The Use of Corona Discharge Patterns in the Diagnosis of State Depression and State Anxiety

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THE USE OF CORONA DISCHARGE PATTERNS IN THE DIAGNOSIS OF
STATE DEPRESSION AND STATE ANXIETY

by

William Hovsepian

A Dissertation Submitted to the Faculty of the Graduate School of Loyola
University of Chicago in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Philosophy

1980
ACKNOWLEDGMENTS

The author wishes to express his deep appreciation to his dissertation committee for their foresight in allowing him to undertake this study, their ever-present support in seeing the job through, and their warm friendship which made a difficult task appear easy.

Special thanks are extended to my raters, Mr. Mark Groberski, Ms. Janice Kowalski, and Ms. Ileen Liss, for their fine work, and to Dr. Frank Slaymaker for his critical assessment of the statistical analyses.

In addition, the author would like to thank Mr. Mark Daskovsky, of the Parmly Hearing Laboratory, whose electronic wizardry proved invaluable in this task.

Finally, to the support and understanding given to me by my parents over these years: The long wait is over.
VITA

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INTRODUCTION

"Kirlian", "Kirlian photography", or electrophotography, as it is referred to, has been the center of controversy among researchers for well over twenty years. The technique, first widely publicized in 1959 by Semyon and V. H. Kirlian, two Russian researchers, has been extensively investigated in the Soviet Union. Until recently, this form of research has received little or passing notice in the United States. Perhaps the scarcity of such research in this country may have partly reflected anti-Soviet feelings during the "Cold War" of the late 1950's and early 1960's or may have been due to a lack of communication between researchers on this side of the Atlantic and behind the Iron Curtain.

In the late 1960's, at Stanford University, perhaps the first Kirlian laboratory in the United States was set up to extensively examine this phenomenon. In contrast to the U.S.S.R., Kirlian photography in this country has been identified with parapsychological phenomenon and, in the eyes of many, is equated with techniques that border upon voodoo. In many cases, this nefarious image has been engendered by overzealous researchers (or over enthusiastic dilletantes in the field) who have associated the aura produced by this phenomenon with being a measure of an object's bioplasma. Such equation is, at present, scientifically untenable and unsound and represents an almost reckless abandon of scientific objectivity and conservatism.
It is time to divorce Kirlian photography or electrophotography from its unhappy marriage to parapsychology and begin to seriously investigate its possible potential as a research and/or diagnostic tool in the area of traditional psychological investigation. Initial attempts to employ the Kirlian technique to assess degree of interpersonal attraction (Murstein & Hadjolian, 1977) and as a diagnostic tool in organ system pathology (Kightlinger, 1975) have provided promising evidence of its usefulness in these areas. Expanding upon these successful endeavors, the present investigation will attempt to explore the potential of Kirlian photography to differentiate between depression and anxiety in human subjects.
REVIEWS OF RELATED LITERATURE

Kirlian Photography

"Kirlian" photography or "electrophotography" derives its name from two Soviet biologists, Semyon and Valentina Kirlian, who, in 1959 (based upon work begun in 1939), described a process by which an object (animate or inanimate) was placed upon a piece of color film print paper which, in turn, was set on a plexiglass insulator superimposed on a dielectric plate which carried a high-voltage charge (Kirlian & Kirlian, 1973). The object to be imaged was engulfed by a high-voltage, high-frequency electric field, which was the only source of illumination. The high-voltage, high-frequency alternating current passed through the object and film inducing cold emission of electrons from the object's surface and recording the luminance provided by the ionization and recombinant events on film (Boyers & Tiller, 1973; Krippner, 1973; Pehek, Kyler, & Faust, 1976). Although construction of this apparatus varies from researcher to researcher, the basic equipment consists of a Tesla coil, used as an energy source, which is plugged into an outlet and rigged to a metal (dielectric) plate. The voltage travels over the surface of the object, and the electricity hitting the photographic print paper serves to produce the latent image. The length of the exposure time depends upon the speed of the film and the strength of the current (Murstein & Hadjolian, 1977). For a more technical review of this apparatus, the reader is encouraged to review Boyers & Tiller (1973)
A contact print of an object is made in this manner. But in addition to the image of the object when the film is developed, many luminous spots or streaks varying in length, number, and color surround the object. Terms such as "field" or "aura" (Krippner, 1973; Murstein & Hadjolian, 1977), "nimbus" (Krippner, 1973), "corona discharge patterns" or "prominances" and "streamers" (Boyers & Tiller, 1973; Pehek, Kyler, & Faust, 1976) have been used to describe these streaks and spots that exist in addition to the object's image.

Attempts have been made to determine what these streaks and spots represent. Dean (1977) and Krippner (1973) felt that these fields represent electrons which exit from the surface of the object at differing velocities and form the streaky-spotty patterns. Krippner (1973) has stated that this phenomenon represents energies of mental origin, but expressed in physical output which bridges the gap between "psyche" and "soma." Boyers and Tiller (1973) reported that the intensity and character of these energy emissions in the Kirlian process seem to be strongly dependent upon the mental, emotional, and physical health conditions of the subject being photographed. These investigators, rather than using mentalistic constructs, attempted to describe the corona discharge patterns, which they called "streamers," in terms of the changing flow (from the cathode to the anode) of electrons. This is how they describe the process:

The varying states in the development of streamers begins with electrons being released from the cathode by natural ionizing events (cosmic rays) or uv (ultraviolet) radiation, or field emission. These electrons are accelerated by the field and ionize
the air molecules yielding an exponential growth in the number of electrons and positive ions, i.e., an avalanche. The electrons, owing to their small mass, drift at velocities 200 times that of the positive ions and are quickly swept to the anode. The electron avalanche releases photons from the anode which produces additional local ionization of the air. At threshold voltage or above, an avalanche of positive ions, which after becomes a positive streamer, moves toward the cathode at high speeds. As such a high-potential front approaches the cathode, tremendous fields are built up and the intense uv light from the luminance tip creates a burst of photoelectrons to be ejected from the cathode. These multiply rapidly in the high-field, leading to an extremely ionized and accelerated high-field region that propigates itself to the anode as a potential space wave of ionization at extremely high speeds (pp. 3105-3106).

Dobervich (1974) offered another explanation of the corona discharge patterns produced in Kirlian photography. She felt that they were not the result of unrecognized energies from the object, but could be explained by physical factors, particularly the spacing between film, object, and electrical source:

Although the precise nature and cause of these patterns has not yet been completely determined, terms like "aura", "energy body", or "bioplasma" have been freely used in the Kirlian literature to describe these spots (Thathachari & Pushpa, 1977). Such usage is equated with parapsychological research which is viewed with a great deal of skepticism in the country. Thathachari and Pushpa (1977) felt that there was no compelling need to use such terminology. This admonishment may have been in an attempt to separate Kirlian research from many close alignment to paranormal processes thus allowing a more conservative, scientific approach to be used in explaining and examining this phenomenon. Kirlian and Kirlian (1977) also felt that these discharge patterns were not a paranormal process.
Serious research attempts have been undertaken to better understand the physics of the Kirlian process as well as to assess particular subject and environmental factors which may influence the photographs. Pehek, Kyler, and Faust (1976) attempted to investigate the parameters of the Kirlian process by conducting a number of small experiments to determine what factors in the physics of the process as well as characteristics of the subject would influence the corona discharge. They define the corona discharge as a luminous, low-current, gaseous discharge occurring in the atmosphere of the electric-field-strength below the threshold for spark breakdown. The corona discharges were grouped into four dimensions: 1) Streamer range: the length of streamer images extending radially from the subject-film boundary (further subdivided into long streamers that may be faint and a denser group of short streamers); 2) Streamer density: the overall impression of the degree of streamer activity given by a photograph; 3) Secondary images: images surrounding and possibly within the subject-film boundary that have a diffuse character; and, 4) Streamer curvature. A number of physical parameters were then examined to assess their influence on each of these dimensions.

The results indicated that streamer range was most influenced by the film type used; the attenuation of the streamer was most pronounced when Polaroid 55p/n film was used. Other factors that affected streamer range was electric field bending due to the mismatch of dielectric contacts at dielectric interfaces, the relative thickness of the dielectric components between the subject and high-voltage, the water vapor content of the atmosphere, and geometric characteristics of the
surface of the object. Increases in atmospheric water content influenced the range of streamers by reducing their range through absorption of photons which otherwise would have been available for propigating positive streamers by photoionization or vapor may reduce the streamer breakdown voltage by influencing the charge sheath that formed about a positive point.

With respect to streamer surface characteristics, Pehek, Kyler, and Faust (1976) speculated that the spacing and regularity of corona sites suggested that they may be the illumination of sweat pores, "considering the small radius of curvature of sweat duct openings (about 25 micrometers), it would not be surprising if these were the most likely corona sites on the human body" (p. 266).

Factors that influenced streamer density of fingertip photographs were washing the fingertips with alcohol or acetone, which caused an increase in density. However, hydration of a finger in water and saline solution, depending upon the temperature, decreased streamer activity. This finding has been supported by Omura (1976) who reported diminished discharge patterns after 30 sec. of hydration in pure water. Palmar sweat activity correlated negatively with skin resistance; when sweat activity was high and GSR values low, the density of the photographic image was low. Hyperventilation by a subject, which was expected to increase palmar activity, also reduced streamer density.

In addition to the above, Pehek et al. used six subjects who had their fingertips photographed before and after the following:
hyperventilation; receiving a loud tone burst (100 db SPL); receiving a pinch (via forceps); and performing mental arithmetic exercises (serial subtraction by odd numbers). Reduction in corona discharge was measured. Reduction was not consistent among all subjects, and no single condition produced a large reduction with all subjects. Smallest corona response was obtained in the mental arithmetic condition, the tone burst evoked a strong response in four of the six subjects, while five responded significantly to the pinch. In the hyperventilation condition, corona reduction occurred with all subjects and was significant in five of them. An additional finding in the study was that the image of a finger corona obtained after an earlier corona photograph of the same finger was often more dense, provided that the time between the two photographs was not long. This effect could last up to one minute between the two exposures. Pehek et al. suggested that, "This effect is either a result of dehydration of the stratum corneum or sweat duct emptying accompanied by depolarization of the sweat duct neurons in the electrical field. A return to moisture equilibrium may take an appreciable period of time." (p. 269). Pehek et al. felt that most of the variation in the images of the corona could be accounted for by the presence of moisture (both perspiration and water vapor from hydrated skin) on or within the subject's surface, "During exposure, the moisture is transformed from the subject to the emulsive surface of the photographic film, hence the electric field at the surface of the subject." (p. 269).

Other investigators (Omura, 1976; van der Schaar, 1976) have also
confirmed that water vapor in the air can affect discharge patterns. Variations in humidity (between 48% and 68%) were sufficient to cause fluctuations in discharge patterns. Omura (1976) also noted that differences in barometric pressure can decrease or increase the intensity of the discharge pattern.

Murstein and Hadjolian (1977) reported that fingertip pressure affected the corona discharge pattern, specifically its diameter. When very firm pressure was applied, the diameter of the fingertip area was larger. With lighter pressure, the diameter was smaller. Emissions around the fingertip area was affected by the diameter of the area which, in turn, was affected by pressure. With smaller areas emissions were wider and with larger areas emissions were narrower. This fingertip pressure variable has been further studied by Clynes (1970) who has used impulses from the pressure of a finger, via pressure transducers, to demonstrate that imagining different emotional and affective states can produce differences in fingertip pressure. He called this phenomenon Sentics.

To control for pressure effects, Targ and Cohen (1974) suggested that objects be photographed through a vertically suspended glass electrode plate. The plate should be mounted on a frame and function like a pendulum. By means of a fixed finger holder, the subject would be made to displace the plate away from him to a prespecified distance. Gravity would hold the frame and plate against the subject's finger with constant force. A potentiometer should also be added to insure that the subject would not accidentally or deliberately move the plate.
Omura (1976) has listed other variables which can influence the corona discharge pattern. Briefly, these variables are: poisons, cardiovasuclar drugs, tranquilizers, morphine derivatives, methadone, gas inhalation, intake of beverages such as alcohol and soft drinks, as well as various foods including chocolate, candies, and cake.

Variations in the color of the Kirlian corona images have also been investigated. Moss and Johnson (1971) analyzed the coloration of the photographs of hundreds of subject fingertips. In their studies, the subject holds a dielectrically covered electrode in one hand, through which a charge is sent. They found that when a subject was in a relaxed state, the photographic field usually registers a dark blue color. When the subject was angered, the photographic field displays as a red blotch. Thus, Moss and Johnson (1971) contend that the Kirlian field coloration is affected by mood and emotion. Dean (1977), although unable to find reliable discriminating differences between sound and carious teeth in the components of the Kirlian photographs, incidentally discovered a difference in the coloration in the components of the tooth with respect to the density of the tooth material. The tooth tissues exhibited a different appearance under the Kirlian influence. Enamel appeared granular blue, dentin was uniformly blue, and cementum appeared as a streaky pink-red.

Boyers and Tiller (1973) examined the physical properties of the photographic emulsion paper itself as a potential explanation for the effects of coloration. In their investigation, the authors reported that a bluish-white coronal field was the overwhelmingly dominant color
of the discharge. In air, at high field streams, the normal color of the streamer (corona) was light blue. Yellowish flashes had also been observed at times in the discharge field, and this was thought to have been due to the presence of sodium from NaCl on the electrode surface. Additionally, they speculated that if minute carbon flakes are ejected from the electrode and made incandescent in the corona burst, they may give rise to red or yellow streaks of light.

In their analysis of the properties of the color film emulsion paper itself, Boyers and Tiller (1973) stated that the film consisted of three emulsion layers separated by two filter layers and a plastic supporting or backing which was usually coated with a grey anhalation coating. When white or uv (ultraviolet) light strikes the film from the emulsion side, the first emulsion, which is a blue-sensitive film responding to uv and blue light, is exposed by the uv and blue components. The first filter layer passes to red and green components and the green component exposes the second emulsion, an orthochromatic emulsion sensitive to blue, and green. The second filter layer, which passes red and blue, allows the red component to pass and expose the third emulsion, a panchromatic emulsion sensitive to uv, blue, green, and red. Thus, the first emulsion is exposed by uv and blue, the second emulsion is exposed by green, and the third emulsion is exposed by red. In the condition just described, when a light source strikes the emulsion side first, the first emulsion (coding blue) is exposed to all the light initially, and the blue will receive the greatest exposure yielding a blue-white pattern. This occurs when an opaque film backing is used.
When the situation is reversed, and light strikes the support side first, the third emulsion (coding red) will receive a greater exposure yielding an overall result of orange or reddish-orange. Tiller (1975) further noted that when light strikes both sides of the film, a summation effect is obtained, i.e., red + blue = magenta. In retrospect though, Boyers and Tiller (1973) stated that this explanation of the Kirlian field is not necessarily the only or proper explanation.

Possibly in an attempt to lend support to the hypothesis that the Kirlian effect is measuring something related to paranormal phenomenon rather than physiological phenomenon, Moss and Johnson (1971) asserted that when the parameters of photography are held constant, the Kirlian technique is not related to changes in heart rate, GSR, vasoconstriction, skin temperature, or sweat. This assertion runs counter to the findings of Murstein and Hadjolian (1977), Pehek, Kyler, and Faust (1976), and Schwartz (1974), who reported that their research supports the hypothesis that corona discharge patterns are associated with indicators of sweating such as GSR. As Pehek et al. and Schwartz give no clear-cut explanation of what produces the sweating, Murstein and Hadjolian (1977) venture that it is related to mood, particularly in interpersonal relations.

With respect to the possibility of interpersonal factors affecting the corona discharge pattern, Moss and Johnson (1974) stated that the age and sex of the experimenter-photographer can influence the size of a subject's corona. An elderly experimenter yielded smaller coronas from a young subject than did a young research assistant. A male
photographer elicited smaller coronas from a male subject than from a female subject. However, van der Schaar (1976), although not specifying the age or sex of his photographer, reported no age or sex differences in his subjects' photographs. Based upon Moss and Johnson's (1974) findings, van der Schaar should have found a difference; his experimenter should have differentially influenced the discharge patterns of opposite-sex, and opposite-age subjects.

Murstein and Hadjolian (1977), using undergraduate students at a Catholic college and at a northern seaboard college for subjects, were interested in determining the relationship between fingertip corona discharges and interpersonal attraction. They hypothesized that subjects would respond with larger coronas to: 1) opposite-sex photographers as compared with same-sex photographers; 2) to seductive opposite-sex photographers as compared with normally behaving opposite-sex photographers; 3) to opposite-sex unknown peers as opposed to same-sex unknown peers; and, 4) to liked as opposed to disliked same-sex peers. All of these hypotheses were supported except for the second. In the case of the second hypothesis, a significant result was obtained in the direction opposite to that which was originally predicted.

Perhaps the most novel aspect of their research was the design of a 7-point aura scoring system, devised by Murstein and Hadjolian (1977), based upon the intensity, size, and "freedom from anxiety" displayed by the coronal discharge pattern. Intensity of the aura was determined by its brightness and color: the brighter the aura, the more intense it was. Size was measured by the length of the spike rather than the
diameter of the discharge which varies as a function of a subject's finger size. Anxiety was indicated by the presence of fingerprints within the aura photographs. Eight undergraduate students (four male and four female) served as judges and were trained with photographs of corona discharges secured during a pilot study. The scoring system was as follows: A score of 7 was given if the auras in the photograph were longer than 1/8" and were predominantly white in color. A score of 6 was given if the auras were identical to those in the previous category, but less than 1/8". A score of 5 was given to auras greater than 1/16" in size and blue in color. A score of 4 was given to auras of less than 1/16" of blue coloration with barely visible spikes. A score of 3 was given to auras that were barely visible, had no spikes, were slightly blue in color, and were of dim or of little intensity. A score of 2 was assigned to photographs which contained no auras at all, and a score of 1 was given to brownish smudges that were fingerprints. The reliability of judges using this system ranged from .96, for judgments of photographs taken using only one subject, and .996 when judgments were made with two subjects (an undergraduate subject and an experimenter) represented on a photograph.

Several studies have been conducted using Kirlian techniques in an attempt to validate acupuncture phenomena and as an aide to organ pathology diagnosis. Wei (1975) demonstrated that either electrical stimulation or acupuncture needling of the limb of a cat produced an observable difference in the coronal discharge pattern of the cat's paw as compared to discharge patterns recorded when the cat was in a resting state with no stimulation applied. Poock (1975) reported that
there was a significant change in the electrophioluminescence of acupuncture points, corresponding to diseased upper and lower teeth, during gas laser radiation of the oral cavity. Kightlinger (1975) found that there were blanked-out parts of the coronal discharge pattern from pictures of fingers and toes that corresponded to acupuncture organ points. Using these indices as reference points, Kightlinger was able to successfully diagnose conditions of gastrointestinal flu, duodenal ulcers, carcinoma of the stomach, hyperpyrexia, chronic lung disease, and, in one case, schizophrenia. Omura (1976) was able to detect changes in the coronal discharge patterns that corresponded with onset and termination of arthritis. However, van der Schaar (1976) was unable to demonstrate a difference in the coronal discharge patterns of 20 healthy patients and 20 patients suffering from psoriasis.

In summary, Kirlian photography has undergone some preliminary research to assess what the technique is measuring and what physical factors may influence the technique. Research findings seemed to suggest that the coronal discharge patterns appeared to be associated with moisture (sweat) emanating from the skin surface of the subject (Pehek et al., 1976). Boyers and Tiller (1973), Murstein and Hadjolian (1977), and Schwartz (1974) indicated that the locus of the discharge pattern may be a function of the subject's skin resistance level which may reflect changes in subject's mood states and physical condition. Other authors have suggested that the Kirlian process may be a useful diagnostic instrument in the area of psychosomatic illness (Krippner, 1973) and organ pathology (Kightlinger, 1975). If these assertions that the
corona discharge patterns reflect mood states and can be used as a diagnostic tool are correct, then perhaps the use of Kirlian techniques could be further applied as a physiological diagnostic technique in the investigation of mood disorders such as depression, and anxiety.

**Depression and Anxiety**

Much of the research in depression and anxiety has tended to use patient populations manifesting trait depression or anxiety. A distinction should be made at this point between what is termed "state" and "trait" anxiety and depression. Tests designed to measure traits are, by definition, relatively unaffected by time of testing, but the so-called state measures are time sensitive. Trait anxiety and depression are assumed to be relatively more stable and enduring or refer to an individual's general or usual way of feeling. State anxiety and depression, on the other hand, are assumed to be transient and situationally induced and refer to an individual's immediate or temporary way of feeling (Becker, 1977). Although much attention in the literature has been devoted to the study of depression and anxiety, research attempts to assess these states have been fraught with problems. In particular, these problems seem to center around the differentiation between these two mood states. Becker (1977) noted that the most difficult differential diagnosis to make between nonpsychotic depressive disorders and other nonpsychotic personality disturbances is that between depression and anxiety. This is because many patients display symptoms of both disorders. Kelly and Walter (1969) claimed that depression was a symptom complex rather than a single entity. Whybrow and Mendels (1969) felt that it is a difficult task to interpret data of such a heterogeneous symptomatological
system as reported in cases of depression. Both Whybrow and Mendels (1969) and Kelly and Walter (1969) noted that it is not only difficult to differentiate depression from anxiety, but also to differentiate from other psychiatric disorders as well.

Klerman (1974) described the symptom picture of the outpatient depressive as consisting of anxiety, tension, insomnia, and restlessness. Furthermore, many depressive episodes were preceded by chronic anxiety. Zung (1968) indicated that depression manifests itself as a disorder with: 1) affective changes; 2) psychological changes; and 3) physiological changes. These same manifestations may be attributed to anxiety disorders as well.

Zuckerman, Persky, and Curtis (1968) reviewed the research on depression and anxiety. Much of this research was conducted using samples of psychiatric patients manifesting heterogenous disorders of varying nature. Anxious patients were usually depressed and most depressed patients exhibited some elevated degree of anxiety. Costello and Comrey (1967) had previously noted this finding, adding that depression and anxiety appear to be inseparable at a symptomatic level, while earlier authors (Gilberstadt & Maley, 1965) reported that clinically "pure" states of depression and anxiety were rare.

With such symptomology overlap, how can depression and anxiety be differentiated? Many techniques (clinical, psychometric, and physiological) have been used in an attempt to parcel out the difference between these two conditions. Some have felt that a distinction between anxiety
states and depression may be made on clinical grounds (Garmay, 1956; 1958; Stenbach, 1963). Roth, Gurney, Garside, and Kerr (1972) used a symptom improvement-pattern index to differentiate depressed and anxious patients. They conducted a follow-up study of the progress of 126 patients who had been previously diagnosed as suffering from anxiety or depressive illnesses. At the time of their discharge, 80% of the depressed group and 56% of the anxious group were clinically rated as improved. Six months later, 67% of the depressed group and 44% of the anxious group were still rated as improved. One year later, 56% of the depressed and 51% of the anxious group were continued to be rated as improved. Over a one to three year period after their discharge, the depressed patients continued to improve, while the anxious patients fluctuated in improvement. Symptomatically, anxious patients tended to show phobias, feelings of depersonalization and derealization, and perceptual disturbances (phobic anxiety cluster), whereas the depressed patients did not display these symptoms. Roth, Gurney, Garside, and Kerr (1972) felt that these anxiety features were able to discriminate between the two groups whereas depressive features were not able to discriminate between the two groups because of their wide overlap. Thus, an improvement pattern characterizing depressive patients as a group who show initial marked improvement and then a decrease over time, while the anxious group of patients fluctuate around their initial discharge improvement rate may seem to be a poor measure to differentiate between these two groups. Possibly the differentiation by symptom pattern as Roth et al. (1972) offer with respect to anxiety features may prove promising. However, this too may be of little use as Roth et al. (1972) are forced to concede that anxiety states of long-standing nature
tend to acquire prominent depressive symptoms with the passage of time. Thus, early discriminators could soon be washed away if the differential diagnosis was conducted at a period of some duration after initial onset of the disorder.

The phenomenon of one mood state blending in with the symptom picture of another mood state over periods of time had been previously noted by Mapother (1926). However, he took the reverse side of the merging symptom picture that Roth et al. (1972) posited and felt that anxiety states should be merely regarded as subdivisions of manic-depressive illness since they (and not depressive features) merged with depression to become what is known as an agitated depression. Lewis (1966) also supported this view and rather than seeing the depression-anxiety dichotomy as separate entities, also felt that the two are subdivisions with much symptom overlap.

Psychometric techniques have been used unsuccessfully to parcel out the overlap between anxiety and depression. Zung (1971) indicated that persons with anxiety could not be differentiated from those with other disorders (such as depression) on anxiety evaluation scales. When used alone, other psychometric indices may suffer from an inability to effectively discriminate between anxiety and depression (Kelly & Walter, 1969; Matarazzo, Guize, & Matarazzo, 1973; Sampson & Binder, 1972). This has further been confirmed by Zubin and Fleis (1970) who noted that earlier investigators, using factor analysis of rating scales and self-report items, had difficulty in arriving at separate anxiety and depression factors.
Some investigators have used physiological measures, such as GSR (as well as other physiological measures such as EEG, EMG, heart rate, respiration, and blood flow), in an attempt to describe and discriminate between anxiety and depression. With respect to "GSR" measures, much confusion arises in the literature due to the interchangeability between terms referring to this measure of the electrical activity of the skin. If one places two electrodes on the skin surface and drives a small constant current through them, the skin behaves as a resistor. A voltage develops across the electrodes and by application of Ohm's law one can calculate the apparent resistance (which ranges between 10,000 and 500,000 ohms). This measure is contrasted with galvanic skin response (GSR) or psychogalvanic response (PGR) in which a sudden noise, questions posed to the subject or stated by him, and drugs will, to varying degrees, be followed about two seconds later by a rapid decrease in measured voltage (Edelberg, 1972). The amplitude of this voltage drop indicates a fall in the skin resistance and is the measure used. Authors sometimes confuse these two measures and lump them under the general rubric, "GSR".

Greenfield, Katz, Alexander, and Roessler (1963); McCarron (1970); Riazansky (1965); and, Spiegel and Acker (1967), reported that physiological measures can describe various affective disturbances such as depression. Gilberstadt and Maley (1965) and Malmo and Shagass (1949) demonstrated this ability for anxiety. These studies indicated that the psychological state of depression is associated with a decrease in skin resistance response (SRR), while the psychological condition of anxiety is associated with an increase in SRR. It has been suggested that the
depth of depression is related to the degree of lowered skin resistance responsiveness (Riazansky, 1965).

McCarron (1973) used physiological measures such as skin resistance, heart rate, respiration rate, and EMG tracings in a study involving a group of 30 controls with clinically normal MMPI's and 10 male university students with abnormal MMPI representing a reactive depression symptom pattern. Reactive depression was operationally defined through the use of the MMPI 2-4, 2-4-7 code types. None of the subjects were receiving psychotherapy, taking medication, or were clinically diagnosed as depressed. However, those in the depressed group seemed to indicate situational factors such as marital separation or recently failing a test as precipitating the depression. Depressed groups were differentiated from controls by decreased skin resistance, rapid heart rate, increased respiration rate, and greater activation complexity on the EEG. The lability of the SRR was found to be the most reliable factor in discriminating depressed from normals. The depressed SRR's, McCarron felt, were apparently reflecting somatic fatigue to psychic stress or other physiological or biochemical processes.

Becker (1977) criticized McCarron's (1973) findings by pointing out that a confound may have existed in the study in that the anxiety levels of McCarron's reactive depression group were not adequately controlled. Anxiety may have interacted with depression in his sample and the MMPI may have largely confounded the two.

In 1954, Shagass introduced the concept of "sedation threshold"
which referred to the measurement of GSR changes that occurred while a patient was under sedation. He claimed that the sedation threshold seemed to be: 1) a reliable measure of "manifest anxiety" and, 2) an objective method for the differential diagnosis of depressive states.

Perez-Reyes, Shands, and Johnson (1962), in an attempt to update Shagass' (1954) views, studied the sedation threshold changes of 20 normal, 10 psychoneurotically depressed, and 8 psychotically depressed subjects. Perez-Reyes et al. (1962) found that the GSR activation threshold for the psychotic group was the lowest. However, no difference in GSR recording was found between the psychoneurotically depressed subjects and normal subjects. On the other hand, significant GSR differences were noted between psychotic and psychoneurotic subjects.

Zuckerman, Persky, and Curtis (1968) reported a study comparing physiological measures obtained from 29 psychotic and 25 normal patients and their self-rated levels of anxiety, depression, and hostility. The physiological measures consisted of GSR, basal heart rate, and respiratory rate. These autonomic variables yielded significant or borderline significant ability to discriminate between the psychotic and normal groups. Rated anxiety was positively correlated with GSR fluctuation and respiratory rate. Rated depression was positively correlated with GSR fluctuation and heart rate, but the absolute values of the correlations were low. Rated hostility did not correlate with these autonomic variables. Using psychometric measures to tease out the differences between anxiety and depression, these investigators found that anxiety and depression could not be separated as distinct affects. They concluded
that it would be more appropriate to speak of dysphoria as a term to
cover both depression and anxiety. Thus, in the Zuckerman, Persky, and
Curtis (1968) study, the overlap between depression and anxiety seems to
have been of such an extent that physiological measures failed to dis­

criminate between these two affective states.

In a similar vein, Bull and Gale (1971) investigated response re­
covery and felt that GSR recovery had been observed to be a reliable
aspect of autonomic functioning. However, when they used GSR measures
of recovery on depressed neurotic and anxious subjects, they found a
correlation of .59 (p = .07). This would seem to support Zuckerman
et al.'s (1968) findings in demonstrating that an overlap between GSR
measures of anxiety and depression exist, thus adding to the difficulty
of differentiating between these two states with this measure. In a
study that may further add to the hypothesis that anxiety and depression
may be overlapping states, Froese, Cassem, Hackett, and Silverberg (1975)
recorded the GSR levels of 25 acute coronary patients who were given self­
rating scales of anxiety, depression, mental status, and denial. Over­
all mean GSR showed no relationship to anxiety, depression, or denial
scores.

Gilberstadt and Maley (1965) reported that GSR techniques could
differentiate between anxiety and depression. They postulated that a
relationship exists between clinical states such as anxiety and depres­
sion and levels of physical activity. Using 73 male patients who were
given the MMPI and described as anxious or depressed and comparing their
GSR levels with 14 normal subjects, these investigators found that the
presence of anxiety was associated with lowered skin resistance. Nevertheless, Gilberstadt and Maley (1965) felt that there still existed an overlap between the clinical states of anxiety and depression and speculated that "pure" states of depression or anxiety are rare.

Some studies, using physiological measures to discriminate depression from other psychiatric groups, have reported positive results. In a study conducted by Janssen and Topman (1971), the GSR levels of 9 endogenous depressed women were compared with those of 10 neurotically depressed and 11 schizophrenic women. Basal GSR was highest with the most depressed group; however, amplitude of the GSR was about equal for all groups. In addition, GSR levels appeared to be higher for extroverted patients than for introverted. A criticism of this study may be that an uncontrolled anxiety element may have been present in the depressed groups creating an agitated state. This anxiety may have been reflected in the extroversion exhibited by some of Janssen and Topman's subjects.

An investigation by Greenfield, Katz, Alexander, and Roessler (1963), using 10 male and 10 female patients, found that subjects, regardless of their psychiatric status or classification, who exhibited a lowered physiological responsivity (GSR level) to a series of auditory stimuli, demonstrated a higher score on the D scale of the MMPI than did subjects showing greater responsivity (GSR level).

Positive results were also obtained by Liberson (1949) who recorded GSR level to auditory and visual stimuli secured from 500 psychiatric patients. An EEG tracing was also obtained. No relationship could be
found between GSR and alpha depression as measured by the EEG. This is not too surprising as Greenfield, Katz, Alexander, and Roessler (1963) noted that intercorrelations between autonomic measures were uniformly low. However, Liberson (1949) did find a significant GSR difference, with respect to amplitude, among psychiatric groups. Depressed and organic patients showed the lowest amplitude which decreased even further after frontal lobotomy.

Noble and Lader (1972) attempted to determine if GSR could differentiate between types of depression. Feeling that phenomenological and statistical studies had failed to agree on a valid distinction between endogenous and reactive depression, Noble and Lader (1972) set out using physiological measures in an attempt to differentiate the two states. The physiological measures used were salivary secretion, skin conductance, forearm EMG, and forearm blood flow. The endogenous groups showed a significantly lower mean GSR level than did the reactive group. The other variables failed to discriminate between the two diagnostic groups.

Overall, the use of measures of the electrical activity of the skin as a technique to differentiate depression and anxiety has produced a mass of conflicting research findings. Although some studies report the ability of these measures to discriminate between these two mood states (Gilberstadt and Maley, 1965; Malmo and Shagass, 1949), other studies using these measures have failed to demonstrate this ability (Froese et al., 1975; Zuckerman et al., 1968). Perhaps some of the conflicting results are due to methodological problems inherent in this type of research. Studies which report that skin resistance levels are able to
measure depressive disorders (Janssen & Topman, 1971; McCarron, 1970) apparently have failed to control for the influence of subject anxiety on this measure. Studies which report poor results with skin resistance measures (Froese et al., 1970) appear to have failed to control for the influence of other pathological states which may have been present in their subjects.

Rationale and Hypotheses

There is evidence that Kirlian photography seems to be a useful technique in measuring interpersonal attraction and mood states (Murstein & Hadjolian, 1977; Schwartz, 1974). Boyers and Tiller (1973) reported that the intensity and character of the energy emissions in the Kirlian process seem to depend strongly on the mental, emotional, and physical health of the subject being photographed. Krippner (1974) suggested that Kirlian photography may be useful in the diagnosis and prediction of psychosomatic illness. Boyers and Tiller (1973), Murstein and Hadjolian (1977), and Schwartz (1974) have asserted that the Kirlian effect is a measure of fluctuations in subjects' skin resistance. Since traditional skin resistance measures have been demonstrated in some studies to be an effective measure of depression (Greenfield, Katz, Alexander, & Roessler, 1963; McCarron, 1970; Riazansky, 1965; and, Spiegel & Acker, 1967) and to differentiate depression from anxiety (Gilberstadt & Maley, 1965; Malmo & Shagass, 1949), Kirlian photography may be a good measure of depression and may possibly be able to differentiate this affective state from anxiety. If the electrophotographic technique could differentiate between these affective conditions, it would offer a number of positive features that would make it more
practical to use than skin resistance measures. These features include: 1) lower cost of the equipment, 2) less obtrusive testing conditions for the subject as no wires or electrolyte creams need be applied, and 3) the greater speed at which the measure can be obtained.

Although much of the previous research on depression and anxiety was conducted using trait measures of these two affective conditions, many of the studies in the literature (Moss & Johnson, 1971; Murstein & Hadjolian, 1977) have used Kirlian photography as a state measure. The use of state measures of depression and anxiety would appear to be methodologically more uniform and consistent when using the Kirlian technique to assess these conditions. Thus, the primary purpose of the present investigation will be to attempt to use Kirlian techniques to differentiate between state depressed, state anxious, and nondepressed-nonanxious subjects. In addition, this investigation will attempt to determine if skin resistance levels can differentiate between these groups of subjects and if a relationship exists between coronal discharge patterns and skin resistance levels.

A number of methodological modifications have been added to circumvent some of the criticisms of past research. Subjects in the present study will be assessed on two affective scales. One scale will measure state depression and the other scale state anxiety. Thus, each subject will have two scores on these states, representing high or low amounts of state depression and state anxiety. In this manner, four groups of subjects will be obtained comprising all possible combinations of high and low state depression and state anxiety. This procedure will be
instituted to more carefully assess the overlap between depression and anxiety factors; a feature missing from some studies (Janssen & Topman, 1971; McCarron, 1970).

In addition, all subjects will be screened with psychometric techniques so that only subjects showing no other psychiatric disorder will be used in this study. This measure will be introduced to more carefully control any additional disorder(s) which may be present in the subject and which could confound or interact with the depression and anxiety measures.

Before the subjects agree to participate in this study, they will be apprised of various dietary, medicinal, and health restrictions which must be complied with at the time they are to be tested. All of the dietary and medicinal factors that Omura (1976) reported could affect the discharge patterns will be included as part of the subject's restrictions. At the time of testing, a health checklist, specifically designed for this study, will be administered to all subjects. The checklist will inquire as to whether the subjects have complied with each of the various dietary, medicinal, and health restrictions imposed upon them. This checklist will be included to more carefully control dietary, medicinal, and health factors that might influence the discharge patterns and the skin resistance measure.

Furthermore, photographic sessions will be conducted with the subject's finger inserted and locked into an insulated clamp mounted on a stand. This procedure will be introduced in an effort to ensure that constant distance exists between the object to be photographed
(subject's fingertip) and the photographic paper. This procedure is in response to Dobervich's (1974) criticism that Kirlian phenomenon may be due to distancing effects between the object, film, and electrical source. In addition, use of this finger clamp provides some control over the amount of pressure and movement that subjects' exert while being photographed, which can effect corona patterns (Murstein & Hadjolian, 1977) and ensures some uniformity of pressure exerted on the film paper.
The present investigation hypothesizes that:

1. There will be a significant difference in the skin resistance levels of subjects who are high-depressed as compared to those who are low-depressed.

2. There will be a significant difference in the skin resistance levels of subjects who are high-anxious as compared to those who are low-anxious.

3. There will be a significant interaction between the levels of depression and levels of anxiety with respect to subjects' skin resistance levels.

4. The Kirlian process will be able to significantly differentiate between subjects who are high-depressed and those who are low-depressed.

5. The Kirlian process will be able to significantly differentiate between subjects who are high-anxious and those who are low-anxious.

6. There will be a significant interaction between the levels of depression and levels of anxiety with respect to subjects' corona discharge patterns.

7. There will be a significant positive correlation between subjects' corona discharge patterns and their skin resistance levels.
METHOD

Subjects

An initial group of 184 undergraduate students attending Loyola University of Chicago, who participated in this study for course credit, and who had signed written consent forms (Appendix A), were individually administered the Depression Adjectives Checklist Form G (Lubin, 1967), form X-1 (State) of the State-Trait Anxiety Inventory (Speilberger, Gorsuch, & Lushene, 1970), the Mini-Hult (Kincannon, 1968), and a Subject Health Checklist (Appendix B). Those subjects who scored 9 or above on the Depression Adjectives Checklist (DACL) were considered high-depressed, and those who scored 4 or below were considered low-depressed (Lubin reported a mean score of 7.83 for his depressed undergraduate sample). Those subjects who scored 43 or above (70th percentile) on the State-Trait Anxiety Inventory (STAI) were considered high-anxious, and those subjects who scored 36 or below (33rd percentile) were considered low-anxious (Speilberger et al. reported that the norm for their undergraduate sample was 36 and that a mean score of 43 was obtained for this group after an anxiety arousing examination). Subjects with T-scores above 70 on any of the clinical scales of the Mini-Mult were excused from the study. Subjects who checked-off any of the items on the Subject Health Checklist were either excused from the study or rescheduled at a time when they could comply with the demands of the questionnaire.

From this initial group, 20 male and 20 female students were
Castaloy Utility Clamp with vinyl insulated grip and a Fisher Support Stand. The clamp was attached 45cm below the top of the Support Stand, and flush with the Kirlian glass insulated photographic plate, and served to hold and position the subject's left-index-finger.

The photographs were recorded on 5cm X 5cm Kodak 78P Ectracolor photography print paper which was developed with Uni-Color R-2 color chemistry.

A Grass polygraph (Model 5) with a Model 5A Amplifier connected to a Model 5Pl Low Level D. C. Preamplifier was used to record subject's skin resistance.

State depression was measured with the Depression Adjectives Check-list Form G (Lubin, 1967). The DACL has obtained interlist correlations ranging from .80 to .93 (Goodstein, 1972). Internal consistancy ranges from .79 to .90. Predictive validity ranges from .79 between DACL scores and psychiatrist's ratings, to .95 between DACL scores and subject's self-ratings of depression (Fogel, Curtis, Kordasz, & Smith, 1966). State anxiety was measured with form X-1 (State) of the State-Trait Anxiety Inventory (Speilberger, Gorsuch, & Lushene, 1970). The reliability of the STAI (form X-1), computed using alpha reliability coefficients, ranges from .89 to .94 (Speilberger, Gorsuch, & Lushene, 1970). The Mini-Mult (Kincannon, 1968) was used as a screening device to rule-out the possibility of other underlying psychiatric disorders present in the subject. Correlations between the clinical and validity scales of the Mini-Mult and full MMPI range from .78 to .96 with a median of .88 (Newmark, Newmark, & Cook, 1975).
A Subject Health Checklist (Appendix B) was administered to control for the possible effects of certain substances reported by Omura (1976) which, if ingested by a subject, could influence their corona discharge patterns.

The scoring system devised by Murstein and Hadjolian (1977) was used to analyze the subject's corona discharge patterns.

Procedure

Each subject was screened and tested in a photographic darkroom illuminated by one 15 watt Kodak Safelight (red filtered). The temperature in the room was kept at a constant 23.8°C (± 2°C) and relative humidity at a constant 35% (± 5%). The polygraph was activated and allowed to warm-up for 15 minutes before each subject entered the testing room and remained activated while the subject was being screened. The photographer/experimenter was a 26 year old white, male graduate student at Loyola University of Chicago.

Upon entering the experimental room, each subject was seated in a chair situated between the electrophotography set and the polygraph and was administered the Subject Health Checklist. Subjects who did not comply with the Health Checklist requirements were excused from the experiment. Those subjects who complied with the requirements of the Health Checklist were then administered the DACL, STAI, and Mini-Mult. These tests were scored immediately after the subject had completed them. Those subjects who met the preselection criteria on these tests began their participation in the experiment.
Immediately following their test screening, the experimenter explained to each subject the procedure involved in hooking him up to the apparati. The subject was also asked if he/she wore any electrically implanted devices such as heart pace-maker or hearing aid. Those subjects responding in the negative were allowed to continue in the study.

The subject was then instructed to remove all jewelry from his/her hands and wrists. These items were placed in a small tray for safekeeping and were returned at the conclusion of the experiment. The fingertips of both hands of the subject were then cleaned with alcohol. Next, two Grass GSR electrodes, filled with Beckman electrolyte jelly, were attached to the volar region of the first and third distal phalanges of the right-hand. The subject then rested his right-arm in a 27.5cm X 19cm X 7cm styrene block with a 7cm X 5cm channel cut through it and anchored to the table with non-slid adhesives. This was used to control the subject's arm movements while the skin resistance measure was obtained. The subject then inserted the index finger of his left-hand into the Fisher clamp, with the volar surface resting on the glass insulated Kirlian dielectric plate. A 7.5cm X 1.5cm strip of Scholar Bond paper (#22005) was placed between the dorsal surface of the index finger and the upper jaw of the clamp. The clamp was slowly closed and locked into place at the point where the paper strip was unable to be pulled free by the experimenter. The subject was then instructed to relax, look straight ahead, refrain from talking or closing his/her eyes to rest, and to sit as still as possible. It was explained to the subject that their skin resistance would be measured for approximately five-minutes with the polygraph, after which time the electrodes would be removed. The
experimenter went on to add that the electrophotography apparatus would then be activated for a one-second exposure and that while this apparatus was on, he/she might see a greenish glow coming from the machine and might feel a slight tingling sensation in their left-forefinger. Finally, the subject was informed that although this experiment involved a lot of electrical equipment, there was absolutely no danger of him/her receiving an electric shock. The subject was then allowed five-minutes to acclimate himself/herself.

The polygraph amplifiers were then calibrated for the subject. The polygraph was then set for 5.5 minutes of recording (at 6mm/sec. chart speed). During the first 30 seconds of running time, an initial skin resistance level in ohms was obtained. Thereafter, at one-minute intervals, skin resistance levels, measured in ohms of resistance, were recorded. Because of a sudden battery failure in the low level D.C. preamplifier's balance voltage circuit, two male subjects in the low-depressed/high-anxious group had their skin resistance levels recorded by measuring the amount of pen deflection from baseline with a ruler, rather than by using the balance voltage control dials, as was the usual procedure. At the end of five-minutes of recording, the GSR electrodes were detached to prevent the possibility of electric shock while the electrophotography apparatus was in use. A sheet of color print paper was then inserted under the subject's left-index-finger. To hold the paper securely in place, the edges were positioned between the interstice of the glass photographic plate and the sidewalls of the electrophotography apparatus. The electrophotography set was then activated for a one-second exposure.
The florescent ceiling lights in the darkroom were then activated and the subject was unhooked from the apparatus and debriefed. The experimenter asked the subject not to discuss the experiment with others as such disclosures could seriously affect the results.

The print paper was then developed using Uni-Color R-2 color chemistry strictly to manufacturer's specifications. All solutions were kept at 21°C, and 20 seconds of draining time were allowed between each step of the process. Emersion time in the Developing Solution was 8.5 minutes. The print was then placed in the Uni-Color Stop Bath Solution for one-minute. The print was then placed in the Blix Solution for two-minutes and then given a two-minute rinse in tap water. Finally, a one-minute emersion in the Stabilizer Solution completed the process. The print paper was then dried.

**Discharge Pattern Scoring System**

A seven-point scoring system was devised for the corona discharge photographs (Appendix C), similar to the one used by Murstein and Hadjolian (1977), but designed to better reflect the quality of photographs obtained in this investigation. The departure from Murstein and Hadjolian's system occurred in two areas. Part of Murstein and Hadjolian's system analyzed the parameters of color and length of the discharge pattern. The system used in the present study, while still analyzing length, substituted density of the discharge pattern (as indicated by the presence or absence of a thick, dark band composed of discharge spikes surrounding the fingertip) for coloration, as the colors that Murstein and Hadjolian describe in their photographs did not appear in the prints obtained in
this investigation. This finding may be due to differences in the photographic medium used in the electrophotographic process: Murstein and Hadjolian used film as the medium for their photographs, while the present investigation employed the traditional print paper approach used by the Kirlians. In addition, the new system included a parameter not found in Murstein and Hadjolian's system. This parameter involved analyzing the prints for distinctively large gaps between the spike patterns (punched-out areas) which may have reflected the presence of pathology (Kightlinger, 1975). This particular parameter was assigned a scale value of 2 on the scoring system as all training prints that contained this feature also fit Murstein and Hadjolian's criteria for assigning a score of 2 to the print. In addition to the seven printed descriptions of the criteria to be met for assigning a score value to the photographs, a visual aid was provided for the judges. This visual aid was a Kirlian print, mounted next to each printed description, which best represented the criteria.

Two volunteer student judges (one male and one female), who were trained with prints taken during the experiment but not used in the final analysis, independently and blindly rated the 40 photographs.
RESULTS

A preliminary analysis was undertaken to test the differences between the means of the High Depressed (HD) and Low Depressed (LD) groups, and the High Anxious (HA) and Low Anxious (LA) groups. This analysis was conducted to determine if the cut-off scores on the DACL and STAI produced groups of subjects whose reported level of depression or level of anxiety was significantly different. The means and standard deviations of DACL and STAI scores for these groups are reported in Table 1. A t-test was computed between the means of the DACL scores of the HD and LD groups and was found to be significant at the .001 level, $t(38) = 12.19$. Another t-test was computed between the means of the STAI scores of the HA and LA groups and was found to be significant at the .001 level, $t(38) = 10.06$. A subsequent analysis was performed to determine whether there were any sex differences in the DACL and STAI scores for these groups of subjects. The means and standard deviations of DACL and STAI scores by sex of subject are reported in Table 2. A t-test was computed between the means of the DACL scores of the male and female subjects in this investigation and was found to be nonsignificant, $t(38) = .73$. Another t-test was computed between the means of the STAI scores of the male and female subjects in this investigation and was also found to be nonsignificant, $t(38) = .42$. Thus, male and female subjects were not significantly different from each other on the DACL and the STAI. Overall, these analyses indicated that the HD group reported themselves to
Table 1
Means and Standard Deviations of the DACL and STAI Scores for the Four Subject Groups

<table>
<thead>
<tr>
<th></th>
<th>High Depressed</th>
<th>Low Depressed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DACL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>12.00</td>
<td>2.90</td>
</tr>
<tr>
<td>SD</td>
<td>3.04</td>
<td>1.37</td>
</tr>
<tr>
<td><strong>STAI</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>46.50</td>
<td>32.30</td>
</tr>
<tr>
<td>SD</td>
<td>3.92</td>
<td>5.02</td>
</tr>
</tbody>
</table>
Table 2

Means and Standard Deviations of DACL and STAI Scores by Sex of Subject

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DACL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>8.05</td>
<td>6.85</td>
</tr>
<tr>
<td>SD</td>
<td>5.44</td>
<td>4.93</td>
</tr>
<tr>
<td><strong>STAI</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>39.95</td>
<td>38.80</td>
</tr>
<tr>
<td>SD</td>
<td>9.31</td>
<td>7.73</td>
</tr>
</tbody>
</table>
be significantly more depressed than the LD group, and the HA group reported themselves to be significantly more anxious than the LA group, with no sex differences in their DACL or STAI scores. These results suggested that the cut-off scores for the DACL and STAI used in this study were adequate in creating a high depressed, and a high anxious group whose reported mean level of depression and anxiety was significantly greater than those reported in the low depressed, and low anxious groups. Thus, the HD and HA groups could be significantly differentiated from the LD and LA groups on the basis of their respective DACL and STAI scores.

**Skin Resistance**

For each of the 40 subjects used in this analysis, an overall skin resistance level (in ohms resistance) was determined by computing the average skin resistance, in ohms resistance, obtained over the five one-minute recording points on the polygraph after the initial skin resistance level was obtained. This initial skin resistance level was not used in the computation of these overall scores for each subject in order to prevent the possibility that initial discomfort in or unfamiliarity with the experimental apparatus might affect the data. The means and standard deviations of the skin resistance levels for the HD, LD, HA, and LA groups are reported in Table 3.

In order to determine whether these groups of subjects significantly differed in skin resistance level, a two (levels of depression) by two (levels of anxiety) analysis of variance was computed with skin resistance level as the dependent measure. The results of this analysis are presented in Table 4. The first hypothesis stated that there is a significant
Table 3
Means and Standard Deviations of Skin Resistance Level in Ohms as a Function of Levels of Depression and Anxiety

<table>
<thead>
<tr>
<th></th>
<th>High Depressed</th>
<th>Low Depressed</th>
<th>High Anxious</th>
<th>Low Anxious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>47835.02</td>
<td>46822.10</td>
<td>49677.80</td>
<td>44979.32</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>48907.84</td>
<td>47776.31</td>
<td>50519.38</td>
<td>45951.60</td>
</tr>
</tbody>
</table>
Table 4

ANOVA Summary Table of Skin Resistance Level in Ohms as a Function of Depression and Anxiety

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>d.f.</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>1</td>
<td>41040672.00</td>
<td>0.67</td>
</tr>
<tr>
<td>Anxiety</td>
<td>1</td>
<td>883026688.00</td>
<td>14.53*</td>
</tr>
<tr>
<td>Depression by Anxiety</td>
<td>1</td>
<td>16906496.00</td>
<td>.27</td>
</tr>
<tr>
<td>Error</td>
<td>36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .001
difference in skin resistance level of subjects who are high-depressed as compared to those who are low-depressed. A nonsignificant main effect of depression was observed \( F(1,36) = .67, p > .05 \). This result does not support this hypothesis. The second hypothesis stated that there is a significant difference in skin resistance level of subjects who are high-anxious as compared to those who are low-anxious. A significant main effect of anxiety was observed \( F(1,36) = 14.53, p < .001 \). This result supports this hypothesis. The third hypothesis stated that there is a significant interaction between levels of depression and levels of anxiety with respect to subjects' skin resistance level. A nonsignificant interaction effect of depression and anxiety was observed \( F(1,36) = .27, p > .05 \). This result does not support this hypothesis. Thus, overall, only the HA and LA groups could be significantly differentiated on the basis of their skin resistance level.

As an additional analysis, a two (levels of depression) by two (levels of anxiety) by two (levels of sex) ANOVA was computed with skin resistance levels as the dependent measure to determine if there were sex differences with respect to skin resistance level. A nonsignificant main effect of sex was observed, \( F(1,32) = 3.14, (p > .05) \), along with \( F \) ratios less than one for all interactions with this variable. These results indicated that there was no overall significant difference in skin resistance levels between male and female subjects in this study, nor were there any significant differences between male and female subjects in any of the affective groups used in this study.

Additional analyses were also performed to assess the degree of
relationship between skin resistance level and STAI scores, and skin resistance level and DACL scores. A Pearson product-moment correlation was computed between subjects' scores on the STAI and their skin resistance levels. A moderate correlation of .42 (df 38) was obtained which was significant at the .01 level, indicating that high STAI scores were associated with high skin resistance levels and vice versa.

The Pearson product-moment correlation between subjects' scores on the DACL and their skin resistance levels yielded a nonsignificant (p > .05) correlation of .27 (df 38). This finding indicated that there was no significant relationship between DACL scores and skin resistance levels.

Corona Discharge Patterns

A Pearson product-moment correlation was computed to assess inter-judge reliability between the two judges' (hereafter referred to as Judge A and Judge B) ratings of the corona discharge patterns on the 40 subjects' prints using the discharge pattern scoring system. This analysis yielded an r of .87 (p < .001), indicating that there was good agreement between the two judges in their assignment of ratings to each print using the discharge pattern scoring system. This finding then allowed further analyses to be performed on the data.

The means and standard deviations of the corona discharge pattern ratings for each judge are reported for the HD, LD, HA, and LA groups in Table 5. To assess if Judge A tended to rate each of these groups significantly differently from Judge B, t-tests were computed between the means of the two judges ratings on the HD, LD, HA, and LA groups.
Table 5
Means and Standard Deviations of the Judges' Kirlian Ratings for the Four Subject Groups

<table>
<thead>
<tr>
<th></th>
<th>High Depressed</th>
<th>Low Depressed</th>
<th>High Anxious</th>
<th>Low Anxious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Judge A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>3.90</td>
<td>3.80</td>
<td>3.30</td>
<td>4.40</td>
</tr>
<tr>
<td>SD</td>
<td>1.71</td>
<td>2.00</td>
<td>1.78</td>
<td>.94</td>
</tr>
<tr>
<td>Judge B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>4.40</td>
<td>4.20</td>
<td>3.90</td>
<td>4.70</td>
</tr>
<tr>
<td>SD</td>
<td>1.50</td>
<td>1.76</td>
<td>1.7.</td>
<td>1.45</td>
</tr>
</tbody>
</table>
The results indicate that there was no significant differences between the two judges' corona discharge pattern ratings for the HD (t 38 = .983), LD (t 38 = .585), HA (t 38 = 1.08), and LA (t 38 = .644) groups. Thus, there was no significant difference in the means of the ratings that Judge A made in each of these groups, as compared to the means of the ratings that Judge B made.

In order to determine whether the corona discharge pattern ratings for each judge could differentiate between these groups, a multivariate analysis of variance (MANOVA) was computed using levels of depression and levels of anxiety as the two independent measures and Judge A's and Judge B's ratings as the two dependent measures. A MANOVA rather than ANOVA was selected to analyze this data because it would be inappropriate to average the judges' ratings and come up with one source for each subject (and thus perform one ANOVA) when, in actual applied practice, a clinician would only be evaluating individual scores and not averaged scores in his assessment of individual prints. Using MANOVA techniques, separate ANOVAs were computed using each judge's ratings as the dependent measure, and a final multivariate analysis was computed using both judge's ratings combined as the dependent measure.

Table 6 reports the results of the two (levels of anxiety) by two (levels of depression) ANOVA with Judge A's corona discharge pattern ratings as the dependent measure. A significant effect of anxiety was observed (F 1,36 = 4.00, p<.05), along with F ratios less than one for depression and the interaction. Thus, Judge A's corona discharge pattern ratings were able to significantly differentiate between high-anxious and
Table 6

ANOVA Summary Table on Judge A's Kirlian Ratings

as a Function of Depression and Anxiety

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>d.f.</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>1</td>
<td>0.025</td>
<td>0.01</td>
</tr>
<tr>
<td>Anxiety</td>
<td>1</td>
<td>13.225</td>
<td>4.00*</td>
</tr>
<tr>
<td>Depression by Anxiety</td>
<td>1</td>
<td>0.225</td>
<td>0.07</td>
</tr>
<tr>
<td>Error</td>
<td>36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05
low-anxious subjects.

Table 7 reports the results of the two (levels of anxiety) by two (levels of depression) ANOVA with Judge B's corona discharge pattern ratings as the dependent measure. The main effect of anxiety failed to reach significance (F 1,36 = 2.41, p> .05), and F ratios were less than one for depression and the interaction. Thus, unlike Judge A, Judge B's ratings failed to significantly differentiate high-anxious from low-anxious ratings.

Table 8 reports the test of the greatest characteristic root (the eigenvalue representing the amount of variance accounted for by the ratings) for each main effect and the interaction using both judges' ratings as the dependent measure. The fourth hypothesis stated that the Kirlian process is able to significantly differentiate between subjects who are high-depressed and those who are low-depressed. A nonsignificant main effect of depression was observed (F 1,36 = .40, p>.05). This result does not support this hypothesis. The fifth hypothesis stated that the Kirlian process is able to significantly differentiate between subjects who are high-anxious and those who are low-anxious. A significant main effect of anxiety was observed (F 1,36 = 4.13, p<.05). This result supports this hypothesis. The sixth hypothesis stated that there is a significant interaction between the levels of depression and levels of anxiety with respect to the subjects' corona discharge patterns. A nonsignificant interaction effect of depression and anxiety was observed (F 1,36 = .27, p>.05). This result does not support this hypothesis. Thus, overall, using both judges' ratings as a dependent measure, high-anxious and low-anxious subjects could be significantly differentiated using corona
<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>d.f.</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>1</td>
<td>0.40</td>
<td>0.15</td>
</tr>
<tr>
<td>Anxiety</td>
<td>1</td>
<td>6.40</td>
<td>2.41</td>
</tr>
<tr>
<td>Depression by Anxiety</td>
<td>1</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Error</td>
<td>36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 8

MANOVA Summary Table of the Overall Effect of Both Judges' Kirlian Ratings as a Function of Depression and Anxiety by Testing the Greatest Characteristic Root Using Roy's Maximum Root Characteristic

<table>
<thead>
<tr>
<th>Effect</th>
<th>Characteristic Root</th>
<th>Characteristic Vector</th>
<th>d.f.</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Judge A</td>
<td>Judge B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>0.00109442</td>
<td>-0.14374</td>
<td>1,36</td>
<td>0.40</td>
</tr>
<tr>
<td>Anxiety</td>
<td>0.11472087</td>
<td>0.11786</td>
<td>-0.03554</td>
<td>1,36</td>
</tr>
<tr>
<td>Depress. by Anxiety</td>
<td>0.00750528</td>
<td>-0.18263</td>
<td>0.17614</td>
<td>1,36</td>
</tr>
</tbody>
</table>

*p < .05
discharge pattern ratings: however, most of the contribution for this effect came from Judge A (although Judge B's ratings did tend to account for some of the variance in scores). Neither individually nor in unison could the judges' corona discharge pattern ratings differentiate between high-depressed and low-depressed or the groups created by the interaction of levels of depression and levels of anxiety.

To test whether there were any differences in the corona discharge pattern ratings of male subjects as compared to female subjects, an additional MANOVA was computed using levels of sex as a third independent variable. The results of this analysis failed to demonstrate, either in individual or overall judges' ratings, a significant effect of sex (Judge A, F 1,32 = 1.64; Judge B, F 1,32 = 3.00; Overall, F 1,32 = 3.23; p > .05 for each analysis). All interaction with sex also yielded F ratios that were statistically nonsignificant (p > .05). Thus, overall, the corona discharge pattern ratings for male subjects was not significantly different from those of female subjects, nor were the discharge pattern ratings significantly different between male and female subjects in any of the affective groups used in this study.

Further analyses were conducted to assess the relationship between DACL scores and the judges' corona discharge pattern ratings. A Cannonical correlation was computed between subjects' STAI scores and the judges' corona discharge pattern ratings. This correlation (.28, X^2(2) = 3.18) was also not significant (p > .05) indicating that there was no significant relationship between subjects' STAI scores and judges' corona discharge pattern ratings of their prints. Thus, it would appear that the corona
discharge pattern ratings could only significantly differentiate between extreme scores in the anxious groups as demonstrated by the MANOVA technique, but failed to demonstrate a significant relationship when the range of anxiety scores were analyzed. This finding can be further substantiated by examining the individual correlations computed between subjects' STAI scores and each judge's corona discharge pattern ratings. The Pearson correlation between Judge A's ratings and STAI scores was \( r = -0.28 \) \((p > 0.05)\) and the correlation between Judge B's ratings and STAI scores was \( r = -0.22 \) \((p > 0.05)\). These findings indicated that individually, neither Judge A's nor Judge B's ratings correlated significantly with STAI scores. Thus, although Judge A could significantly differentiate between high- and low-anxious groups with his ratings in the MANOVA analysis (Judge B could not), his ratings did not significantly covary with the range of STAI scores used in this study.

**Kirlian and Skin Resistance as Predictors of Anxiety**

In order to assess the relationship between judges' corona discharge pattern ratings and skin resistance levels, a canonical correlation was computed between these two measures. The seventh hypothesis stated that there is a significant positive correlation between subjects' corona discharge patterns and their skin resistance levels. A correlation of \( r = 0.147 \) was obtained which yielded a chi-square of \( 0.812 \) which was statistically nonsignificant \((p > 0.05)\). This result does not support this hypothesis. This finding indicated that there is no significant relationship between judges' corona discharge pattern ratings and skin resistance levels.

Since previous analyses had demonstrated that there was a significant
main effect of anxiety using either skin resistance levels or corona discharge pattern ratings as the dependent measure, but subsequent analysis indicated that the correlation between these two measures was nonsignificant, it was (post hoc) hypothesized that each of these measures may have accounted for unique sources of variance in measuring anxiety. To determine the contribution of skin resistance levels and corona discharge pattern ratings in the measurement of anxiety, multiple regression analyses were performed using skin resistance level and corona discharge pattern ratings as predictors on the criterion, STAI scores. In the first analysis, skin resistance level was entered as the first variable in the equation. The multiple $R$ of .48 was significant ($p < .05$), $F(3, 36) = 3.64$, $MS$ error = 59.65, indicating that taken together, both predictors significantly accounted for variance in the anxiety criterion. The overall multiple $R^2$ was .23, indicating that 23% of the variance in the anxiety criterion was predicted (accounted for) by skin resistance level and corona discharge pattern ratings. Breaking down this data to examine the multiple $R^2$ change that occurred when each predictor was entered into the equation revealed that the multiple $R^2$ for skin resistance level alone was .18 ($F 1, 38 = 8.38, p < .001$) indicating that 18% of the variance in the criterion was accounted for by this variable. Thus, the addition of the corona discharge pattern ratings as a predictor only increased the multiple $R^2$ by five-percent. A test to determine the significance of the increase in the multiple $R^2$ when the corona discharge pattern ratings were added yielded an $F(2, 36)$ of 1.24 which was nonsignificant ($p > .05$). In the second regression analysis, essentially the same findings were obtained when the corona discharge pattern ratings were entered as the first
variable in the equation. These results indicated that skin resistance levels alone appeared to be the best predictor of anxiety (accounting for the most variance in STAI scores) with corona discharge pattern ratings contributing little to the prediction. Thus, although both measures may have accounted for unique sources of variance in anxiety, as measured by the STAI, the skin resistance measure alone appeared to be the best predictor of anxiety as measured by the STAI.
DISCUSSION

The purpose of this study was to assess the use of corona discharge patterns, obtained through electrophotographic techniques, as a means of differentiating between levels of state depression, levels of state anxiety, and the combination of these two states. In addition, this investigation attempted to determine if skin resistance levels (measured in ohms) could also differentiate between these conditions, and to assess the relationship between corona discharge patterns and skin resistance levels.

With respect to subjects' skin resistance level, the results of this study indicated that there was a significant difference between the skin resistance levels of high-anxious subjects and low-anxious subjects. The high-anxious subjects had greater levels of skin resistance (as measured in ohms) than did low-anxious subjects. This finding has also been reported by Gilberstadt and Maley (1965) and Malmo and Shagass (1949). However, Gilberstadt and Maley (1965) and McCarron (1973) found that their depressed subjects had significantly lowered skin resistance. The present investigation was unable to substantiate these findings, as it failed to differentiate between high- and low-depressed subjects and the groups formed by the interaction of levels of depression and levels of anxiety.

A possible explanation for the partial disparity in the results found in this study and those reported by Gilberstadt and Maley (1965) and McCarron (1973) may be that these latter investigators used trait
measures in the selection of subjects, while the present investigation used state measures. Trait measures may have reflected more pronounced or enduring physiological differences in their groups of subjects that may not have been present in this investigation.

It may also be possible that the controls used in this present investigation were responsible for the disparity in findings. Not only were attempts made to control for dietary and health factors in this study (such controls were not mentioned by these investigators, nor in any other study in this genre) which would spuriously effect the results, but controls were also imposed to screen against other forms of severe pathology which could confound the "pure" nature of the groups. It is possible that dietary and health factors (and possibly differences in room temperature and humidity, which were controlled for in the present study), as well as overlap with other diagnostic categories, could have produced the significant results in these other studies.

The present investigation found no difference between the skin resistance levels of male and female subjects. While the present investigation did not find gender differences in skin resistance level, Edelberg (1972) has reported that some studies have found such differences. This disparity in results may possibly be explained in terms of monthly menstrual cycle. As Edelberg (1972) also noted that menstruation is responsible for some of the sex differences found in electrodermal activity, and the present investigation did not use female subjects who reported that they were currently menstruating, this factor was not present to differentially influence the results. Another possible explanation for this
disparity in findings may be that the studies reported by Edelberg (1972) may have failed to account for possible differences in subjects' mood state. The lack of gender differences in skin resistance levels found in the present study may be explained by the fact that the male and female subjects used in this investigation did not significantly differ in their reported level of anxiety nor in their reported level of depression. It may have been that the lack of differences in affective level between male and female subjects did not manifest the physiological changes necessary for a difference to be detected in skin resistance levels.

With respect to subjects' corona discharge patterns, the results of the present study indicated that there was an overall (both judges' ratings combined) significant difference between the discharge patterns of high-anxious and low-anxious subjects, but no significant difference between high- and low-depressed subjects, nor were there any significant differences between groups of subjects formed by the interaction between levels of anxiety and levels of depression. High-anxious subjects' prints were judged to have significantly lower corona discharge pattern scores, based on the scoring system devised for this study, than were the prints of low-anxious subjects. These lower corona discharge pattern scores were assigned to prints characterized by a "washed-out" appearance of the photograph, with little or no visible spike patterns, and smudgy in quality. This significant effect for anxiety appeared to be a weak effect as only one of the two judges' ratings (Judge A) reached significance in differentiating the high- and low-anxious groups. Although overall, the combination of both judges' ratings did result in a
significant main effect for anxiety, this effect was obtained primarily through the contribution of one judge (Judge A).

This weak finding, coupled with a lack of significance for the other effects, could not be attributed to an initial lack of clear differentiation between the levels of depression and levels of anxiety in these groups of subjects. Analyses of subjects' DACL and STAI scores indicated that there were highly significant differences in reported levels of depression and levels of anxiety. Thus, the high-depressed subjects significantly reported themselves to be more depressed than the low-depressed subjects, and the same results were found for levels of anxiety. However, it should be noted that this study dealt with depression and anxiety as psychologically defined constructs. Consequently, differences in these groups may be due to differences in mood states rather than variability in clinical entities (traits). In a clinical setting, these entities may be associated with more pronounced or enduring physiological characteristics. Thus, although differences in mood state may have been present in this study, such differences may not have been enough for a strong difference to be detected in discharge patterns, as may be the case with differences in clinical entities.

Furthermore, these weak and nonsignificant results were not due to a significant disparity in the ratings made by one judge as compared to the other judge within each group of subjects (HD, LD, HA, LA). Analyses involving the comparison of one judge's ratings with the other judge's ratings within each of these groups of subjects indicated that there was no significant difference in the ratings assigned by one judge within each
of these groups as compared to the other judge

Nor were these weak and nonsignificant results a product of poor quality or radical photographs that were not reflected by the criteria established for the scoring system, as neither judge reported any difficulty in assigning a score value to any of the photographs (all seven score values in the system were used by both judges) and indicated that all photographs fell well within the criteria defined by the coronal discharge pattern scoring system. In addition, the overall reliability (interjudge reliability) between both judges' ratings on all 40 photographs was significant and substantial ($r = .87$), indicating that there was good agreement between the two judges as to the assigned score value to be given to each photograph.

However, this agreement between judges was not perfect, and it is possible that the slight differences in ratings between one judge and the other on some photographs, which resulted in a reliability coefficient less than unity, may have been enough to produce the weak effect for anxiety. As the one judge's ratings (Judge A) that could significantly differentiate the high- and low-anxious subjects just reached the .05 level, the slight disparity in the ratings of the other judge (Judge B) with these ratings may have been enough for that judge to fail to reach significance in differentiating the high- and low-anxious groups. Thus, the combined effect of both judges' ratings in differentiating levels of anxiety produced a weak effect that just barely reached significance. If the agreement in ratings between judges had not been as strong as they were, it is likely that the overall effect would have been lost.
In addition to the possibility that a lack of pronounced physiological differences between groups of subjects may have been responsible for the nonsignificant results obtained in this study due to the "state" nature of the affective disorders measured in this study, other explanations might also be offered to account for these nonsignificant findings. Failure of both judges, either individually or in unison, to significantly differentiate high-depressed and low-depressed subjects and to differentiate groups of subjects formed from the interaction of levels of depression and levels of anxiety, may have been due to instability in the photographic image of the corona discharge pattern over time. Perhaps the electrophotographic technique produced images that changed very rapidly corresponding to physiological or mood state, thus nullifying, over the course of time, any initial effect which may have differentiated the groups. Van der Schaar (1977) reported an inability to obtain stable photographs using a test-retest method where two photographs of the same subject were taken with a latency interval of one-second. However, as an adjunct to the primary purposes of this present investigation, a group of 20 additional subjects who fulfilled the criteria for participation in this experiment, had two exposures, separated by a three-second time interval, taken of their left-index-finger. These 20 pairs of prints were then scrambled and given to another judge (Judge C) who rated them using the corona discharge pattern scoring system. A test-retest reliability coefficient of .87 was obtained which was significant at the .001 level, indicating that good test-retest stability in prints was achieved over an interval three times as long as that reported by van der Schaar (1977). However, this finding must be tempered by the very real possibility that
the stability of the image produced over this short duration may have decayed over longer periods of time. Perhaps the degree or quality of the depression or anxiety changed or decreased during the 20 minutes (on the average) between the time the DACJ and STAI were administered and the electrophotographs were taken in this study. If the electrophotographic process was sensitive in picking up these changes, it may have failed to detect a difference between the groups because the groups themselves may have been becoming more alike (or were changing) after the time of initial test screening.

This explanation would seem to apply less to the anxiety variable than to the depression variable as both skin resistance levels and coronal discharge pattern ratings significantly differentiated between levels of anxiety at approximately 15 and 20 minute intervals (respectively) from the time of initial test screening. These findings indicated that the groups formed by the levels of anxiety did not change so dramatically from the time of initial test screening that significant differences failed to be detected by both dependent measures at a later point in time.

However, this explanation may possibly account for a lack of significant differences with the depression variable and the interaction effect. Due to the state nature of the test, increasing spans of time should decrease the stability coefficient. This becomes apparent when one examines the lack of stability of the STAI (after 60 minutes, \( r = 0.33 \) for male subjects and 0.16 for female subjects; Spielberger, Gorsuch, & Lushene, 1969), and the DACJ (after one week, \( r = 0.22 \); Lubin & Himelstein, 1976).
The test-retest reliability for the STAI, after only 60 minutes, is very low. Although we do not know the rate of decay of either test, one might speculate that with these low coefficients for the STAI over such a short period of time, the effect for anxiety would have been the more difficult to obtain than would the effect for depression which was measured with a test that had only slightly lower coefficients over an appreciably longer latency interval. As it was, a weak (but significant) effect for anxiety was obtained, and the weakness of this effect may have been due to changes in the levels of anxiety over the course of time. On the other hand, no significant effect was obtained for levels of depression using a test which had only slightly lower test-retest reliability coefficients than the STAI, but whose latency interval spanned a much longer period of time. Thus, the coefficient of stability for the DACL may have been greater than that of the STAI had the latency intervals between testings been equivalent. In that case, findings similar to that obtained for the levels of anxiety should have been obtained for the levels of depression. However, McNair (1972) questioned the sensitivity of the DACL to measure affect changes over time.

Only if the electrophotographic technique was more sensitive in reflecting minute affect changes over time than the DACL could an explanation of changing affective conditions over the 20 minute time span, negating any initial differentiating effects in the levels of depression and the interaction, become plausible in describing the results of this study.

A more likely explanation for the failure of the judges' ratings
to differentiate between high- and low-depressed groups, and the groups formed by the interaction of levels of depression and levels of anxiety, may have been that the analysis of corona discharge pattern density (a feature added in the present study to better reflect the quality of the photographs obtained, and representing the higher score values in the system) and length, are not important parameters in the analysis of depression. Then again, it may just be that the electrophotographic technique is incapable of measuring levels of depression. Perhaps the electrophotographic technique, despite wide claims of its utility as a diagnostic tool for pathology, may in this instance be useful only as an arousal measure (in differentiating levels of anxiety) as differentiation between levels of depression could not be made with the present scoring system criteria.

Overall, the results of this investigation indicate that the corona discharge pattern parameters used in the scoring system for this study do not provide discriminable differences for the levels of depression, nor for the discrimination of groups formed by the interaction of levels of depression and anxiety. In retrospect, it is not too surprising that the coronal discharge patterns did not differentiate between levels of depression or the groups formed by the interaction of anxiety and depression as many other researchers, using physiological techniques, have failed to find significant differences between levels of depression (e.g., Perez-Reyes, Shands, & Johnson, 1962) or between anxiety and depression (e.g., Froese, Cassem, Hackett, & Silverberg, 1975; Zuckerman, Persky, & Curtis, 1968).

In addition, this investigation found no significant differences
between the corona discharge pattern scores of male and female subjects. This result supported van der Schaar's (1977) previous findings of no gender differences in the coronal discharge patterns in his sample. However, this finding runs counter to the results obtained by Murstein and Hadjolian (1977) and Moss and Johnson (1974) who found that the sex of the photographer significantly affected the corona discharge patterns of opposite-sex subjects. The present investigation, using a male experimenter/photographer, found no difference in the corona discharge patterns of male and female subjects. There are several possible explanations for this disparity in findings. One possible explanation of this finding, as compared to Murstein and Hadjolian's (1977) findings and possibly Moss and Johnson's (1974) findings, may lie in the setting in which the photographic medium was used. The present study used traditional print-paper techniques in which a red safe-light could be used during the experiment. Murstein and Hadjolian (1977) and Moss and Johnson (1974) used film, which precludes the possibility of using any type of illumination while conducting the photographic session. It may be quite possible that differences in the photographic media themselves (print-paper vs. film) may have contributed to differences in the print quality which produced the effect. Even more likely, it may be the lack of illumination that would have to be used in their studies which may have increased the arousal level of the male and female subjects differentially (depending upon the sex of the experimenter/photographer) and produced this effect. Then again, another possible explanation may have been that the control of dietary and health factors (especially the elimination of females subjects who were menstruating) used in the present investigation (and not reported
in these other studies) may have negated any differential effect found in studies that failed to control for these factors.

A rather interesting finding in this study was that the correlation between subjects' corona discharge pattern scores and their skin resistance levels (as measured in ohms) was not significant. This finding runs counter to the contentions of Murstein and Hadjolian (1977), Pehek, Kyler, and Faust (1976), and Schwartz (1974) who believed that the corona discharge patterns were related to sebacious activity. However, this finding is consistent with those reported by Moss and Johnson (1971) who claimed that when the parameters of photography were held constant (as they were in this investigation), the Kirlian effect was not related to GSR or sweat activity.

Based on the present findings, this investigator does not propose that the electrophotographic technique is measuring some extraordinary effect as Moss and Johnson (1971) seem to imply, but rather (post hoc) hypothesizes that the Kirlian effect may be a unique (although weak) predictor of anxiety, and accounted for variance that was not accounted for by the skin resistance measure. As the levels of anxiety could be significantly differentiated with subject's skin resistance level and overall, with the corona discharge pattern scores, these results appeared to indicate that each measure may be a unique predictor of anxiety.

Perhaps both measures could be used in conjunction to better predict anxiety. However, analyses with multiple regression techniques revealed that although both measures may be unique predictors, skin resistance
levels were the best predictor of anxiety as measured by the STAI, with corona discharge patterns contributing a nonsignificant amount to the prediction. Thus, it would appear that skin resistance levels are the best predictors of anxiety (and arousal) while the weak effect of corona discharge patterns were unable to significantly account for unique variance in the anxiety criterion. Additional analysis revealed that the corona discharge pattern ratings of both judges, either individually or in unison, did not correlate significantly with the STAI. Thus, although one judge's ratings were able to significantly differentiate between extreme levels of anxiety as measured by the STAI, his ratings failed to demonstrate any significant covariation with this anxiety measure.

As the best predictor of anxiety, skin resistance levels correlated significantly with STAI scores, but did not correlate significantly with DACL scores. These findings indicated that higher anxiety scores (but not higher depression scores) were associated with higher skin resistance level (in ohms) and vice versa.

Overall, the present investigation found evidence to support only two of the seven hypotheses offered. High-anxious subjects had significantly higher levels of skin resistance (in ohms) than did low-anxious subjects. Coronal discharge pattern ratings, although significantly different in high- versus low-anxious subjects using a weighted combination of both judges' ratings, demonstrated this result primarily through the contribution of one judge's ratings. In addition, the Kirlian effect was found to be a weak contributor to the prediction of anxiety as compared to skin resistance measures. Overall, skin resistance levels
appeared to be the more robust measure in the analysis of anxiety. Neither measure could significantly differentiate between levels of depression groups formed by the interaction of levels of depression and levels of anxiety.

As the electrophotographic technique appeared to produce a weak effect in differentiating levels of state anxiety and was unable to differentiate between levels of state depression, perhaps future research might focus on the use of this technique with trait anxious and trait depressed subjects or with clinical populations with more severe forms of these affective disorders. It is possible that the form of anxiety and depression measured by the state indices used in this study, which are assumed to reflect situational episodes, may not have been accompanied by the physiological changes necessary to be robustly reflected in the corona discharge patterns. The trait measure, by virtue of the subjects' endorsement of items reflecting the more pervasive and enduring nature of the disorder, as compared to state measures, may possibly be reflected by more extreme physiological changes. Such changes may be necessary for a strong difference to be detected in the discharge patterns.

In addition to the controls used in the present investigation to reduce the possibility of extraneous variables influencing the coronal discharge patterns (especially the controls for room temperature and humidity which to date have not been reported in any published electrophotographic study), control checks over time should be imposed on the photographs to assess their stability. As alluded to previously in this section, a three-second stability in photographs was achieved in the present
investigation. Although the time period where the initial depression and anxiety measures were administered and the electrophotographs were taken did not, on the average, exceed 20 minutes, future research using state measures should assess the decay rate of the photographs (and the affective measures, as well) over this intervening period of time.

Experimentally, this could be done by taking an electrophotograph immediately after the DACL and STAI screening, and then again immediately after the skin resistance measure was taken, followed by a readministration of the DACL and STAI. In this way, one could perhaps determine if the initial composition of the groups had changed over this period of time (by examination of the two sets of test scores), and whether the photographs reflected any change in the groups over this same time period.

Finally, future research should investigate the various types of photographic media (film vs. print-paper) to assess the quality of the photographs produced and to determine which medium produces the optimum discriminating qualities for differentiating levels of depression and levels of anxiety. This could be done by photographing the subjects' index finger using both film and print-paper (counter-balancing the order of presentation) in the same study.

In summary, the present investigation demonstrated that levels of state anxiety could be weakly differentiated using electrophotographic techniques. This technique might be used in future investigations as a gross measure of arousal. In particular, it might be employed in stress research where the level of arousal is induced and manipulated, or it may be a useful technique in studies using trait anxious subjects. Further
investigation with this technique, using subjects drawn from a clinical population, where physiological states may be more robustly reflected in the discharge patterns, appears to be necessary in order to assess its utility as a differential diagnostic tool.
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I voluntarily agree to serve as a research subject in Experiment Daisy, conducted by William Hovsepian at Loyola University of Chicago. I understand that my participation in this experiment is for research purposes only and that my identity as a subject as well as my test results in this study will be kept anonymous.

Signed: ___________________ Date: __________

Witnessed: ___________________ Date: __________
Subject Health Checklist

Please read the items below and check those that apply to you Today. This information is confidential and only for research purposes. Place no identifying marks on this material, this is to preserve your anonymity.

1. _____ I currently have a cold and/or fever
2. _____ I have recently (within the last five days) gotten over a cold and/or fever
3. _____ I have eaten food, candy, or other snacks within the last hour
4. _____ I have smoked a cigarette in the last 15 minutes
5. _____ I have taken alcohol or soft drinks within the last hour
6. _____ I have taken medication today and/or am currently taking medication (tranquilizers, barbiturates, morphine, methadone, amphetamines, cold capsules, cough syrup containing codine, marijuana, LSD)
7. _____ For Females Only: I can currently in my month menstrual period
APPENDIX C
Corona Discharge Pattern

Scoring System

SCORE 7: Discharge patterns are densely packed to form a dark solid band and are 1/8" or greater in length

SCORE 6: Discharge patterns are densely packed to form a dark solid band and are less than 1/8" in length

SCORE 5: Discharge patterns are not densely packed but have visible spikes 1/16" or greater in length

SCORE 4: Discharge patterns are not densely packed with barely visible spikes and are less than 1/16" in length

SCORE 3: Discharge patterns are barely visible and have no spikes

SCORE 2: Photograph has no discharge patterns at all or has a gap in the discharge pattern

SCORE 1: Photograph is composed of brownish smudges
The dissertation submitted by William Hovsepian has been read and approved by the following committee:

Dr. James E. Johnson, Director
Associate Professor, Psychology, Loyola

Dr. Thomas P. Petzel
Associate Professor, Psychology, Loyola

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Assistant Professor, Psychology, Loyola

The final copies have been examined by the director of the dissertation and the signature which appears below verifies that any necessary changes have been incorporated and that the dissertation is now given final approval by the Committee with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

April 24, 1980
Date

Director's Signature