P .05 level and therefore does not support Hypothesis I (b).

Hypothesis II (c): The average mean difference score for the Happiness Imagery Conditions (Indirect and Direct) for Unstimulated Neutrophil Adhesion will be different than the average mean difference score for Sadness Imagery Conditions (Indirect and Direct) for Unstimulated Neutrophil Adhesion.

The significance of the F value for Hypothesis II (c) (P .227) was not statistically significant at the P .05 level and therefore does not support Hypothesis I (c).

Hypothesis II (d): The average mean difference score for the Happiness Imagery Conditions (Indirect and Direct) for Stimulated Neutrophil Adhesion will be different than the average mean difference score for Sadness Imagery Conditions (Indirect and Direct) for Stimulated Neutrophil Adhesion.

Due to missing data Hypothesis II (d) was not tested.

Hypothesis II (e): The average mean difference score for the Happiness Imagery Conditions (Indirect and Direct) for Secretory IgA will be different than the average mean difference score for Sadness Imagery Conditions (Indirect and Direct) for Secretory IgA.

The significance of the F value for Hypothesis I (b) (P .663) was not statistically significant at the P .05 level and therefore does not support Hypothesis I (e).

Hypothesis III:

The average mean difference score for the Indirect Conditions (Happiness and Sadness) will be different than

the average mean difference score for the Direct Conditions (Happiness and Sadness).

Specifically:

Hypothesis III (a): The average mean difference score for the Indirect Conditions (Happiness and Sadness) for White Blood Cell Count will be different than the average mean difference score for the Direct Conditions (Happiness and Sadness) for White Blood Cell Count.

The significance of the F value for Hypothesis I (b) (P .934) was not statistically significant at the P .05 level and therefore does not support Hypothesis I (a).

Hypothesis III (b): The average mean difference score for the Indirect Conditions (Happiness and Sadness) for Neutrophil Percentage in the White Blood Cell Count will be different than the average mean difference score for the Direct Conditions (Happiness and Sadness) for Neutrophil Percentage in the White Blood Cell Count.

The significance of the F value for Hypothesis III (b) (P .696) was not statistically significant at the P .05 level and therefore does not support Hypothesis I (b).

Hypothesis III (c): The average mean difference score for the Indirect Conditions (Happiness and Sadness) for Unstimulated Neutrophil Adhesion will be different than the average mean difference score for the Direct Conditions (Happiness and Sadness) for Unstimulated Neutrophil Adhesion.

The significance of the F value for Hypothesis III (c) (P .719) was not statistically significant at the P .05 level and therefore does not support Hypothesis I (c).

Hypothesis III (d): The average mean difference score for the Indirect Conditions (Happiness and Sadness) for Stimulated Neutrophil Adhesion will be different than the average mean difference score for the Direct Conditions (Happiness and Sadness) for Stimulated Neutrophil Adhesion.

Due to missing data Hypothesis III (d) was not tested.

Hypothesis III (e): The average mean difference score for the Indirect Conditions (Happiness and Sadness) for Secretory IgA will be different than the average mean difference score for the Direct Conditions (Happiness and Sadness) for Secretory IgA.

The significance of the F value for Hypothesis III (e) (P .171) was not statistically significant at the P .05 level and therefore does not support Hypothesis I (e).

Hypothesis IV:

The average mean difference score for the Indirect Happy Condition and the Direct Sad Condition will be different than the average mean difference score for the Indirect Sad Condition and the Direct Happy Condition.

Specifically

Hypothesis IV (a): The average mean difference score for the Indirect Happy Condition and the Direct Sad Condition for White Blood Cell Count will be different than the average mean difference score for the Indirect Sad Condition and the Direct Happy Condition for White Blood Cell Count.

The significance of the F value for Hypothesis IV (a) (P .708) was not statistically significant at the P .05 level and therefore does not support Hypothesis I (a).

Hypothesis IV (b): The average mean difference score for the Indirect Happy Condition and the Direct Sad Condition for Neutrophil Percentage in the White Blood Cell Count will be different than the average mean difference score for the Indirect Sad Condition and the Direct Happy Condition for Neutrophil Percentage in the White Blood Cell Count.

The significance of the F value for Hypothesis IV (b) (P 1.00) was not statistically significant at the P .05 level and therefore does not support Hypothesis I (b).

Hypothesis IV (c): The average mean difference score for the Indirect Happy Condition and the Direct Sad Condition for Unstimulated Neutrophil Adhesion will be different than

the average mean difference score for the Indirect Sad Condition and the Direct Happy Condition for Unstimulated Neutrophil Adhesion.

The significance of the F value for Hypothesis IV (c) (P .950) was not statistically significant at the P .05 level and therefore does not support Hypothesis I (c).

Hypothesis IV (d): The average mean difference score for the Indirect Happy Condition and the Direct Sad Condition for Stimulated Neutrophil Adhesion will be different than the average mean difference score for the Indirect Sad Condition and the Direct Happy Condition for Stimulated Neutrophil Adhesion.

Due to missing data Hypothesis IV (d) was not tested.

Hypothesis IV (e): The average mean difference score for the Indirect Happy Condition and the Direct Sad Condition for Secretory IgA will be different than the average mean difference score for the Indirect Sad Condition and the Direct Happy Condition for Secretory IgA.

The significance of the F value for Hypothesis IV (e) (P .414) was not statistically significant at the P .05 level and therefore does not support Hypothesis I (e).

In summary, only one planned comparison for Treatment Effects was statistically significant. The White Blood Cell Count - Neutral versus Other Conditions comparison was found signficant at the P .05 level.

Sex Effects

In addition to testing for Treatment Effects one of the primary questions for the study was whether there would be a difference between the effects of emotional imagery on the immune system of men and the effects of emotional imagery on the immune system of women? Hypothesis V addresses the question of gender differences for the combined

Treatment Conditions.

The appropriate F values for the main effects of Sex are listed in Table 6 and correspónd with the following hypotheses.

Hypothesis V:

> The average mean difference score for men for the five Treatment Conditions will be different than the average mean difference score for women for the five Treatment Conditions.

Specifically:

> Hypothesis V (a): The average mean difference score for men for the five Treatment Conditions for the White Blood Cell Count will be different than the average mean difference score for women for the five Treatment Conditions for the White Blood Cell Count.

The significance value of F for the White Blood Cell Count for Sex was P .667. Therefore, the F test fails to support Hypothesis V (a) for White Blood Cell Count.

> Hypothesis V (b): The average mean difference score for men for the five Treatment Conditions for the Neutrophil Percentage in the White Blood Cell Count will be different than the average mean difference score for women for the five Treatment Conditions for the Neutrophil Percentage in the White Blood Cell Count.

The Percentage of Neutrophils in the White Blood Cell Count significance value for Sex was P .603. The F value for Percentage of Neutrophils therefore fails to support Huypothesis V (b).

> Hypothesis V (c): The average mean difference score for men for the five Treatment Conditions for the Stimulated Neutrophil Adhesion will be different than the average mean difference score for women for the five Treatment Conditions for the Stimulated Neutrophil Adhesion.

The significance value of F for Adhesion for Sex was P .496. The significance value of F for Adhesion fails to support Hypothesis V (c).

> Hypothesis V (d): The average mean difference score for

men for the five Treatment Conditions for the Stimulated Neutrophil Adhesion will be different than the average mean difference score for women for the five Treatment Conditions for the Stimulated Neutrophil Adhesion.

Due to missing data Hypothesis V (d) was not tested.

Hypothesis V (e): The average mean difference score for men for the five Treatment Conditions for Secretory IgA will be different than the average mean difference score for women for the five Treatment Conditions Secretory the IgA.

The IgA significance value of F for Sex was P .903. The F value of IgA for the main effect of Sex therefore, does not support Hypothesis V (e).

In summary, none of the tests for Sex as a Main Effect were found significant at the P .05 level.

Sex and Treatment Interaction

The Sex by Treatment analysis of variance provides the F values for the Sex by Treatment interactions in addition to testing for Sex as a Main Effect (See Table 7). There were no interactions that were significant at the P .05 level. There were, however, two interaction tests that appeared important to address. The comparison of Indirect versus Direct for the White Blood Count had an F value significance of P .077 and the comparison of Happy versus Sad for the IgA variable had an F value significance of P .082.

Although the above interactions were not significant at the .05 level, they may still have implications for the interpretation of Treatment Outcomes. To clarify the relationship between Sex and Treatment Outcomes, Table 8 lists the means and standard deviations of

Table 8

Treatment Condition Means and Standard Deviations for Multivariate Analysis of Sex and Treatment

	Mean Differences	Standard Deviation
White Blood Count		
Neutral		
Male	-237.33	490.72
Female	-387.67	571.48
Total	-312.50	522.48
Indirect Happy		
Male	-404.67	385.68
Female	-633.00	565.83
Total	-518.33	484.05
Indirect Sad		
Male	-512.11	664.32
Female	-694.00	1144.34
Total	-603.06	912.52
Direct Happy		
Male	-810.11	691.90
Female	-378.11	761.43
Total	-594.11	739.94
Direct Sad		
Male	-798.22	534.08
Female	-316.22	336.37
Total	-557.22	498.97
Neutrophil Percentage		
Neutral		
Male	- 0.22	4.82
Female	- 1.67	4.85
Total	- 0.72	4.79
Indirect Happy		
Male	- 2.33	10.06
Female	0.56	8.26
Total	0.56	8.98
Indirect Sad		
Male	0.44	7.32
Female	- 0.89	8.16
Total	- 0.22	7.55
Direct Happy		
Male	1.00	8.40
Female	3.44	7.00
Total	2.22	7.60
Direct Sad		
Male	- 2.11	5.78
Female	2.33	8.19
Total	0.11	7.24

Table 8 Continued

	Mean Differences	Standard Deviation
Adhesion		
Neutral		
Male	- 0.44	18.94
Female	- 1.78	4.99
Total	- 1.11	13.46
Indirect Happy		
Male	7.00	11.12
Female	- 3.22	11.18
Total	1.88	12.03
Indirect Sad		
Male	3.00	16.26
Female	- 1.89	13.38
Total	0.56	14.67
Direct Happy		
Male	- 0.44	23.98
Female	1.11	15.74
Total	0.33	19.69
Direct Sad		
Male	- 1.11	12.98
Female	0.57	18.46
Total	- 0.56	15.49
IgA		
Neutral		
Male	0.8256	1.11
Female	1.0311	1.17
Total	0.9283	1.11
Indirect Happy		
Male	0.5811	1.89
Female	0.6967	0.95
Total	0.6389	1.45
Indirect Sad		
Male	- 0.0933	1.30
Female	0.2967	1.54
Total	0.1017	1.40
Direct Happy		
Male	1.7189	1.70
Female	0.0744	1.85
Total	0.8222	1.95
Direct Sad		
Male	0.6011	1.44
Female	1.4256	2.92
Total	1.0133	2.27

the five Treatment Conditions for each dependent variable. The averages and standard deviations within a given Treatment Condition are listed by Sex and by the total of both sexes. Figure 2 graphically portrays the information for White Blood Count that was listed in Table 8. Similarly, Figure 3 graphs the same information for the IgA variable.

In Figure 2 the lines for the male and female groups cross and the means for the five Treatment Conditions are considerably different for men and women. The type of relationship in Figure 2 is disordinal since the outcomes for the sexes reverse when the Indirect condition is compared to the Direct condition.

Figure 3 also shows a disordinal relationship for the IgA comparison of Direct Happy Condition and Direct Sad Condition.

The implications of these disordinal relationships will be discussed in Chapter V.

Supplementary Analyses

The significance of the treatment effects for the Neutral versus Other Conditions contrast (White Blood Cell Count) suggested additional analyses. The first supplemental analysis (White Blood Count Combined Conditions) was the same as the Sex by Treatment analysis but was done only for White Blood Cell Count and a new set of comparisons were used. The comparisons used in the White Blood Count Combined Conditions analysis were Neutral versus Indirect Conditions, Neutral versus Direct Conditions, Neutral versus Happy Conditions, Neutral versus Sad Conditions.

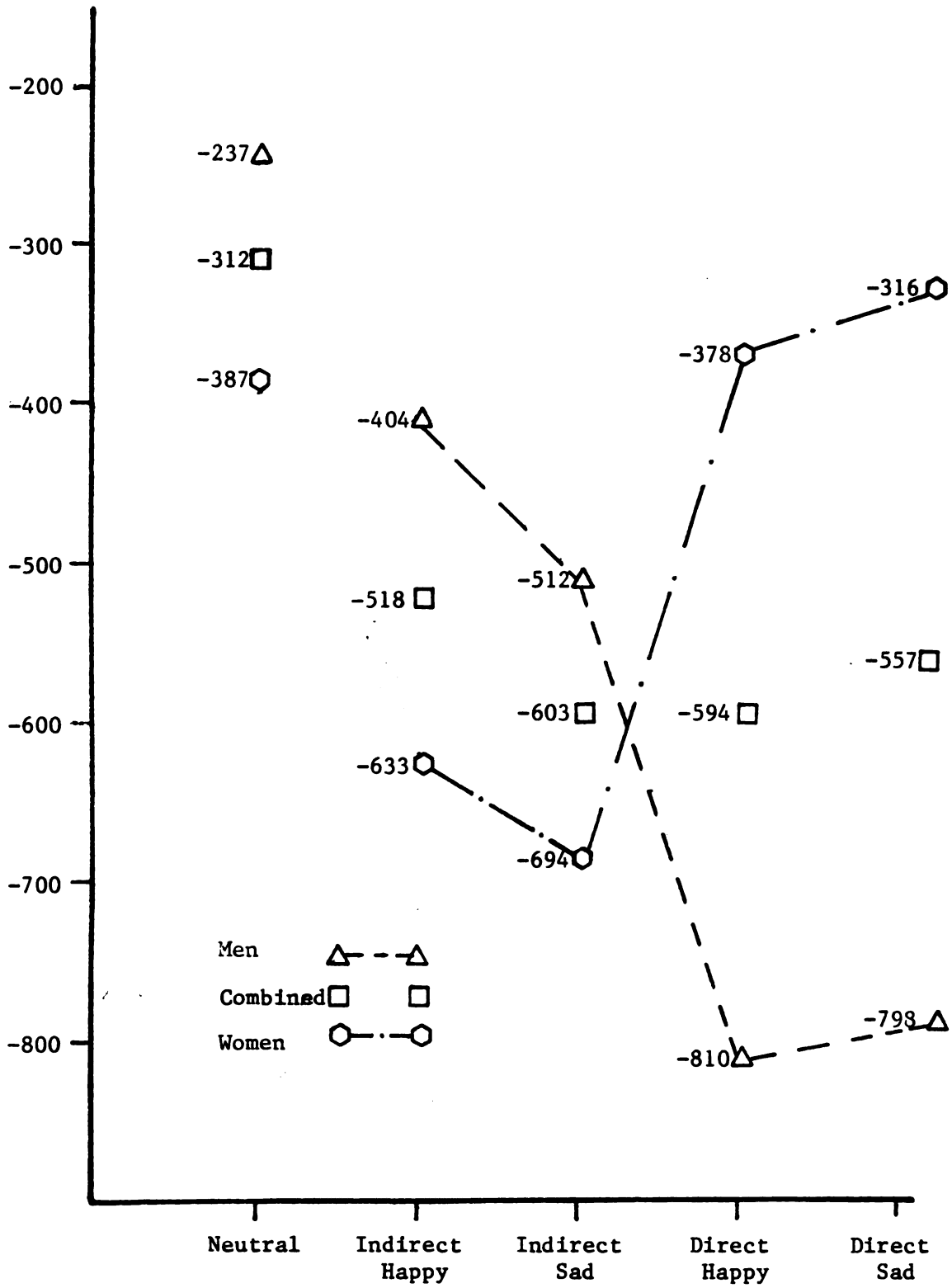

Figure 2. Average difference scores for White Blood Cell Count for Sex

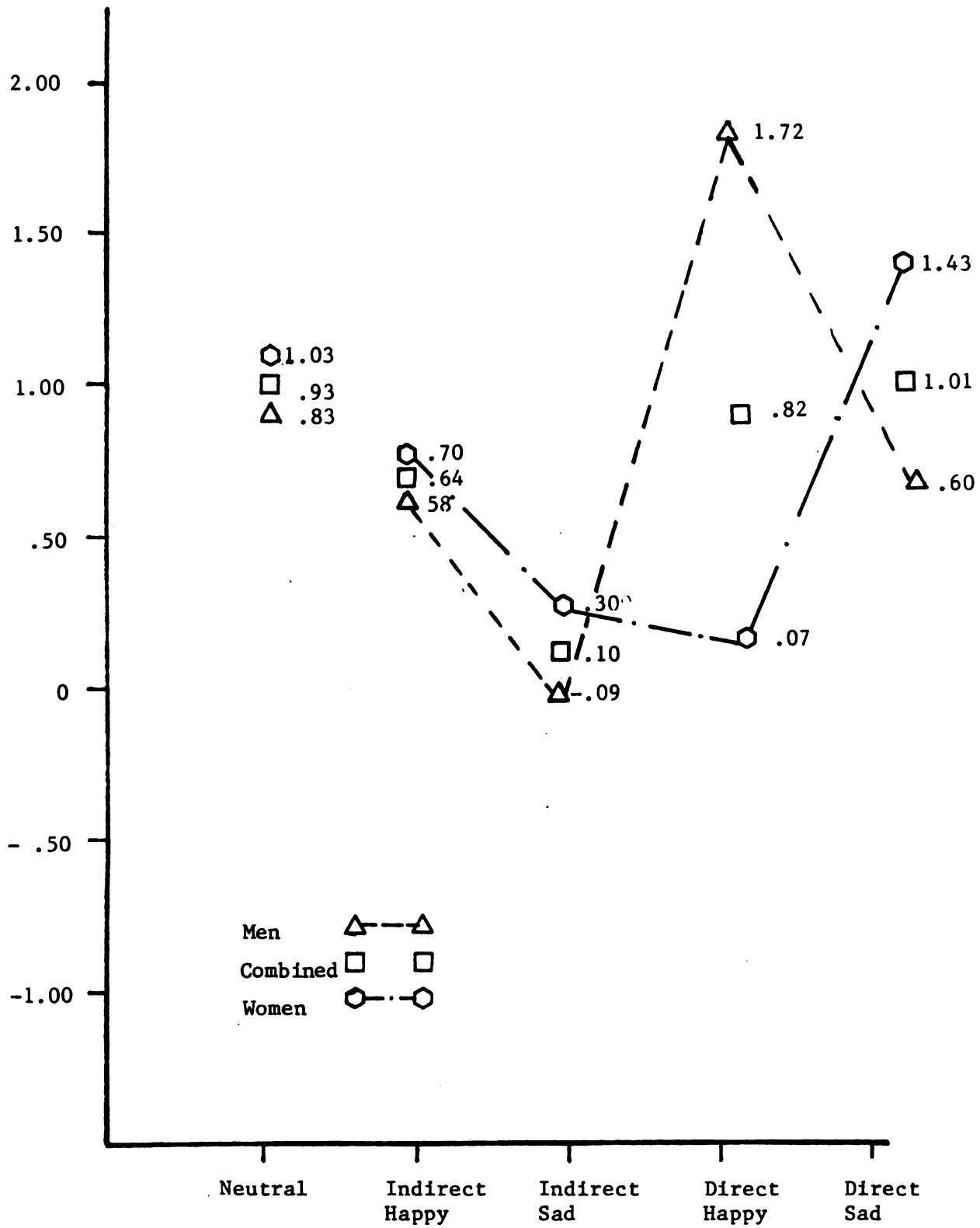

Figure 3. Average difference scores for IgA by sex.

The result from the White Blood Count Combined Conditions analysis are listed in Table 9. The results for the Main Effect of Sex are the same as stated in Table 5 because the same test for Sex was performed in the White Blood Count Combined Conditions analysis as was performed in the Sex by Treatment analysis.

The Neutral versus Indirect comparison (P .026) for Treatment Effects and the Neutral versus Sad comparison (P .009) for Treatment Effects were significant at the P .05 level. The Neutral versus the Direct Conditions (P .078) for Treatment Effects and the Neutral versus Happy Conditions (P .089) for Treatment Effects were not significant at the P .05 level.

There was only one significant Sex by Treatment interaction effect for the White Blood Count Combined Comparisons. The significance value of F (P .045) for the interaction of Sex and the Neutral versus Direct Conditions comparison was significant at the P .05 level.

Another supplemental analysis was done for the White Blood Cell Count (WBC Individual Comparisons) comparing the Neutral Condition separately with each of the other four Treatments Conditions. The results for the White Blood Cell Count Individual Comparison analysis are listed in Table 10.

The values for the Main Effect for Sex for the Individual Comparisons analysis is the same as those listed previously in Table 6 and Table 9.

The Neutral versus Indirect Happy comparison (P .064) had the lowest F significance value, but was not significant at the P .05 level.

Table 9
Multivariate Analysis for White Blood Count Combined Conditions

Source	d.f.	Mean Square	Value of F	Sig of F
Sex	1	112,430.68	0.19	.667
Treatment Contrast:				
Neutral vs Indirect	1	740,695.70	6.02	.026**
Neutral vs Direct	1	831,080.33	3.55	.078*
Neutral vs Happy	1	714,269.34	3.28	.089*
Neutral vs Sad	1	859,566.90	8.90	.009**
Interactions				
Sex and Neutral vs Indirect	1	9,001.81	0.07	.790
Sex and Neutral vs Direct	1	1,106,561.33	4.72	.045**
Sex and Neutral vs Happy	1	190,764.08	0.88	.363
Sex and Neutral vs Sad	1	270,700.45	2.80	.113
Within	8	584,770.20		
Total	17			

*P .10
**P .05

Although none of the Individual comparisons were significant, the interaction of Sex and the Neutral versus Direct Sad comparison (P .044) was significant at the P .05 level.

The Combined Comparisons for White Blood Cell Count analysis yielded two statistically significant Treatment comparisons (Neutral versus Indirect and Neutral versus Sad) and one significant Sex by Treatment interaction (Neutral versus Direct). The Individual Comparisons for White Blood Cell Count analysis had no statistically significant Treatment comparisons but had one significant Sex by Treatment interaction (Neutral versus Direct Sad).

Table 10
Multivariate Analysis for White Blood Count Individual Conditions

Source	d.f.	Mean Square	Value of F	Sig of F
Sex	1	112,430.68	0.19	.667
Treatment Contrasts:				
Neutral vs Indirect Happy	1	383,161.00	1.70	.211
Neutral vs Indirect Sad	1	759,802.78	3.95	.064*
Neutral vs Direct Happy	1	713,743.36	1.93	.184
Neutral vs Direct Sad	1	539,000.69	2.88	.109
Interactions:				
Sex and Neutral vs Indirect Happy	1	13,689.00	0.06	.809
Sex and Neutral vs Indirect Sad	1	2,240.44	0.01	.915
Sex and Neutral vs Direct Happy	1	763,002.25	2.06	.170
Sex and Neutral vs Direct Sad	1	899.652.25	4.80	.044**
Within	8	584,770.20		
Total	17			

*P .10
**P .05

Summary

Multivariate Analyses for repeated measures were used to test for Order Effects, Main Effects of Treatment, Main Effects of Sex, Sex by Treatment Interaction Effects and for supplemental analyses of the White Blood Cell Count variable.

No significant Order Effects were found in the study.

The Neutral versus Other Conditions comparison for White Blood Cell Count was significant at the P .05 level. There were no significant Main Effects for Sex in the study. There were, however, two Sex by Treatment Interaction comparisons that were considered important to examine even though they were not statistically significant at the P .05 level: the Sex by Treatment Interaction comparison for White Blood Cell Count Indirect versus Direct (P .077) and the Interaction comparison for IgA Happy vs Sad conditions (P .082).

The White Blood Cell Count results showed a disordinal relationship between men and women for the Direct versus Indirect Conditions. The IgA variable also showed a disordinal relationship between the sexes but for the comparison of Happy versus Sad.

Two supplemental analyses were applied to the White Blood Cell Count variable to better understand the signficance of the Neutral versus Others comparison and to clarify the disordinal relationship of Sex for the Indirect versus Direct comparison.

The results of the White Blood Count Combined Comparisons analysis indicated statistically significant Treatment Effects at the P .05

level for the Neutral versus Indirect comparison (P .026) and the Neutral versus Sad comparison (P .009).

The White blood Count Combined comparisons analysis also yielded a statistically significant Interaction Effect between Sex and the Neutral versus Direct comparison (P .045) at the P .05 level of significance.

The White Blood Count Individual analysis compared the Neutral Condition separately with each of the other four Conditions. None of the individual comparisons were statistically significant at the P .05 level.

There was, however, a Sex by Treatment comparison Interaction for the Neutral versus Direct Sad comparison (P .044) that was significant at the P .05 level.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary of the Study

The relationship between the mind and the body has been of interest to persons in diverse fields for many years. Philosophers, religious leaders, physicians, and psychologists have all wrestled with the questions of whether these concepts of body and mind represent different entities and, if they are different, how they interact.

One of the important issues to consider in looking at the influence of the mind on the body has been the reassessment of those body systems historically labelled "autonomous" or "involuntary". For example, the advent of biofeedback demonstrated that many bodily systems thought to be autonomous can be influenced by central nervous system (CNS) activity if an individual has the appropriate information about that system (Shearn, 1962; Frazier, 1966; Engel, 1972; Blanchard & Young, 1974).

The immune system is one of the body mechanisms that has been viewed as autonomous from CNS influence. However, a new field called psychoneuroimmunology has begun to challenge this assumption. Some studies in psychoneuroimmunology have shown, for instance, conditioned immunosuppression (Ader, 1981), immunosuppression related to emotional stress (Bartrop, Luckhurst, Lazarus Kiloh & Penny, 1977), and direct

CNS influence on immune function (Black, et al., 1963; Minning, 1982; Schneider, et al., 1984). The establishment of these CNS links to the immune system is significant in exploring etiology, prevention, and treatment of various diseases including: cancer, autoimmune diseases, and infectious diseases (Ader, 1981).

Purpose of the Study

The purpose of the study was to investigate the influence of happy and sad emotions (experienced through mental imagery) on immune responsivity as measured by changes in responsivity of neutrophils (white blood cells) and changes in secretory IgA (an antibody found in saliva) levels. Two types of emotional imagery were used to elicit the Treatment Conditions in the study. In the first part of the study, the emotional imagery was used to establish an emotional state and then examine the Indirect Effect this state had on immune responsivity. In the second phase of the study, the imagery focused on the neutrophils cells and secretory IgA themselves responding in a "happy" or "sad" manner. Thus, the second imagery process, was an effort to manipulate Direct CNS influence on neutrophil/IgA activity.

By using both the emotional state imagery and the neutrophil/IgA imagery, not only was the general question of CNS influence addressed but also the differential effect of Direct versus Indirect emotional imagery.

The primary questions for the study were as follows:

1) Will a 20 minute emotional imagery state of happiness or sadness (Indirect Effect) effect immune responsivity as measured by changes in neutrophil function and secretary IgA

levels in saliva?

2) Will a 20 minute imagery process in which an individual focuses on the neutrophil cells and saliva secretory IgA responding in a happy or sad emotional manner (Direct Effect) effect immune responsivity as measured by changes in neutrophil function and secretory IgA levels in saliva?

3) Will there be a difference between the effects of the imagery states of happiness and sadness (Direct and Indirect combined) on the neutrophil function and secretory IgA levels in saliva?

4) Will there be a difference between the effects of the Direct Effect imagery states and the Indirect states on the neutrophil and secretory IgA levels in saliva?

5) Will there be a difference between the effects of emotional imagery on the immune system of men and the effects of emotional imagery on the immune system of women as measured by changes in blood neutrophil function and secretary IgA levels in saliva?

Design and Statistical Analysis

The subjects for the experiment were volunteers who were comfortable experiencing strong emotional states. The study included both sexes and participants were screened for age, life events, depression, and daily habits that could influence immune responsivity.

Each subject experienced five different imagery conditions: a Neutral Condition where the subject sat quietly for twenty minutes, an Indirect Happy Condition, an Indirect Sad Condition, a Direct Happy Condition and a Direct Sad Condition.

Each Treatment Condition followed the same sequence: the procedures for the session were reviewed with the subject, samples of blood and saliva were submitted, relaxation-focusing instructions were read, twenty minutes of imagery, the second set of blood and saliva samples were submitted and the session was debriefed.

The dependent measures for the study were White Blood Cell Count, Percentage of White Blood Cells that were neutrophils, Adhesion of Neutrophils, Stimulated Adhesion of Neutrophils and IgA levels in saliva.

The order in which subjects completed the treatment conditions was randomly determined within a latin square design and a multivariate analysis of variance for repeated measures was performed to rule out Order Effects as a possible extraneous variable.

The Stimulated Adhesion results were not analyzed statistically because of missing data. The White Blood Cell Count, Percentage of Neutrophils, Adhesion, and IgA measures were analyzed using a Sex by Treatment, multivariate analysis of variance for repeated measures, with planned comparisons. The analyses were applied to difference scores established by subtracting the pretreatment measure for each Condition from the appropriate post-treatment measure.

Additional multivariate analyses of similiar form were used to clarify the relationships between the Treatment Conditions for the one statistically significant comparison (White Blood Count-Neutral versus Other Treatments).

Conclusions

The study yielded several interesting results which will be addressed by the order of analyses reported in Chapter IV.

Order Effects

The lack of statistical significance for the Order Effects analysis confirmed that Order at a general level had been controlled.

Treatment Effects

The only main treatment effect comparison to show statistical significance at the P .05 level was the White Blood Cell Count for the Neutral versus Other Treatments comparison. Given the lack of statistical significance for the remaining comparisons, Hypotheses one through four, stated in null form, were not rejected for the Neutrophil Percentage, Adhesion, and IgA variables. That is to say, there were not significant differences between the Neutral Condition and Other Conditions (Indirect Happy, Indirect Sad, Direct Happy, and Direct Sad); no significant difference between Happy Conditions and Sad Conditions; no significant difference between the Indirect Conditions and the Direct Conditions; and no significant interactions between the Indirect/Direct Conditions and the Happy/Sad Conditions.

Sex Effects

All of the Hypotheses addressing gender differences (V, V(a), V(b), V(c), V(d) and V(e)) lacked statistical significance. Therefore there were not statistical differences between men and women when the sexes were compared across all five Treatment Conditions for a given variable. The lack of significance for Sex as a main effect does not, however, preclude the interaction of Sex with a specific Treatment

Condition. The interaction of Sex can be with a specific Treatment Condition or group of Treatment Conditions. There were, in fact, no Sex by Treatment comparisons interactions that were significant at the P .05 level of significance. There were, however, two interaction tests that appeared important to address because of their low P values and apparent disordinal relationships. The White Blood Count Sex by Indirect versus Direct interaction (P .077) and the IgA Sex by Direct Happy versus Direct Sad interaction (P .082) will be discussed for their possible implications for the main Treatment Effects.

Disordinal Relationships

Although none of the Sex by Treatment comparisons interactions were statistically significant at the P .05 level, Figure 3 (See Chapter IV) and Figure 4 (See Chapter IV) suggest some degree of relationship exists between Sex and some of the Treatment comparisons.

Figure 4 graphically suggests a disordinal relationship between Sex and the Direct Happy versus Direct Sad Conditions for the IgA variable. The presence of a disordinal relationship between the Treatment Conditions and Sex would tend to negate the possibility of Treatment Effects being found statistically significant. In the case of IgA, a significant Treatment Effect for the Direct Conditions may have been found for women, or for men, if the sexes had been analyzed separately.

The White Blood Cell Sex by Indirect versus Direct relationship was also disordinal for Sex (see Figure 3). The disordinal relationship for the sexes for White Blood Count would also tend to

negate the possiblity of statistical significance for Treatment Effects for the Indirect versus Direct comparison. The disordinal relationship of Sex and the Indirect versus Direct Conditions, again, would tend to negate the possibility of statistical significance for the Neutral versus Others comparison. The Neutral versus Others comparison remained significant statistically because of the large differences between the Neutral Condition and most of the Treatment conditions means for White Blood Cell Count. The disordinal relationship while not negating the Treatment main effect for the Neutral versus Others comparison, strongly demonstrates the difference between men's and women's responses to the Indirect and Direct conditions as measured by White Blood Cell Count.

White Blood Cell Count Combined Conditions Analysis

The disordinal relationship of Sex and Treatment Conditions also influences the supplemental analyses done on the White Blood Cell Count variable. Two of the Treatment Effect comparisons, Neutral versus Indirect (P .026) and Neutral versus Sad (P .009), in Table 9 (See Chapter IV) were signficant at the .05 level. The other two comparisons Neutral versus Direct (P .078) and Neutral versus Happy (P .089) had very low significance levels for F, but were not significant at the P .05 level. The Sex by Neutral versus Direct interaction was significant at the .05 level. The comparisons in Table 9 suggest that there are significant differences between the Neutral Condition and the combined Indirect Conditions, and between the Neutral and the combined Sad Conditions. The Treatment Effects significance level of F for the

Neutral versus Direct Comparison was lessened because of the interaction with Sex. As Figure 3 illustrates both of the female difference means (Direct Happy and Direct Sad) were higher values than the male difference means. The same relationship exists between men and women for the White Blood Cell Count Indirect Conditions but in the opposite direction. The Sex by Neutral versus Indirect Conditions interaction was not significant because the differences in means between the sexes were not as great as they were in the Direct Conditions.

White Blood Cell Count Individual Conditions Analysis

The White Blood Count Individual Conditions analysis also yielded one significant interaction (Sex by Neutral versus Direct Sad comparison) at the P .05 level (see Table 10, Chapter IV). As seen previously in Figure 3, changes in White Blood Cell Count for women were about the same for the Direct Sad Condition as they were for the Neutral Condition. Men, on the other hand, had substantially larger changes in White Blood Cell Count for the Direct Sad Condition than for the Neutral Condition. Thus, it is likely that the Neutral versus Direct Sad comparison would have been statistically significant if the sample had been limited to men.

Individual and Combined Analyses Compared

It is interesting to note that two of the White Blood Count Combined Conditions (Neutral versus Indirect and Neutral versus Sad) were statistically significant, while none of the Individual Conditions

were significant when compared to the Neutral Condition.

The lack of significance for the White Blood Cell Count Neutral versus Direct Sad can be explained, in part, by the interaction effect with Sex (P .044). Where as the Direct Sad Condition had little effect on women, it did have a pronounced effect on the White Blood Count of men. It is likely the other three individual comparisons lack significance due to the large within Treatment Condition variance (see standard deviations Table 8) and the small number of subjects in the study.

Summary of Conclusions

The design of the study appears to have adequately controlled for the effects of Order of Treatments.

No significant differences were found between men and women in the study when the Sexes were compared across all five Treatment Conditions but there were some interactions between Sex and certain Treatment Conditions.

The only Treatment Effect that was significant compared the Neutral Condition to the other four Treatment Conditions with White Blood Cell Count as the dependent variable.

Although not statistically significant in the Sex by Treatment analysis, two Sex by Treatment interaction tests were examined further. Both the White Blood Count Indirect versus Direct comparison and the IgA Happy versus Sad comparison showed disordinal relationships for Sex and Treatment Condition.

When a supplemental Combined Conditions analysis was performed on

the White Blood Count variable the Neutral versus Direct condition did have a statistically significant Sex by Treatment comparison interaction (Neutral versus Direct Sad P .044). The above significant interaction combined with the previously mentioned disordinal relationships suggest that Sex does in fact interact with some of the Treatment Conditions and specifically that the effects of Direct Conditions are significantly greater for men than for women.

Beyond the interaction findings the Combined Conditions analysis had two significant Treatment Effect comparisons (Neutral versus Indirect P .026 and Neutral versus Sad P .009).

Discussion

It is interesting to note that the only dependent variable to show statistically significant findings was the White Blood Cell Count (WBC). WBC can be considered the most general measure of the four blood assays used in the study (WBC, Neutrophil Percentage, Adhesion and Stimulated Adhesion). The significant WBC findings suggest that a general response of the immune system to emotional states was demonstrated.

The change in WBC can be explained at two levels: 1) changes in blood flow as a result of changes in sympathetic/parasympathetic activity and 2) changes in white blood cell activity as a result of hormonal/neurotransmitter influences.

Each treatment condition for the study began with a brief relaxation-focusing instruction while the subject was seated in a comfortable chair. It is likely that this relaxation-focusing process

resulted in some parasympathetic activity which would cause a slowing of the blood flow. A certain percentage of any given circulating white blood cell will be found free floating in the blood stream, while the remainder of the cells will be resting against the blood vessel wall. The number of white blood cells free floating is determined, in part, by how fast the blood flows. The faster the blood flows, the greater the shearing effect and consequently the greater the number of free floating white blood cells available for venapuncture sampling.

Since the relaxation-focusing exercise slowed the blood flow this would decrease the number of cells free floating because more cells would settle on the walls of the blood vessel or be able to remain attached if they were actively adhesive. The settled or attached cells would then not be available for the sampling procedure used in this study and therefore, there would be a drop in the number of white blood cells between pre and post measures.

The above explanation of deceased blood flow and a drop in WBC is supported by the fact that the Neutral Condition showed a drop in WBC although not as large as those found for the other Treatment Conditons (See Figure 3). Subjects were given the same relaxation-focusing instructions during the Neutral Condition and then asked to sit quietly for twenty minutes until the second sample was taken. The drop in WBC for the Neutral Condition can be thought of as representing a general response to a relaxed and restful state.

The larger decreases in WBC for the Treatment Conditions other than the Neutral Condition can also be explained, in part, by a decrease in blood flow. Schwartz (et al., 1981) in his study of

happiness, sadness, fear, and anger showed that the heart did indeed slow in response to sadness. His results regarding heart rate for happiness in the non-exercise portion of his study were even lower than the heart rate for sadness.

A slowing of the heart rate as a partial explanation of the WBC drop is consistant with the Treatment Effects findings for the supplemental analyses. The two statistically significant comparisons were for the Neutral versus Indirect Conditions and for the Neutral versus Sad Conditions (See Table 9). The means for the Neutral versus Direct Conditions also showed a great deal of change for men, but not for women.

The significant Neutral versus Indirect comparison indicates that the combined Indirect Conditions (Happiness and Sadness) were significantly different than the Neutral Condition. The statistically significant difference between the Indirect Conditions and the Neutral Condition implies that there was an additional impact beyond the change caused by simple relaxation. Studies cited by Hall (1982) and the work of Schneider (et al., 1984) parallel the WBC Neutral versus Indirect Conditions results from this study. Hall argues that relaxation associated with hypnotic conditions does not adequately account for changes documented in bodily reactions that are associated with the immune system (e.g. allergic responses, loss of warts, etc.). Hall points out that both inhibition and enhancement of immune responses have been documented so a general response such as relaxation (as a result of a hyponotic state) cannot fully account for the bodily changes found. Similarly, Schneider (et al., 1984) was able to reverse

an immune response by changing the content of the imagery. If the original immune response in the Schneider study was simply the result of a relaxation process the immune response would have remained the same with the new imagery content. The results cited by Hall (1982) and Schneider (et al., 1984) are consistent with Lang's (1978) Bioinformational Model which states that a given image will differently affect the body depending on the content of the image. In the present study, the content of the Indirect Conditions were significantly different than the content of the Neutral Condition and the difference between the Neutral and Indirect Conditions was statistically demonstrated.

Following Lang's (1978) model, it would be quite likely that the Happy Conditions in the study would yield results different than the results for the Sad Conditions. In general there were not satistically significant differences when comparing the Happy Conditions to the Sad Conditions for the measures employed in this study. However, the Neutral versus Sad comparison in the supplemental analysis did prove to be statistically significant.

Several other studies have also demonstrated changes in immune functioning that may parallel the significant Neutral versus Sad comparison found in this study. A few recent studies have focused on the emotional states of bereavement and also on depression. It can be assumed that Sadness would be one of the predominate feelings experienced by people experiencing either bereavement or depression.

Bartrop and his colleagues (1977) have shown depressed T-cell functioning in persons bereaving the loss of someone they were close to

emotionally. Linn (et al., 1982) also studied people experiencing bereavement but additionally assessed their levels of depression. When divided into high and low depression groups the more highly depressed group showed lessened immune response both to in vivo (delayed hypersensitivity tests) and in vitro (lymphocyte response to phytohemagglutinin). A third study by Kronfol (et al., 1982) compared the in vitro lymphocytic response of melancholic psychiatric patients, non-melancholic psychiatric controls, and normal controls. The melancholic group showed a marked decrease in lymphocytic response in comparison to both control groups.

In summary, it can be argued that part of the drop in WBC for the five treatment conditions can be a result of slowed blood flow because of increased parasympathetic activity. The statistically significant comparisons of the Neutral versus Indirect Conditions and the Neutral versus Sad Conditions are consistent with related theory and research that show a change in immune function as a result of depressed mood. In comparing the results of this study to the other studies cited in the discussion, it should be noted that a drop in WBC is not being equated with depressed immune function. Rather, the parallel is the fact that the Sad Conditions in this study showed the most defined immune response. The drop in WBC can not be considered positive or negative.

At the beginning of this discussion section it was stated that the drop in WBC could be accounted for at two levels 1) changes in blood flow as a result of changes in sympathetic/parasympathetic activity and 2) changes in white blood cell activity as a result of

hormonal/neurotransmitter influences. The argument for decrease in blood flow as a partial influence on lower WBC readings has been addressed in the above paragraphs. The possible effects of hormones or neurotransmitters on the WBC are less clear in this study.

Of the four dependent measures in the study (WBC, Neutrophil Percentage, Adhesion and Stimulated Adhesin) Adhesion and Stimulated were the most direct means of assessing the effects of hormones or neurotransmitters. The Stimulated Adhesion measure was not statistically analyzed because of missing data and therefore can not be used to assess the responsiveness of the neutrophils to a known neurotransmitter. The Adhesive results were not statistically significant and therefore do not add further understanding why there were drops in the WBC for the various Treatment Conditions. Thus, the dependent measures used in this study did not show a clear change as a result of hormonal/neurotransmitter activity.

It is, however, unlikely that the total changes in WBC within the this study can be explained simply by a reduced blood flow. The WBC includes many cells other than neutrophils and it is quite possible that these cells were influenced by hormones or neurotransmitters in a manner that would lessen their count. Cunningham (1981) lists several hormones that have been shown to influence immune activity including: corticosteroids, androgens, estrogens, progesterone, growth hormone, thyroxine and insulin. Thus, while it is quite likely the WBC was influenced by hormonal influences, there is no firm evidence from the present study to confirm a hormonal/neurotransmitter level of influence.

In addition to the WBC main Treatment Effects listed above, there were also Sex by Treatment interactions for the Neutral versus Direct comparison and the Neutral versus Direct Sad comparison that were statistically significant. Both of the statistically significant Sex by Treatment comparisons were for comparisons between the Neutral Conditions and Direct Conditions: Direct Happy and Direct Sad combined in the first comparison and Direct Sad alone in the second comparison.

Efforts at explaining the Sex by Treatment interactions fall largely in the area of conjecture. One of the differences in men and women for the three Treatment Conditions (Neutral, Direct Happy and Direct Sad) may be how easily a given sex relaxes (Neutral Condition).

Another factor may be how the sexes relate to the imagery process for the Direct Conditions. In the Direct Conditions the subject had to both generate an affect and then project that affect into their concept of IgA and Neutrophils. Men and women have been shown to relate differently to emotions (Schwartz et al., 1979 & 1980a) and studies have also shown different preferences for the sexes in cognitive processing that could influence the Treatment Conditions in the study.

A third level of explanation could be differences in physiology of men and women. Even if the same cognitive process had taken place for men and women the following endocrine (Frankenhauser, 1975) and immune responses may be different (Bellanti, 1978; Rogers et al., 1979).

While each of the above explanations for the Sex by Treatment interactions has some face validity there is not supporting evidence within the study to exspouse one view over another. If the study had included measures of level of relaxation (e.g. EMG levels), cognitive

style, or endocrine response then a more definitive picture may have emerged regarding the interaction of Sex and Treatment Conditions.

Implications for Future Research

The results of this study combined with the various studies cited in the literature review suggest that further investigation of the influences of emotions on the immune system is warranted.

One of the most obvious implications from this study for future research is the need to have large sample sizes whenever possible. Given the relatively small sample size and the large within Treatment Condition variance in this study, it is impressive that any statistically significant results were found. Larger sample sizes would control for some of the variance encountered and it would allow relationships to be more easily demonstrated if they in fact exist.

Another design change for future research may involve repeated sessions of the same feeling for a given subject. A clearer physiologic pattern for a particular feeling may emerge using a repeated sessions approach and the effect of practice could also be assessed. Several studies (Black, 1963; Schneider et al., 1984; Shurman, 1983) have suggested the importance of repeating whatever procedure (imagery, hypnosis, etc.) that is being used to influence the immune system.

An obvious possibility for additional research would be the exploration of feelings other than happiness and sadness. Happiness and sadness were chosen, in part, because they are considered opposites in a theoretical sense. It may well be that feelings such as anger or

rage could cause a greater physiological change and, therefore, would be more likely to establish changes in immune functioning.

General physical activity levels could also be a variable to explore in future research. All the subjects for the present study followed an imagery technique that basically involved little physical movement. If subjects actively expressed a feeling state the results may be considerably different than those found in the present study.

The study clearly highlights the importance of considering sex differences in the design and interpretation of future studies. Although there were not main effects for gender differences, there were interactions between sex and some of the Treatment Conditions. Designs using both sexes and testing for gender effects would be ideal. If resource limitations preclude the use of both sexes, then the generalization of a single sex study should be done in a very cautious manner.

In addition to looking at gender differences, future studies could well consider differences in factors such as cognitive style, hypnotizability, or creativity. Subjects could be pre-selected on the basis of one or more cognitive parameters and then correlations done to see if various cognitive traits result in a greater or lesser influence on immune system activity.

Finally, a more general suggestion for future reserch has been stated by Cunningham (1981). Cunningham has suggested that psychoneuroimmunologic studies need to have multiple and concurrent measures on several psychological and biological levels. By looking at several measures simultaneously some patterns may emerge that otherwise would not be detected. The relationships of CNS and the immune system are

obviously complex and simple cause and effect designs may not be the best approach in studying psychoneuroimmunologic relationships.

APPENDICES

APPENDIX A

CONSENT FORM

Michigan State University
Department of Counseling Psychology
and
Department of Psychiatry

1. I have freely consented to take part in a scientific study being conducted by: Gerald Hermanson, M.A.
under the supervision of: William Hinds, Ph.D., Professor of Counseling Psychology and C. Wayne Smith, M.D. Professor of Anatomy.

2. The study has been explained to me and I understand the explanation that has been given and what my participation will involve.

3. I agree to donate a maximum of 30 c.c. of whole blood per venapuncture, and no more than 55 c.c. in a 24 hour period for this scientific study. Each blood donation will consist of two venapuncture samples up to a maximum of 5 donations.

4. In return for each donation period I will receive $5.00. I will be paid after my last donation period or at the time I choose to discontinue my participation in the study.

5. I am fully aware of the risks inherent in the donation of these samples.

6. I have no known health problem for which blood donations might be detrimental, and I will report any change in my health, or blood donations given elsewhere before any donation.

7. I understand that in the unlikely event of physical injury resulting from research procedures, Michigan State University, its agents, and employees will assume that responsibility as required by law. Emergency medical treatment for injuries or illness is available where the injury or illness is incurred in the course of an experiment. I have been advised that I should look toward my own health insurance program for payment of said medical expenses.

8. I am aware that the procedures include experiencing various emotional states.

9. I understand that I will be filling out a number of inventories that will be used by the investigator to examine and rule out factors that may influence the physiologic responses being measured in the study. The information in these inventories will be kept confidential and will be stored in a manner that will keep my anonymity. If I wish to have my responses interpreted to me I can request this information at the end of the study.

10. I understand that the results of the study will be treated in strict confidence and that I will remain anonymous. Should the study results be published my participation will remain anonymous. Within these restrictions, results of the study will be made available to me at my request.

11. I understand that my participation in the study does not guarantee any beneficial results to me.

12. I understand that, at my request, I can receive additional explanation of the study after my participation is completed.

13. I have not been coerced in any way to participate in this experiment and I understand that I am free to discontinue my participation in the study at any time without penalty.

Signed_____

Date_____

APPENDIX B

DEMOGRAPHIC DATA AND BACKGROUND INFORMATION

Demographic Data and Background Information

1. Name _____

2. Sex _____M _____F

3. Age _____

4. Height _____

5. Weight _____

6. Race _____

7. Occupation _____

8. Educational level _____

9. Do you understand the procedures for taking the blood and saliva samples? _____Yes _____No

   How do you feel about these procedures?

10. Do you follow a specific type of diet (such as vegetarian)?

    If so, what? _____

    Do you take any dietary supplements (Vitamins, etc.)? __

    If so, what? _____

    How much? _____

11. Please describe your typical weekly pattern of exercise.

12. How many hours of sleep do you typically get per night?__

13. Are you currently under much stress? _____ Explain:

14. Have you recently experienced a significant interpersonal loss either through separation or death? _____

    If so, when_____

15. Are you taking medication for anything? (includes birth control pills) _____

    If so, what? _____

16. Have you had an infection or illness recently? _____

    If so, what? _____

17. When do you expect your next menstrual period? _____

APPENDIX C

PRETREATMENT QUESTIONNAIRE

Pretreatment Questionaire

1. Name_____

2. Have you taken any dietary supplements during the past week?

   If so, what?_____

   How much?_____

3. Please describe when and how much you exercised this last week:

4. What was the average number of hours you slept per night this last week?_____

   How many hours of sleep did you get last night?_____

   Do you feel rested this morning?_____

5. Have you experienced a significant interpersonal loss this last week?
   If so, what?_____

6. Have you taken any medication this last week?

   If so, what?_____

7. Have you had an infection or illness this last week?

   If so, what?_____

8. Have you consumed any alcohol, aspirin, or marijuana during the past 24 hours?_____

   If so, how much?_____

9. Are you currently experiencing menstration?_____

APPENDIX D

BECK DEPRESSION INVENTORY

BECK INVENTORY

Name _____ Date _____

On this questionnaire are groups of statements. Please read each group of statements carefully. Then pick out the one statement in each group which best describes the way you have been feeling the PAST WEEK, INCLUDING TODAY! Use the answer sheet provided and fill in the circle which corresponds with the number of the statement.

1. 0 I do not feel sad.
   1 I feel sad.
   2 I am sad all the time and I can't snap out of it.
   3 I am so sad or unhappy that I can't stand it.

2. 0 I am not particularly discouraged about the future.
   1 I feel discouraged about the future.
   2 I feel I have nothing to look forward to.
   3 I feel that the future is hopeless and that things cannot improve.

3. 0 I do not feel like a failure.
   1 I feel I have failed more than the average.
   2 As I look back on my life, all I can see is a lot of failures.
   3 I feel I am a complete failure as a person.

4. 0 I get as much satisfaction out of things as I used to.
   1 I don't enjoy things the way I used to.
   2 I don't get real satisfaction out of anything anymore.
   3 I am dissatisfied or bored with everything.

5. 0 I don't feel particularly guilty.
   1 I feel guilty a good part of the time.
   2 I feel quite guilty most of the time.
   3 I feel guilty all of the time.

6. 0 I don't feel I am being punished.
   1 I feel I may be punished.
   2 I expect to be punished.
   3 I feel I am being punished.

7. 0 I don't feel disappointed in myself.
   1 I am disappointed in myself.
   2 I am disgusted with myself.
   3 I hate myself.

8. 0 I don't feel I am any worse than anybody else.
   1 I am critical of myself for my weaknesses or mistakes.
   2 I blame myself all the time for my faults.
   3 I blame myself for everything bad that happens.

9. 0 I don't have any thoughts of killing myself.
   1 I have thoughts of killing myself, but I would not carry them out.
   2 I would like to kill myself.
   3 I would kill myself if I had the chance.

10. 0 I don't cry anymore than usual.
    1 I cry more now than I used to.
    2 I cry all the time now.
    3 I used to be able to cry, but now I can't cry even though I want to.

11 0 I am no more irritated now than I ever am.
1 I get annoyed or irritated more easily than I used to.
2 I feel irritated all the time now.
3 I don't get irritated at all by the things that used to irritate me.

12. 0 I have not lost interest in other people.
1 I am less interested in other people than I used to be.
2 I have lost most of my interest in other people.
3 I have lost all of my interest in other people.

13. 0 I make decisions about as well as I ever could.
1 I put off making decisions more than I used to.
2 I have greater difficulty in making decisions than before.
3 I can't make decisions at all anymore.

14. 0 I don't feel I look any worse than I used to.
1 I am worried that I am looking old or unattractive.
2 I feel that there are permanent changes in my appearance that make me look unattractive.
3 I believe that I look ugly.

15. 0 I can work about as well as before.
1 It takes an extra effort to get started at doing something.
2 I have to push myself very hard to do anything.
3 I can't do any work at all.

16. 0 I can sleep as well as usual.
1 I don't sleep as well as I used to.
2 I wake up 1-2 hours earlier than usual and find it hard to get back to sleep.
3 I wake up several hours earlier than I used to and cannot get back to sleep.

17. 0 I don't get more tired than usual.
1 I get tired more easily than I used to.
2 I get tired from doing almost anything.
3 I am too tired to do anything.

18. 0 My appetite is no worse than usual.
1 My appetite is not as good as it used to be.
2 My appetite is much worse now.
3 I have no appetite at all anymore.

19. 0 I haven't lost much weight, if any lately.
1 I have lost more than 5 pounds.
2 I have lost more than 10 pounds.
3 I have lost more than 15 pounds.

I am purposely trying to lose weight by eating less. Yes _____ No _____

20 0 I am no more worried about my health than usual.
1 I am worried about physical problems such as aches and pains; or upset stomach; or constipation.
2 I am very worried about physical problems and it's hard to think of much else.
3 I am so worried about my physical problems, that I cannot think about anything else.

21. 0 I have not noticed any recent change in my interest in sex.
1 I am less interested in sex than I used to be.
2 I am much less interested in sex now.
3 I have lost interest in sex completely.

APPENDIX E

LIFE EXPERIENCES SURVEY

The Life Experiences Survey

Listed below are a number of events which sometimes bring about change in the lives of those who experience them and which necessitate social readjustment. Please check those events which you have experienced in the recent past and indicate the time period during which you have experienced each event. Be sure that all check marks are directly across from the items they correspond to.

Also, for each item checked below, please circle the extent to which you viewed the event as having either a positive or negative impact on your life at the time the event occurred. That is, indicate the type and extent of impact that the event had. A rating of -3 would indicate an extremely negative impact. A rating of 0 suggests no impact either positive or negative. A rating of +3 would indicate an extremely positive impact.

SECTION I

	0 to 6 mo	7 mo to 1 yr	# yrs ago	extremely negative	moderately negative	somewhat negative	no impact	slightly positive	moderately positive	extremely positive
1. Marriage				-3	-2	-1	0	+1	+2	+3
2. Detention in jail or comparable institution				-3	-2	-1	0	+1	+2	+3
3. Death of spouse				-3	-2	-1	0	+1	+2	+3
4. Death of close family member:										
a. mother				-3	-2	-1	0	+1	+2	+3
b. father				-3	-2	-1	0	+1	+2	+3
c. brother				-3	-2	-1	0	+1	+2	+3
d. sister				-3	-2	-1	0	+1	+2	+3
e. grandmother				-3	-2	-1	0	+1	+2	+3
f. grandfather				-3	-2	-1	0	+1	+2	+3
g. other (specify)				-3	-2	-1	0	+1	+2	+3
5. Foreclosure on mortgage or loan				-3	-2	-1	0	+1	+2	+3
6. Death of close friend				-3	-2	-1	0	+1	+2	+3
7. Outstanding personal achievement				-3	-2	-1	0	+1	+2	+3
8. Minor law violations (traffic tickets, disturbing the peace, etc.)				-3	-2	-1	0	+1	+2	+3
9. Male: Wife/girlfriend's pregnancy				-3	-2	-1	0	+1	+2	+3
10. Female: Pregnancy				-3	-2	-1	0	+1	+2	+3
11. Changed work situation (different work responsibility, major change in working conditions, working hours, etc.)				-3	-2	-1	0	+1	+2	+3
12. New job				-3	-2	-1	0	+1	+2	+3
13. Serious illness or injury of close family member:										
a. father				-3	-2	-1	0	+1	+2	+3
b. mother				-3	-2	-1	0	+1	+2	+3
c. sister				-3	-2	-1	0	+1	+2	+3
d. brother				-3	-2	-1	0	+1	+2	+3
e. grandfather				-3	-2	-1	0	+1	+2	+3
f. grandmother				-3	-2	-1	0	+1	+2	+3
g. spouse				-3	-2	-1	0	+1	+2	+3
h. other (specify)				-3	-2	-1	0	+1	+2	+3

	0 to 6 mo	7 mo to 1 yr	# yrs ago	extremely negative	moderately negative	somewhat negative	no impact	slightly positive	moderately positive	extremely positive
14. Sexual difficulties				-3	-2	-1	0	+1	+2	+3
15. Trouble with employer (in danger of losing job, being suspended, demoted, etc.)				-3	-2	-1	0	+1	+2	+3
16. Trouble with in-laws				-3	-2	-1	0	+1	+2	+3
17. Major change in financial status (a lot better off or a lot worse off)				-3	-2	-1	0	+1	+2	+3
18. Major change in closeness of family members (increased or decreased closeness)				-3	-2	-1	0	+1	+2	+3
19. Gaining a new family member (through birth, adoption, family member moving in, etc.)				-3	-2	-1	0	+1	+2	+3
20. Change of residence				-3	-2	-1	0	+1	+2	+3
21. Marital separation from mate (due to conflict)				-3	-2	-1	0	+1	+2	+3
22. Major change in church activities (increased or decreased attendance)				-3	-2	-1	0	+1	+2	+3
23. Marital reconciliation with mate				-3	-2	-1	0	+1	+2	+3
24. Major change in number of arguments with spouse (a lot more or a lot less arguments)				-3	-2	-1	0	+1	+2	+3
25. Married male: Change in wife's work outside the home (beginning work, ceasing work, changing to a new job, etc.)				-3	-2	-1	0	+1	+2	+3
26. Married female: Change in husband's work (loss of job, beginning new job, retirement, etc.)				-3	-2	-1	0	+1	+2	+3
27. Major change in usual type and/or amount of recreation				-3	-2	-1	0	+1	+2	+3
28. Borrowing more than $10,000 (buying home, business, etc.)				-3	-2	-1	0	+1	+2	+3
29. Borrowing less than $10,000 (buying car, TV, getting school loan, etc.)				-3	-2	-1	0	+1	+2	+3
30. Being fired from job				-3	-2	-1	0	+1	+2	+3
31. Male: Wife/girlfriend having abortion				-3	-2	-1	0	+1	+2	+3
32. Female: having abortion				-3	-2	-1	0	+1	+2	+3
33. Major personal illness or injury				-3	-2	-1	0	+1	+2	+3
34. Major change in social activities, e.g., parties, movies, visiting (increase or decreased participation)				-3	-2	-1	0	+1	+2	+3

	0 to 6 mo	7 mo to 1 yr	# yrs ago	extremely negative	moderately negative	somewhat negative	no impact	slightly positive	moderately positive	extremely positive
35. Major change in living conditions of family (building new home, remodeling, deterioration of home, neighborhood, etc.)				-3	-2	-1	0	+1	+2	+3
36. Divorce				-3	-2	-1	0	+1	+2	+3
37. Serious injury or illness of close friend				-3	-2	-1	0	+1	+2	+3
38. Retirement from work				-3	-2	-1	0	+1	+2	+3
39. Son or daughter leaving home (due to marriage, college, etc.)				-3	-2	-1	0	+1	+2	+3
40. Ending of formal schooling				-3	-2	-1	0	+1	+2	+3
41. Separation from spouse (due to work, travel, etc.)				-3	-2	-1	0	+1	+2	+3
42. Engagement				-3	-2	-1	0	+1	+2	+3
43. Breaking up with boyfriend/ girlfriend				-3	-2	-1	0	+1	+2	+3
44. Leaving home for the first time				-3	-2	-1	0	+1	+2	+3
45. Reconciliation with boyfriend/ girlfriend				-3	-2	-1	0	+1	+2	+3
Other recent experiences which have had an impact on your life. List and rate.										
46.				-3	-2	-1	0	+1	+2	+3
47.				-3	-2	-1	0	+1	+2	+3
48.				-3	-2	-1	0	+1	+2	+3
SECTION 2: Student Only										
49. Beginning a new school experience at a higher academic level (college, graduate school, professional school, etc.)				-3	-2	-1	0	+1	+2	+3
50. Changing to a new school at same academic level (undergraduate, graduate, etc.)				-3	-2	-1	0	+1	+2	+3
51. Academic probation				-3	-2	-1	0	+1	+2	+3
52. Being dismissed from dormitory or other residence				-3	-2	-1	0	+1	+2	+3
53. Failing an important exam				-3	-2	-1	0	+1	+2	+3
54. Changing a major				-3	-2	-1	0	+1	+2	+3
55. Failing a course				-3	-2	-1	0	+1	+2	+3
56. Dropping a course				-3	-2	-1	0	+1	+2	+3
57. Joining a fraternity/sorority				-3	-2	-1	0	+1	+2	+3
58. Financial problems concerning school (in danger of not having sufficient money to continue)				-3	-2	-1	0	+1	+2	+3

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