SKIN CONDUCTANCE RESPONSE

AS A MARKER OF INTUITIVE DECISION MAKING IN NURSING

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DEDICATION

I dedicate this work to my mother,

Dr. Phyllis S. Karns.

Your support and love for the science of nursing lead to my discovery of the same.

You always knew I could do it.

Thank you.

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I would like to thank above all my husband Jon for the tireless hours listening to me develop my dissertation research and helping me analyze the data. My children, Tim, Matt, Calvin and Nico, thank you for understanding when I was on the computer and not in the swimming pool. To Dr. Sims, your example and support led to my application to the doctoral program, and look at me now!! To Dr. Carpenter, thank you for being the only one in the beginning to see the brilliance in my madness. Your tireless support kept me on track to study what interested me the most. To Dr. Ironside and Dr. Ebright, thank you for joining the team in the later stages and being willing to immerse yourselves in the concepts and providing me with much needed direction.

ABSTRACT

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A quasi-experimental design was undertaken to explore the possibility of utilizing electrodermal activity as a marker of intuitive decision making in nursing. This study compared 11 senior female nursing students to 10 female nurses with more than five years of nursing experience completing a clinical decision making task utilizing MicroSim© program software while measuring skin conductance response (SCR). The clinical decision making task chosen was based on the cognitive continuum theory. The somatic marker hypothesis is also a theoretical base for this study. This theory suggests that physiological markers are present during decision making. An independent *t*-test was conducted in SPSS comparing the total number of skin conductance responses generated and overall score in the card task and clinical scenario between the two groups. According to the Somatic Marker Hypothesis, the researcher's definition of intuition, and the results of this experiment, SCR generation shows promise as a marker of intuitive decision making in nursing.

Sharon L. Sims, RN, PhD, FAANP, Chair

TABLE OF CONTENTS

Chapter Four

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

PROBLEM AND JUSTIFICATION FOR THE STUDY

Clinical decision making by nurses is the cornerstone of quality care received by patients. Errors in decision making by nurses can have disastrous consequences (Baker, 1997; Bonner, 2001; Cohen & Benner, 2003). Fewer errors in decision making are made by experienced nurses, and these nurses tend to report differences in the way they make decisions (Benner & Tanner, 1987; Lauri et al., 2001; Martin, 2002; Redden & Wotton, 2001; Simmons, Lanuza, Fonteyn, Hicks, & Holm, 2003). Specifically, when compared with new graduate nurses, experienced nurses report greater use of intuitive decision making (Benner & Tanner; Hoffman, Donoghue, & Duffield, 2004). Although some have posited that intuition can be viewed as irrational and inferior to purely analytical reasoning, Easen and Wilcockson (1996) and Hicks, Merritt, and Elstein (2003) found intuitive decision making to be superior to analytical decision making in relation to task complexity among critical care nurses. Their findings indicated that as task complexity increased, intuitive decision making increased and better decisions resulted.

Decision making research varies widely among disciplines and is often focused on the area of the brain thought to be responsible for or that influences decision making. Numerous studies have been undertaken with the intent to localize and define which area of the brain is responsible for particular executive functions including decision making (Bechara, Damasio, & Damasio, 2003; Haruno et al., 2004; Okuda et al., 2003; Tucker et al., 2003).

One phenomenon that is widely discussed in decision making research is emotion. The word *emotion* has varying meanings among disciplines as well as individuals.

Accordingly, because the definition of emotion varies among researchers and disciplines, it is important to explore the role emotion plays in decision making. Generally, there are two views of emotion. One is that emotion is a somatic state, a type of neural signaling, and the other view of emotion is that it is the expression or physical feeling of this somatic state. Interesting, this author believes the terms *intuition* and *emotion* can often be interchanged. To aid the reader in distinguishing which connotation is desired in this paper, the phrase *somatic emotion* will be used to represent the somatic state. Recent research has also suggested that somatic emotion not only arises from the outcomes of decisions but is also an integral part of the decision process itself. The role that somatic emotion plays in decision making is an area of research that is just beginning to bloom.

Through the use of technology, distinct areas of the brain involved with somatic emotion and decision making can be localized. The general consensus is that decision making is an integrated function of the limbic system combining with other regions of the brain. It has been theorized that the pre-frontal cortex is part of a system that stores information relating to prior rewards and punishments and relates this information subconsciously to elicit a somatic emotional response that aids in decision making (Bechara & Damasio, 2002; Bechara, Damasio, & Damasio, 2000; Bechara, Damasio, Damasio, & Anderson, 1994; Damasio, 1996). Somatic emotion is also essential in the storage and recall of memory, which can directly affect decision making.

The physiology of decision making is a complex process that involves interaction between many areas of the brain. An alteration in any one of these areas can alter decision making drastically. Making a decision requires integration of sensory, limbic, and autonomic information. Decisions are also dependent on memory, emotions, and cognition. It has been shown that subjects who have damage to the occipital frontal cortex (orbito-frontal cortex) lack a somatic emotional anticipatory reaction as measured through skin conductive responses when making decisions (Bechara et al., 1994; Bechara et al., 2000; Bechara & Damasio, 2002; Damasio, 1996). These subjects are also unable to make an advantageous decision. It is hypothesized that the lack of these subconscious reactions hinders the guiding of reasoning, which results in disadvantageous decision making. Interestingly, this reaction could be what some people call *intuition* or *gut-feelings*. Intuition may be the ability to know something without conscious reasoning. This study combines theories of decision making, physiology, and philosophy in an attempt to discover a marker of intuitive decision making in nursing.

Purpose

Intuitive decision making in nursing has been studied almost exclusively using subjective descriptive studies that utilize written scenarios to gauge decision making. This has resulted in a good description of the phenomenon, but science has not yet studied ways to measure the presence or absence of intuitive decision making. If a marker of intuitive decision making were available, it would provide a tool for theory validation as well as allowing the study of physiological components involved with intuitive decision making. Thus, the purpose of this study was to evaluate a physiological marker of nurses' intuitive decision making.

Research Questions

The phenomenon of intuitive decision making by nurses is poorly understood. Although there is a consensus that intuition does exist, there is a lack of tangible evidence resulting in many unanswered questions.

1. What is the physiology of intuitive decision making?
2. Which parts of the brain are utilized during intuitive decision making?
3. Can intuition be taught?
4. Can intuitive decision making be objectively predicted?

For the purpose of this study, the research questions are

1. Do experienced nurses generate more total skin conductive responses than nursing students during a computerized clinical scenario?
2. Do experienced nurses generate more precursory skin conductance responses than student nurses during a computerized clinical scenario?
3. Do experienced nurses perform better than nursing students on a computerized clinical scenario?
4. Do experienced nurses report a greater use of intuition than nursing students on the computerized clinical scenarios?

Specific Aims and Hypotheses

Based on the review of literature, the following specific aims and hypotheses were formulated:

Specific Aim 1 was to compare the skin conductive response generation, precursory and total number, and overall score during a computer-based Iowa Gambling Task (IGT) between two groups: one group comprised fourth semester baccalaureate female nursing students who had successfully completed the last clinical rotation of their academic program and the other group comprised female baccalaureate-prepared nurses with five years or more of work experience.

Hypothesis 1a stated that there would be no difference in the total number of skin conductance responses generated by nursing students and experienced nurses while performing the modified Iowa Gambling Task.

Hypothesis 1b stated that there would be no difference in the number of precursory skin conductance responses generated by nursing students and experienced nurses while performing the Iowa Gambling Task.

Hypothesis 1c stated that there would be no difference in the overall score between nursing students and experienced nurses on the Iowa Gambling Task.

Specific Aim 2 was to compare the skin conductive response generation, precursory and total number, and overall score during a computer-based clinical scenario. One group comprised fourth semester baccalaureate nursing students who had successfully completed the last clinical rotation of their academic program and the second group comprised baccalaureate-prepared nurses with five years or more of work experience.

Hypothesis 2a stated that experienced nurses would generate more total skin conductance responses than nursing students during a computerized clinical scenario.

Hypothesis 2b stated that experienced nurses would generate a greater number of precursory skin conductance responses than nursing students immediately prior to decision making during a computerized clinical scenario.

Hypothesis 2c stated that experienced nurses would perform better on the computer-based clinical scenario than the student nurses.

Specific Aim 3 was to compare the perception of nurses and student nurses on their use of intuition and anxiety levels in both the Iowa Gambling Task and the clinical scenario. One group comprised fourth semester baccalaureate nursing students who had successfully completed the last clinical rotation of their academic program and one group comprised baccalaureate-prepared nurses with five years or more of work experience.

Hypothesis 3a stated that experienced nurses would report a greater use of intuition during the clinical scenarios than the nursing students.

Hypothesis 3b stated that there would be no difference on reported use of intuition on the gambling task between the experienced nurses and nursing students.

Hypothesis 3c stated that there would be no difference in reported anxiety levels on the Iowa gambling task and the clinical scenario between the experienced nurses and students.

Definition of Terms

Amplitude

Theoretical. The *amplitude* of a skin conductance response is the highest level of current produced by a response. Amplitude does not take into consideration a nonresponse. For example, if there is no response after a given stimuli, that nonresponse is not figured into the mean amplitude of skin conductance responses. One measures the amplitude from the baseline of the individual's skin conductance level.

Operational. For the purpose of this study, *amplitude* is defined as the mean of all measurable skin conductance responses from the baseline to the peak.

Electrodermal Activity Recording

Theoretical. Since the 1900s, *electrodermal activity recording* has been theorized to be a measure of the psychophysiological concepts of arousal, attention, and emotion. While the first observations of connections between the electrical state of the skin and psychological factors were made in 1879, it was not until 25 years later that concentrated research began. In 1904, Carl Jung used electrodermal activity as a measurement variable when seeking responses to emotional stimuli invoked by words. He found a significant proportional relationship between level of skin response and the type and degree of emotion elicited (Neumann & Blanton, 1970).

Research has shown that the palmar sweat glands are enervated by the sympathetic nervous system (Fowles et al., 1981; Fredrikson et al., 1998; Shields, MacDowell, Fairchild, & Campbell, 1987). Similarly, studies have provided further validation of sympathetic control by measuring sympathetic action potential in the peripheral nerves and electrodermal activity simultaneously (Dawson, Schell, & Filion, 2000). The results have shown that when there is normal temperature in the room and the subject is normothermic, there is a high correlation between sympathetic nerve activity and electrodermal activity, more specifically skin conductance responses (Wallin, 1981). Thus, electrodermal activity recording measured on the palm is a marker of sympathetic stimulation.

Operational. For the purpose of this study, *electrodermal activity recording* is defined as the recording and measurement of psychologically induced sweating.

Emotion

Theoretical. *Emotion* is a concept that has various definitions warranting a perspective from several different areas of science such as philosophy, psychology and the physical sciences. For this study, the term *emotion* is explored in relation to decision making. Exploring the concept of emotion is crucial because the operational definition of intuitive decision making rests on the assumption that intuition is a form of somatic emotion, a neural signaling. This researcher has chosen to include a synopsis in the review of literature section of the history of emotion as revealed through the great writers of the western world (Hutchins, 1972), thus attempting to realize the evolution of the concept and meaning of emotion through the eyes of philosophy. The literary expression of emotion has great influence on how society chooses to view the meaning and role of emotion. For this study, *emotion* is viewed as a neurologic (somatic) state in opposition to the societal view of emotion as the expression of the somatic state.

Recent literature has suggested that emotions not only arise from the outcomes of decisions, but are also an integral part of the decision process itself. The consensus is that decision making is an integrated function of the limbic system and other regions of the brain. The role that somatic emotion plays in decision making is an area of research that is just beginning to bloom. It is theorized that the brain stores information relating to prior rewards and punishments and relates this information subconsciously to elicit an emotional response that aids in the decision making (Bechara, Tranel, & Damasio, 1997, Damasio, 1996). This could be what some people call “intuition” or “gut-feelings.” Intuition may be the ability to know something without conscious reasoning.

Operational. For the purpose of this study, *emotion* is defined as a somatic state that elicits electrodermal activity.

Intuitive Decision Making

Theoretical. One process of nurses' decision making that is universally acknowledged is the use of intuition (Benner & Tanner, 1987; Catania, Thompson, Michalewski, & Bowman, 1980; Cioffi, 1997; Coulter, 1998; Easen & Wilcockson, 1996; Harbison, 2001; Lauri et al., 1998). The definition of *intuitive decision making* varies from author to author, resulting in a lack of clarity and coherence. For example, Easen and Wilcockson (1996) argued that because of the ambiguity of the concept, there tends to be a belief that intuition is somehow irrational and inferior to purely analytical reasoning (Benner & Tanner). Intuitive decision making can be theoretically defined as a nonconscious, nonanalytical process of making sense of a situation through pattern recognition based on experience.

Operational. For the purpose of this study, *intuitive decision making* is defined as decisions that are influenced by pattern recognition based on experience as evidenced by the production of precursory skin conductance responses.

Latency Window

Theoretical. *Latency window* refers to the time frame in which a skin conductance response occurs and is vital in the analysis of electrodermal activity recording. One must be able to state that the response is due to intended stimuli. Generally, a significant response occurs immediately after the introduction of stimuli.

Operational. For the purpose of this study, *latency window* is defined as the period of 1 to 3 seconds between the decision marker and the initiation of a skin conductance response.

Magnitude

Theoretical. The *magnitude* of skin conductance response refers to the measurement of all significant skin conductance responses. Magnitude incorporates all non responses. For example, if there is not a skin conductance response following the introduction of stimuli, it is considered to be a zero response. This zero response would be incorporated into the mean measurement of magnitude.

Operational. For the purpose of this study, *magnitude* is defined as the mean measurement of all stimulus responses including skin conductance responses and zero responses which occur during the latency window.

Nonsignificant Skin Conductance Response

Theoretical. *Nonsignificant skin conductance response* occurs in the absence of a stimulus. It has been estimated that the normal production of these responses occurs anywhere from 1 to 3 times per minute. A nonsignificant response is a sudden rise in the production of sweat, resulting in an increase in current production that occurs outside of normal time in which a response would be elicited after the introduction of stimuli.

Operational. For the purpose of this study, *nonsignificant skin conductance response (NS-skin conductance response)* is defined as skin conductance response generation that occurs outside of the latency window.

Nurse

Theoretical. The word *nurse* carries several different connotations in today's society. There are several different types of nurses in America today. Nurse can refer to a licensed vocational nurse or an associate, diploma, and baccalaureate-prepared nurse. In general, it means one who is licensed to practice nursing.

Operational. For the purpose of this study, *nurse* is defined as a registered nurse in the state of Texas.

Nursing Student

Theoretical. Similar to the earlier definitions of *nurse*, *nursing student* can also be defined several ways. Theoretically, a nursing student is one who is studying nursing, which encompasses studying to become a licensed vocational nurse, an associate-prepared nurse or a baccalaureate nurse. Often, one is deemed to be a nursing student even before or out of a formal education setting.

Operational. For the purpose of this study, *nursing student* is defined as a female baccalaureate nursing student who has successfully completed her final clinical rotation in her last semester of nursing school.

Precursory SCR

Theoretical. While there is no explicit definition or label in the literature given to SCRs that begin their rise prior to the introduction of stimuli, their existence is evident (Bechara, Tranel, Damasio, & Damasio, 1996). Some have labeled these as anticipatory SCRs. However, labeling these SCRs as anticipatory is in essence interpreting their meaning instead of labeling the phenomenon. These researchers assumed that the SCR is in anticipation of an impending stimulus or decision and not the influencer on a decision.

In relation to decision making, emotion has historically been seen as a real and tangible feeling or state which influences decision making. Damasio (1996) did not refute that emotions can be felt, however, he proposed that emotions can exist without explicit cognition. The researcher proposed that emotion-enhanced decision making is the degree to which choices are aided by somatic signals produced immediately prior to the choice, hence precursory SCRs. This definition encompasses both cognitive and nonconscious aspects of emotion as well as physiologic responses that occur with emotion. This definition provides an avenue for the necessity of emotion as put forth by Darwin (Hutchins, 1972) and is consistent with Freud's view on the role of emotion and cognition.

Operational. For the purpose of this study, a *precursory SCR* is an SCR that starts its rise within 3 seconds before a decision and occurs outside of the latency window of the previous decision.

Skin Conductance Response

Theoretical. *Skin conductance response* is a sudden rise in the production of sweat as captured by electrodermal activity recording. This rise in sweat production produces a rise in conductivity, thus increasing the amount of current produced during electrodermal activity recording. A significant skin conductance response is produced by the introduction of stimuli. The average amplitude varies between individuals with a typical amplitude from 0.1 μS to 2 μS.

Operational. For the purpose of this study, *skin conductance response* is defined as the electrodermal activity recording capturing sudden phasic rises in the level of electrical conductance of the skin greater than 0.1 μS.

Somatic State

Theoretical. The term *somatic state* is widely used in neuroscience research. While several authors have differing views on what constitutes a somatic state, they are generally in agreement that it is a state in which neurological activity is taking place in order to accomplish a task. The limbic system is believed to be a key area of the brain involved with the enacting of a somatic state.

Operational. For this study, *somatic state* is defined as a state in which the neural activation patterns are taking place as a result of the learned connection between stimuli.

Theoretical Framework

Patricia Benner's *From Novice to Expert* (1984) is the nursing theory on which this study rests. Benner theorized that nurses go through five stages of clinical competence. In the first stage, the novice stage, nurses are analytical and do not have life experiences to guide their decision making. Therefore, the decisions made by novice nurses are rule based. In the last stage, the expert stage of clinical competence, nurses do not rely on analytical decision making but rather on intuitive grasps of the situation at hand. In other words, the expert clinician has a deep understanding of the situation and is no longer consciously aware of the rules governing her actions. Based on this theory, it is hypothesized that experienced nurses will use intuition more than the nursing students and perform better on the clinical scenarios.

The primary theoretical framework for this research study is the somatic marker hypothesis. The somatic marker hypothesis proposes that decision making is greatly affected by alterations in somatic emotion and feeling. Decision making is a process influenced by signals (Hinson et al., 2002) that arise from bioregulatory processes. These regulatory processes include those processes that can manifest themselves as somatic emotion and feeling. These influences can be conscious or unconscious, and take place at multiple levels within the process of decision making (Bechara et al., 2000; Tranel & Damasio, 1994). Bechara et al. concluded that the somatic marker hypothesis of Tranel and Damasio is an anatomical as well as cognitive framework that is based on three main assumptions:

1. Human reasoning and decision making are dependent on many varying levels of neural activities both conscious and unconscious. The cognitive (conscious) operations are dependent on sensory input gained from interaction of early sensory neural cortices.
2. These cognitive activities (independent of their content) are dependent on support processes such as working memory, attention and emotion.
3. Reasoning and decision making are dependent on the availability of specific knowledge pertaining to the situation at hand, options for specific outcomes and actors. This knowledge is stored in implicit and nontopographically organized forms within the higher-order cortices.

Based on this theory, it is hypothesized that intuitive decision making in nursing results in part as a response to these biological signals.

Another theoretical framework guiding the overall design of this research proposal is the cognitive continuum theory of judgment (CCT) (Hamm, 1988; Hammond, 2000). According to Hammond, “Various modes, or forms, of cognition can be ordered in relation to one another on a continuum that is identified by intuitive cognition at one pole and analytical cognition at the other” (p. 92). An important key feature of this theory is the character of the task invokes a specific mode of cognition on the continuum. Hammond's modes are divided into six categories (as cited in Colbert, Hammerschlag, Aickin, & McNames, 2004). Tasks that are well structured tend to evoke an analytical mode of decision making while tasks that are ill structured lead to an intuitive mode (see Figure 1). This theory suggests that intuitive decision making is likely to result from scenarios that are loosely structured, pressed for time, and a have a low probability of manipulation. Thus, the computer based clinical scenarios, according to this theory, will invoke an intuitive mode of decision making.

Significance of Study

Intuitive decision making in nursing has been studied almost exclusively using subjective descriptive studies which utilize written scenarios to gauge decision making. This has resulted in a good description of the phenomenon but science has not yet studied ways to measure the presence or absence of intuitive decision making. If an objective marker of intuitive decision making was available, it would provide a tool for theory validation as well as allowing the study of physiological components involved with intuitive decision making.

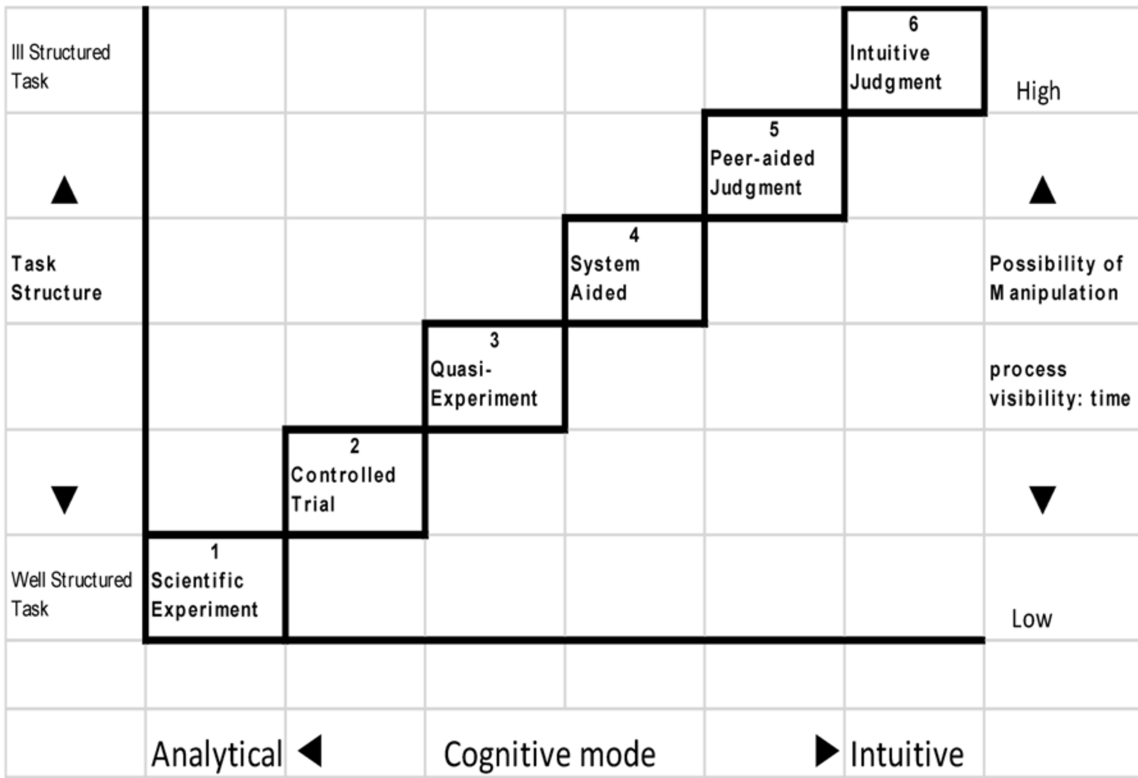
Assumptions

For the purpose of this study, the researcher of this investigation assumed the following:

1. All nurses who participated in the study were truthful in the degree obtained and years of experience in nursing.
2. The generation of significant skin conductance responses during the Iowa Gambling Task and the computerized clinical scenario were elicited based

Figure 1

Cognitive Continuum Theory[1]



[1]Adapted from Hamm (1988)

on the cognitive stimuli inherent within the Iowa Gambling Task and the computerized clinical scenario.

3. The use of a modified computer generated Iowa Gambling Task will produce similar results as the original Iowa Gambling Task as administered during the pilot study.

4. All subjects were psychologically and physiologically fit without a mental disorder that could interfere with results.

Summary

Decision making theory within the body of nursing is just beginning to be developed. One aspect of decision making by nurses is the presence of intuition (Benner & Tanner, 1987; Catania et al., 1980; Cioffi, 1997; Coulter, 1998; Easen & Wilcockson, 1996; Harbison, 2001; Lauri et al., 1998). However, the definition of intuition varies widely resulting in ambiguity and a belief that intuitive decision making is inferior to other forms of decision making (Rew & Barrow, 2007). If intuitive decision making were to be quantitatively measured as opposed to qualitatively reported, it would not only strengthen existing theories of intuition, but it would also provide a means for further research, specifically, research focused on different areas of the brain that are used during intuitive decision making. Studies could be developed comparing the different modes of decision making. A marker for intuition could also aid in developing pedagogies that focus on enhancing intuitive decision making, perhaps through pattern recognition (Banning, 2008). Thus, this study will explore the possibility of finding a biophysical marker for the presence of intuitive decision making by nurses.

CHAPTER TWO

REVIEW OF RESEARCH LITERATURE

The review of literature for this study contains research from several different disciplines and includes studies of concepts such as emotion and intuition. In order to study the phenomenon of intuitive decision making in nursing, discoveries in other fields of science were consulted. The theoretical framework for this study is a combination of philosophy, cognitive science, neurology, and nursing science. As nursing science evolves, it is crucial to include salient research from other disciplines.

Anatomy/Physiology of Decision Making

The physiology of decision making is a complex process that involves interaction between many areas of the brain. An alteration in any one of these areas can alter decision making drastically. Making a decision requires integration of sensory, limbic, and autonomic information. Decisions are also dependent on memory, emotion, and cognition. The human brain is inundated daily with noisy (distracting) information requiring it to respond. On a cellular level, single-cell studies in neuroscience indicate that neural mechanisms absorb this noisy information up to a certain threshold and then respond accordingly (Smith, Thurkettle, & dela Cruz, 2004). In other words, there is a level or magnitude of input necessary before a response is elicited. The brain's ability to interpret the noisy signals is dependent on different areas of the brain functioning properly.

Areas of the Brain involved in the Decision Making Process

There are several different areas of the brain involved in decision making. Numerous studies have been undertaken with the intent to localize and define which area of the brain is responsible for particular executive functions (Bechara et al., 2003; Haruno et al., 2004; Okuda et al., 2003; Tucker et al., 2003). In the following section, the generalized functions of and relationship to decision making of these regions is briefly discussed, and an overview of the anatomy involved will be provided.

Frontal Lobe

The frontal lobe of the brain is named for the frontal bone under which it lies. It occupies the anterior portion of the cortex and is separated from the parietal lobe (posteriorly) by the central sulcus. The frontal lobe is separated from the temporal lobes (inferiorly) by the sylvian fissure and from the corpus callosum (caudally) by the collosomarginal sulcus. The frontal lobes are involved in executive level functions such as planning, reasoning, judgment, impulse control, and memory as well as motor control. The frontal lobe can be further divided into three primary regions: the motor cortex, the pre-motor cortex, and the pre-frontal (orbitofrontal) cortex (Krawczyk, 2002). The prefrontal cortex is held as the most important part of the brain concerning cognitive thinking. However, damage to any other area of the brain that is responsible for sending information to the pre-frontal cortex results in an absence or alteration in the performance of the desired task within the prefrontal cortex.

Prefrontal cortex. The prefrontal cortex is considered to be the most evolved part of the brain. It occupies the front third of the brain, behind the orbit on the ventral surface of the frontal lobes. The dorsolateral prefrontal cortex occupies the outside surface of the prefrontal cortex at the sides and the upper region. It is the part of the brain that contains executive functions, such as decision making, procedural learning, judgment, impulse control, and critical thinking. Our ability to be strategic (planning ahead and time management) and communicate with others is heavily influenced by this part of the brain. The prefrontal cortex is believed to be crucial in the formation of goals and the planning involved in realizing these goals. The prefrontal cortex is responsible for behaviors that are necessary for one to be appropriate, goal-directed, socially responsible, and effective. Different sectors of the prefrontal cortex are involved in distinct cognitive as well as behavioral operations. It has long been known that damage to the ventromedial sector of the prefrontal cortex results in disruptions of social behavior as well as the inability of affective-guided planning and anticipation (Damasio, Tranel, & Damasio, 1990). Studies in rats have shown that lesions to the accumbens core located within the prefrontal cortex resulted in persistent impulsive choice (Cardinal, Pennicott, Sugathapala, Robbins, & Everitt, 2001).

Temporal Lobes

The temporal lobes reside on either side of the brain behind the eyes and underneath the temples. These lobes catalog our experiences through the storing of memories and images. In a sense, they help to define one's sense of self. They also play an important part in emotional stability, learning, and socialization. The temporal lobes help to transform sounds and written words into useful and meaningful information. They allow one to be able to read in an effective manner by allowing one to remember what was read. Studies have indicated that retrospective memory is mediated by the medial temporal lobes, and damage to these areas may result in an insensitivity to future consequences of one's decisions (Okuda et al., 2003).

The temporal lobes also house important components of the limbic system. The limbic system is known as the emotional center of the brain. It includes the amygdala, the cingulate cortex, the hippocampus, and the insula. The amygdala and the hippocampus are important areas of the temporal lobe involved with decision making and will be discussed separately.

Amygdala. The amygdala is an almond-shaped set of subcortical nuclei whose function is the generation of fear, regulation of attention, and other emotional activities, such as the association between stimulus and reward. The amygdala is relatively large and is located beneath the surface of the front, medial part of the temporal lobe. The amygdala activates the cortex for the required processing of stimuli. Studies have shown that emotionally laden visual stimuli have more activation in the visual cortex than nonemotional visual stimuli (Davidson & Smith, 1991). Another important function of the amygdala is the aiding in the ability to perceive in others and creating in oneself emotional or affective behaviors and feelings. A study by Morris et al. (1996) demonstrated that there was a greater flow of blood to the amygdala when exposed to a fearful face when compared to an exposure to a happy face. The amygdala also influences memory through the regulation and mediation of adrenal stress hormones and neurotransmittions with other areas of the brain (McIntyre, Power, Roozendaal, & McGaugh, 2003). This hypothesis is rooted in a consistent and expanding body of animal research (McGaugh, Cahill, & Roozendaal, 1996; McGaugh, Liang, Bennett, & Sternberg, 1984).

Hippocampus. The hippocampus (seahorse) is also part of the limbic system and is involved in a variety of cognitive functions. Located deep within the temporal lobe, it works very closely with the prefrontal cortex through reciprocal connections that lie within the medial thalamus. Studies have implied that the hippocampus may play a time-limited role in the initial formation and consolidation of episodic memory (Okuda et al., 2003). Studies in animals have concluded that the damage to the hippocampus results in disruption of spatial learning, working memory and selective attention (Broersen, 2000).

Cingulate gyrus. The cingulate gyrus rests just above the corpus callosum and forms an important part of the limbic system. It appears to provide an interface between the decision making processes of the frontal cortex, the *emotional* functions of the amygdala, and the brain mechanisms controlling movement. It communicates both ways with all components of the limbic system as well as with other areas of the frontal cortex. The cingulate gyrus also plays an excitatory role in *emotion* and in motivation (Bechara et al., 2003).

Insula. The insula is located within the cerebral cortex at the base of the lateral fissure and has been shown to play a role in the autonomic response to adverse stimuli such as fear. It is also important in the recognition of emotional expressions in others, such as displays of disgust (Calder, Lawrence, & Young, 2001). The insular cortex receives afferents (impulses from the body) from the autonomic regions and sends efferents (away from the insula) to the brain regions whose roles are to regulate the autonomic responses which accompany emotions (Davidson & Smith, 1991).

Contribution of Animal Studies

Primates have served as subjects in research concerning the impact of orbitofrontal cortex damage to cognitive function. It appears that they have prefrontal cortices similar to humans (Amiez, Procyk, Honore, Sequeira, & Joseph, 2003; Butter, 1969; Iverson & Mishkin, 1970). These studies are able to localize lesions within the primates that human studies are incapable of locating. These studies result in a heightening of the knowledge of decision making etiologies of particular areas of the brain. While the focus of many of these studies is the neural processing involved with rewards, it appears that these studies are related to the processing of emotional valence in human decision making (Krawczyk, 2002; Rolls, 2000a). Studies of orbitofrontal cortex damaged primates have also indicated that this region of the brain is involved with motivational behavior and affect as well as rewards processing. It is also evident that this area of the brain is involved with the processing of primary reinforcers (Rolls, 2000a).

Damage to different areas of the brain in primates produces different changes in behavior. Studies have shown that Macaques with damage to the orbitofrontal cortex are impaired at tasks involved with learning about the rewarding or the punishing nature of stimuli (Butter, 1969; Iverson & Mishkin, 1970; Mishkin & Jones, 1972; Rolls, 2000a). The subjects have also been shown to respond inappropriately to learned processes such as a *go-no go* task in which they go when they are not supposed to (Iverson & Mishkin). Damage to the caudal area of the orbitofrontal cortex can also produce emotional changes in the primates such as decreased aggression to known negative stimuli such as humans. These studies are very important when attempting to discern the role of emotions in decision making by allowing us to understand what role might be lost when a particular area of the human brain is damaged.

An interesting phenomenon associated with damage to the orbitofrontal cortex in primates is the loss of stimulus-reinforcer association learning. Baxter, Parker, Lindner, Murry, and Murry (2000) completed a study in which primates were given a task to choose between two objects that were associated with a specific food reward. One of the food rewards was then devalued (associated with undesirable food), which resulted in the primates choosing the object associated with the more desirable food. After they had learned the association between the objects and the desirable food, the primates were given a lesion to either the orbitofrontal cortex or the amygdala. Following this surgery, the primates were still able to choose appropriately. However, the primates were then given a lesion to either the orbitofrontal cortex or the amygdala contralaterally to the original lesion (each monkey had a lesion to both the orbitofrontal cortex and the amygdala). This resulted in the inability of both groups of primates to choose appropriately. This would imply that there is an association between the amygdala and the orbitofrontal cortex necessary for appropriate decision making (Baxter et al., 2000).

Conclusions

To fully understand how somatic emotion influences decision making, it is important to understand what is occurring at the cellular level within the brain during decision making. The basis for reviewing the neural components of decision making is to gain an understanding of how decisions are dependent on different areas of the brain functioning properly at the cellular level. It has been difficult to ascertain the role of somatic emotion in decision making due to the complexity in which decisions are made and the interaction of several areas of the brain.

Decision Making Research

Influence of Emotion on Decision Making

Introduction

It is important to discuss emotion for this study because the researcher believes that the somatic definition of emotion is intertwined with her phenomenon of interest, intuitive decision making. Emotion is a concept that has various definitions warranting a perspective from several different areas of science such as philosophy, psychology, and the physical sciences. The researcher has chosen to include a synopsis of the history of emotion as revealed through the great writers of the western world (Hutchins, 1972), thus attempting to realize the evolution of the concept and meaning of emotion through the eyes of philosophy. The literary expression of emotion has great influence on how society chooses to view the meaning and role of emotion. Current theories on the role, definition, and application of emotion to decision making will be explored. It is important to understand the semantics involved in this area of interest (Cacioppo & Gardner, 1999; Damasio, 1996; Rolls, 2000b).

Affective emotion-enhanced decision making (intuitive decision making) is not a concept readily defined in the literature. It requires the integration of what is theorized about affective emotion and how this influences decision making. The literature selected provides a wide base on which to create, define, and mold this concept. This section will explore the concept of emotion as an entity in itself as revealed in the literature as well as how affective emotion enhances decision making. In order to analyze the concept of emotion-enhanced decision making, the concept of emotion must first be analyzed.

There is a relatively new concept found widely in the literature termed *emotional intelligence*. It has been deliberately excluded from the literature review. Emotional intelligence has been defined as the "ability to monitor one's own and others feelings and emotions, to discriminate among them and to use this information to guide one's thinking and actions" (Vitello-Cicciu, 2002, p. 204). Emotional intelligence deals with the felt emotion and the ability to sense what others are feeling. It is used often in the business world to describe an attribute of successful leaders. The focus of this study is geared toward analyzing how affective emotion may help/hinder clinical decision making.

History

Understanding the differing views about emotion throughout history is essential when attempting to define this phenomenon. One avenue for exploring attitudes about emotion is to explore emotion as seen through the eyes of great works of literature. Encyclopaedia Britannica published *The Great Books* in 1952 that consisted of those books deemed by the editors to be “pre-eminently those which have given western tradition its life and light” (p. xi). They also provided a syntopicon on common themes found within the books. The chapter within this syntopicon entitled *Emotion* provided a wealth of ideas and historical insights into the concept of emotion throughout time. The author’s presented synonyms that they believed had been used throughout society to designate the same psychological fact. These synonyms were *passion*, *affection*, *affect*, and *emotion* (Hutchins, 1972, p. 414). It is interesting to note that when this chapter was written, the authors stated that the terms *affect* and *affection* had ceased to be current. Today, these terms are very current, and this alteration is an example of how concepts change throughout time.

Another avenue for exploring the historical view of emotion is to explore early scientific research dealing with emotion. Darwin’s *Expression of Emotion in Man and Animals* ([1872] 1965) has been the basis for what is generally known as affective neuroscience. Through his tedious observation and documentation, Darwin allowed us a glimpse of the relationship between the nervous system and emotion. One of his principles that is of particular interest in relationship to decision making and somatic emotion is his third principle which states that direct actions of the nervous system act upon the body independently of the will. This Darwinian principle supposes that the psychophysiological nature of emotion often expresses itself independent of consciousness.

Modern neuroscience has taken up where Darwin left off. Through the use of modern technology such as CAT scans, MRI, and PET scans, systems within the brain as related to emotion are now being mapped. The area most often attributed to emotion in the brain is the prefrontal cortex, amygdala, anterior cingulate, hippocampus, and insula (Davidson & Smith, 1991).

Emotion is also historically rich within neuroscience. Heilman and Gilmore (1998) provided a brief historical account about what has been theorized about emotions within the realm of neuroscience. In the 1930s, Papez put forth a theory about a mechanism of emotion, proposing that while the cortex was essential for subjective emotional experience, emotional expression was dependent on the hypothalamus. Other theories followed, and other brain areas were added to the limbic system. These included the hippocampus, amygdala, insula, septum, and several other areas including the mesolimbic system.

Definitions

Various theories exist as to what emotion is (Damasio, 1996; Rolls, 2000c). Perhaps the earliest scientist to look at emotion was Darwin. His book the *Expressions of Emotions in the Man and Animals* (1965) is a description of the various presentations of emotion throughout the animal kingdom. His observations of the similarities between the expression of emotion between cultures as well as species, is a profound argument for the neural basis of emotion. Edmund Rolls (2000a) has proposed the theory that emotions are "states elicited by rewards and punishments, including changes in rewards and punishments" (p. 178). According to Rolls, the goal of any decision is to obtain the reward or avoid the punishment.

In their article *Emotion*, Cacioppo and Gardner (1999) attempted to review trends and methodological issues involved in theories of emotion. While no clear definition of emotion was found, several attributes and assumptions were explored. The closest they came to a definition was their statement that "emotion is a short label for a very broad category of experiential, behavioral, sociodevelopmental, and biological phenomena" (p. 3). This is such a broad definition that almost anything in existence can fall under its umbrella.

One definition for emotion given by Hutchins (1972) was credited to the James-Langue theory that proposed emotional experiences as the "feeling of … the bodily changes" which "follow directly the perception of the exciting fact" (p. 414). In essence "emotions are organic disturbances upsetting the normal course of the body's functioning" (p. 414). This definition rested implicitly on the assumption that emotion is felt or cognitively recognized.

Several authors focused on the neural basis of emotion when attempting to define it, as evidenced by Davidson (2003). He focused primarily on the physiological components of affective processing. His article lacked a definition of emotion, although he attempted to define the neural bases of emotion. It would seem prudent to have a description of emotion before attempting to discover the etiology. Davidson did provide some enlightening illustrations of several attributes of emotion revealed through the writings of Darwin, such as “most of our emotions are inextricably entwined with their expression” (p. 317), and “emotions, unlike most other psychological processes, are instantiated in both the brain and the body” (p. 331). However, these did not provide a clear or concise definition of emotion. Davidson assumed that affective emotion-enhanced decision making was influenced by both situational and dispositional characteristics. If depressed, one was considered to be in a state that had the possibility of being corrected, while one who suffered from damage to the prefrontal cortex was rendered with a trait of impairment.

Several authors simply described attributes about emotion without an explicit definition. For example, Damasio (1996), like others, failed to provide an explicit definition of emotion. He relied heavily on describing attributes, effects, and consequences of emotions without attempting to define emotion. This is illustrated in his statement, “I believe that the results of emotion are primarily represented in the brain in the form of transient changes in the activity pattern of somato-sensory structures” (p. 1414). Heilman and Gillman (1998) also did not provide an explicit definition of emotion. They described (without defining) emotional experience as either transient or enduring. The authors proposed that emotional experience can also be categorized according to its valence and level of arousal. Emotional behaviors were not defined in the article; however, readers were given several examples of categories of emotional behavior, such as verbal-semantic, facial prosodic, and gestural-postural. The authors also described other components of emotion. These were labeled as emotional imagery and emotional memory.

Hutchins' (1972) statement that "emotion is neither knowledge nor action, but something intermediate between the one and the other" (p. 415) was an attempt by the author to define emotion by describing what emotion was not. This attempt continued with the following statement: "The various passions {emotion} are usually aroused by objects perceived, imagined, or remembered, and once aroused they in turn originate impulses to act in certain ways" (p. 415). This statement labeled *passions* (emotion) as a moderator between objects perceived (cognitive recognition) and actions. Another crucial statement within this body of literature, further strengthened the authors' viewpoint on the need for emotion to be recognized to exist. "Analytically isolated from its causes and effects, the emotion itself seems to be the feeling rather than the knowing or the doing…it also involves the felt impulse to do something about the object of the passion" (p. 415). The common theme within this work was that emotions are "felt" and serve as a guide when making a decision. In other words, emotion is cognitive as well as affective. This theme can be found throughout the literature (Agan, 1987; Bolte, Goschke, & Kuhl, 2003; Brooks & Thomas, 1997; Easen & Wilcockson, 1996).

In summary, the definition of emotion varies among authors. It is difficult to ascertain the true meaning inherent in the word *emotion* because belief about the concept varies so broadly (see Appendix A). Thus, the quantitative study of emotion and how it affects decision making is needed.

Functions

The role or function that emotion plays in one's everyday life also varies from author to author. One varying theme among authors as well as disciplines is the level of consciousness involved with emotion. Davidson (2003) attempted to provide an overview of “ways to think about the brain and emotion and consider the role of evolution and expression in shaping the neural circuitry of affective processing” (p. 316). The foremost attribute that he attempted to justify is based on Darwin’s third principle “direct action of the excited nervous system on the body, independently of the will” (p. 317). In other words, the neural signaling involved with emotion often takes place without cognition. It is nonconscious. Davidson proposed that the “hallmark of adaptive, emotion-based decision making” (p. 318) is the ability to plan and anticipate the emotional experience associated with an anticipated outcome. This ability is greatly influenced by the prefrontal cortex’s ability to produce a bias signal that guides an individual to make a more *adaptive* decision.

Reinforcement. Rolls (2000a) also attempted to define the functions of emotion (felt) as the elicitation of autonomic and endocrine responses, flexibility of behavioral responses to reinforcing stimuli, motivation, communication, social bonding, cognitive evaluation of events, storage, and recall of memory, and the persistent and continuing motivation and direction of behavior (Rolls, 2000c). Rolls proposed that antecedents such as rewards and punishers were stimuli or reinforcers that one worked to obtain or avoid, such as food or a painful stimulus. He discussed and defined other influences on behavior, such as motivation. Motivation is what makes one work for a reward. An example of motivation in context is hunger. However, Rolls conceded that emotions can be motivators when he stated:

> Of course, one of the functions of emotions is that they are motivating, as exemplified by the case of the fear produced by the sight of the object that can produce pain, which motivates one to avoid receiving the painful stimulus, which is the goal for the action. (Rolls, 2000c, p. 200).

This statement seems to contradict his definition of emotions as states elicited rather than the elicitors.

Motivation. Rolls (2000a) attempted to provide a function of emotion in his statement “emotional (and motivational) states allow a simple interface between sensory inputs and action systems” (p. 179). Rolls was not exactly stating that emotion is a mediator between sensory inputs and action systems because there is no definition of interface. However, he explained further that emotions are states that are generated by a given sensory input and used as a motivational guide in future actions, and, thus, they are also mediators.

Moderating. Damasio (1996) defined one function of emotion in his statement “the somatic state is alerting you to the goodness or badness of a certain option-outcome pair…When the process is covert the somatic state constitutes a biasing signal” (p. 1415). The statement implied that somatic states (emotion) are causal in the cognitive recognition of the goodness or badness of a choice between options. He provided another logical clarifying statement: “Somatic markers participate in process as well as content” (p. 1415). This statement describes emotion interacting (moderating) during a decision and not just serving as the consequence or result of the decision. Damasio provided a further clarifying statement on the nature of emotion with the following: “Certain emotion-related somatosensory patterns also act as boosters in the processes of attention and working memory” (p. 1415). Once again, he provided a clue on the moderating role emotion plays in cognitive functions. He elaborated on this idea by stating “somatic markers facilitate logical reasoning” (p. 1415). Damasio postulated that somatic markers (emotion) are associated with logical reasoning.

Heilman and Gilmore (1998) provided reasoning similar to that of Davidson (2003) and Damasio (1996) as evidenced through their statement that “stimuli that provoke emotion induce changes in the viscera and autonomic nervous system” (p. 11). Emotion is a moderator between stimuli and changes in the autonomic nervous system. However, their view on emotion was extremely limited by their statement, “Emotions may be classified into two major divisions: experience and behavior” (p. 17). This statement appears to “box in” emotion and further explanation was not given. The relationship is not explicit. The authors explained that damage to certain areas of the brain may hinder emotion without explaining how or why this occurred. Rather, they simply provided what effect damage to certain areas of the brain had on emotion. They acknowledged this route as artificial but easy. For example, the authors presented that certain disorders of the cerebral cortex often resulted in disorders of emotional communication. However, the mechanism of how this happened was not addressed. Nevertheless, they did make a broad statement that many defects may be related to alterations in the neurotransmitter systems within the body, and they simply stated that the etiology of how these neurotransmitters affect mood is unknown.

Executive Functions

Emotions are also attributed to playing a constructive role in executive functions, such as decision making, procedural learning, judgment, impulse control, and critical thinking (Damasio,1994). The author provided a context in which a man was successful in life until his brain was damaged by a brain tumor. While he retained his intelligence, attention and memory, he lost much control over his ‘executive functions.’ He no longer had the ability to experience emotion, which rendered his decision making a “dangerous game of roulette” (p. 4).

Cacioppo and Gardner (1999) further helped to define the role of emotion within the cognitive realm in their statement that “emotions are increasingly recognized for the constructive role they play in higher forms of human experience” (p. 3). They stated that emotion is positively associated with “higher forms of human experience.” While this statement is logical, it tends to be a little ambiguous. It would be helpful to be provided an example of a role and a definition for “higher forms of human experience.” Emotion has been given a causal relationship with behavior by Cacioppo and Gardner through the statement that

> negative emotion has been depicted previously as playing a fundamental role in calibrating psychological systems; it serves as a call for mental or behavioral adjustment. Positive emotion, in contrast, serves as a cue to stay the course or as a cue to explore the environment. (p. 12)

Negative emotion causes behavioral changes and positive emotion causes perseverance and exploration. The authors took an evolutionary need for emotion as evidenced by the preceding statements.

Assumptions/Attributes

One classic assumption, attributed to rationalists as early as the ancient Greeks, is that the highest forms of human cognition, such as rationality, foresight, and decision making can be disrupted by the “pirates of emotion” (Cacioppo & Gardner, 1999). The authors supposed that the science of psychology was largely founded on this assumption, leading to a central focus on cognition and rationality. Avenues in which to decrease the influence that emotions have on these higher order functions have been paramount. Accordingly, Cacioppo and Gardner recognized emotion as physiological as well as psychological, and stated that these processes could not be fully understood without extensive study of the underlying mechanisms involved with decisions.

One assumption by Davidson (2003) repeated throughout the literature was that the goal of a decision is either an award or the avoidance of punishment. The ability to delay the immediate gratification of an available reward in order to obtain a greater goal requires an alternative influence or signal that is nonconscious. He cited an example within the context of depression. Oftentimes, people who are depressed exhibit hypoactivity within the prefrontal cortex as objectively measured through the use of various neuroimaging techniques. He supposed that this hypoactivity would lead to an impairment of bias signals resulting in a disadventitious, non-goal-directed decision.

Cacioppo and Gardner (1999) also explored antecedents of emotion. They supposed (from cited research) that rather than an occurrence of a specific event (stimulus), it was the cognitive appraisal by the individual of the significance of the event that was an antecedent for a specific emotion. They also suggested that these appraisals were themselves influenced by neural structures that had been associated with emotion.

One important attribute that Damasio argued for was the existence of a bodily signal that is sent to the somatasensory cortex causing an emotional biasing. He attributed affective emotion as an elicitor in decision making, not just a state.

In their article *Cortical Influences in Emotion* (1998), Heilman and Gilmore discussed how the brain mediates emotional experiences and behavior. It is interesting to note their assumption that the brain mediates emotion rather than emotion mediating the brain. However, they did explicitly state the “domain of emotions.” The authors premised that this “domain of emotions” (as conceptualized within their fields of behavioral neurology and neuropsychology) included two major divisions, which they labeled as *emotional experience* and *emotional behavior*.

Four theories of possible mechanisms (antecedents) of emotional experience were put forth by Heilman and Gilmore (1998). The facial feedback hypothesis, first proposed by Darwin, supposed that facial feedback induces emotional experience. The Visceral feedback hypothesis proposed in the late 1800s by William James (as cited in Hutchins, 1972) theorized that emotionally provoking stimuli induce changes within the viscera and autonomic nervous system. However, it is the self-perception of these changes that produces the emotional experience. Subcortical theories of emotional experience propose that an afferent stimulus enters the brain and is routed through the hypothalamus. The hypothalamus is responsible for activating the endocrine and autonomic nervous system that produces physiologic changes in the viscera. Module theory entails two possibilities. One is that the brain contains specific systems (modules) devoted to unique emotional experiences, and the other possibility is that several different systems mediate several different unique emotions.

Heilman and Gilmore (1998) put forth an interesting antecedent to emotion. They proposed that the development of *appropriate emotion* is dependent in part on interaction with others. If there is a defect in one's ability to comprehend written or spoken language, one may be unable to develop the appropriate emotional state. The authors once again, did not define *appropriate emotional state*. Although not explicitly stated, they appeared to operate under the assumption that an appropriate emotional state is dependent on others.

James (as cited in Hutchins, 1972) challenged the assumption dealing with antecedents of emotion that assumes that when we encounter something, we feel an emotion and then act upon it. James argued that this sequence is incorrect. Instead, one does not act as a result of the emotion; the emotion is a result of the act. The example given was that we see a bear, are afraid, and then run away. James posited that we are afraid because we run away. Aristotle held a similar belief. He believed that mere awareness of an object does not produce flight; it requires the "heart to be moved" (Hutchins, 1972, p. 413). James assumed that there was some degree of felt bodily disturbance in emotional experience. To James, emotion was the feeling rather than the knowing or the action.

On the other hand, Davidson (2003) provided this interesting statement: "much of the neural signaling about emotion from the brain to the body bypasses the will and thus is often nonconscious" (p. 317). At first glance this statement appears to be quite revealing. However, it is not only ambiguous, but also confusing. Should one assume that "neural signaling about emotion" is itself emotion? Is the "will" responsible for emotion? This associational statement needs further exploration and must be taken within the context of the paper. The relationship was revealed when combined with his preceding use of Darwin's third principle, "direct action of the excited nervous system on the body independently of the will" (p. 317). In simpler terms, emotion does not have to be recognized by the mind to exist.

One important antecedent that is discussed by Hutchins (1972) is the necessity of emotion. There must be a need for the emotion in order for it to exist. Darwin was referenced concerning his work on the expressions of emotion. He believed that emotions were required in order for species survival. He presented that the expression of emotion was universal between and within species. In essence, emotion is thought to be intertwined with instinct (Hutchins).

Rolls' (2000a) statement, "Emotions can be usefully defined as states elicited by rewards and punishments, including changes in rewards and punishment" (p. 178), begs for further clarification. The author concluded that rewards and punishments were causes of emotions. In other words, the antecedent to emotion is reward and punishers. This crucial statement differentiates Rolls' views from other scientists such as Damasio (2003). In order to fully understand this statement, one must dive into the article to discover exactly the meaning of *state* and *rewards and punishments*. Rolls' theory seems to be based on the evolutionary necessity of emotions. Natural selection demands that organisms choose appropriately in order to survive. Rolls believed that nature has accomplished this through the development of sensory systems that can respond to stimuli that enhance chances of survival. An organism that works for the sensation (state) produced when obtaining a reward or one that avoids a punisher will be selected to survive.

When combining Rolls' (2000a) definition with further explanations in the article, it would appear that obtaining the feelings of emotion (state) guides organisms to make a specific choice. However, in the following statement "emotional states (i.e., those elicited by reinforcers) have many functions, and the implementations of only some of these functions by the brain are associated with emotional feelings" (p. 179), Rolls seems to be illogical and incompatible when combined with his earlier definitional statements. If emotions are "states" used by nature to help select the fittest to survive, they must always be “felt.” There is no evolutionary reason for an organism to be in a “state” as a result of a reward or punishment and not know it.

Freud’s belief on the relationship between emotion and reason is discussed in Hutchins (1972) article. He argued that reason is constantly regulating emotion (id). In other words, reason (a cognitive function) is responsible for repressing and controlling emotion. This rests on the assumption that emotion can be controlled to a certain extent by the brain. He also conceived that emotion, in a role reversal, can influence the cognitive function, as evidenced by the statement “rational processes-both of thought and decision-are themselves emotionally determined” (p. 414). According to the author, there has been a consensus that emotion can influence cognitive thinking but all thinking is not dominated by emotion. Thinking that results in knowledge is emotion (felt) free, while thinking directed by emotion results in opinion. The underlying assumption is that *emotion* is perceived.

Summary

When combining what is presented in the literature on emotion and decision making, it is readily apparent that various ideas exist. Damasio (1996) and Davidson (2003) both conceded that emotion does not need to be recognized or felt to exist. Others (Cacioppo & Gardner, 1999; Hutchins, 1972; Rolls, 2000a) presented theories of emotion based on the assumption that emotion must be cognitively recognized. Most of the literature presented different types of emotion such as sadness, happiness, anger, and love; however, the writers did not provide an adequate definition of emotion.

One common theme throughout the literature is that emotion plays a role in decision making. However, there are two different thoughts about how emotions influence decision making. Cacioppo and Gardner (1999), Rolls (2000a), Heilman and Gilmore (1998), and Hutchins (1972) require cognitive knowledge of an emotion as evidenced by a "feeling," whereas, Damasio (1996), and Davidson (2003) operated under the assumption that emotion was often unrecognized. This is a crucial difference that requires one to look at what is provided by the authors as the base for their assumptions.

In relation to decision making, emotion has historically been seen as a real and tangible feeling or state which influences decision making. Damasio (1996) did not refute that emotions could be felt; however, he proposed that emotions could exist without explicit cognition. This researcher proposes that emotion-enhanced decision making is the degree to which choices are aided by somatic signals produced immediately prior to the choice. This definition encompasses both cognitive and unconscious aspects of emotion as well as physiologic responses that occur with emotion. This definition provides an avenue for the necessity of emotion as put forth by Darwin (Hutchins, 1972) and is consistent with Freud's view on the role of emotion and cognition.

Another theoretical basis on which authors have based their beliefs on the nature of emotion is the theory of evolution. As mentioned earlier, Rolls (2000a) explicitly stated that emotion had to exist for the purpose of the survival of the species. Davidson (2003), Damasio (1996) and Heilman and Gilmore (1998) all operated within the framework of evolution. They started with the premise that emotion had to help humans (and other species) make decisions that lead to survival. This premise also leads to the interpretation that genetics play a significant role in emotion-enhanced decision making. Those who had superior decision making passed this trait to their offspring, resulting in the survival of this dominant trait through generations.

There are some attributes of emotion explored, such as Darwin's third principle, that states that emotion often takes place without cognition and is *inextricably entwined* with its expression. The abilities to be transient or enduring were attributes given to emotion by Heilman and Gilmore (1998). However, without a clear definition of emotion, these attributes are applicable to many different phenomena. It is warranted to study statements made in these articles in order to have a broader understanding of what the authors truly believe about emotion as well as the nature of emotion-enhanced decision making.

Decision Making Outside of Nursing

Recent research suggests that emotions not only arise from the outcomes of decisions but are an integral part of the decision making process itself. The consensus is that decision making is an integrated function of the limbic system and other regions of the brain. The role that emotion plays in decision making is an area of research that is just beginning to bloom. Decisions are affected by the sum of personal emotional responses to rewards and punishments. It has been hypothesized that emotion, in the subconscious, provides a signal that may factor into the process of decision making (Bechara & Damasio, 2002). The ability to make decisions may be affected by the ability to create an emotional memory. Patients in multiple studies have had cognitive memories concerning the best choices, but lacked a subsequent emotional memory which might be crucial in decision making (Bechara et al., 1994; Bechara & Damasio, 2002; Bechara et al., 2000; Damasio, 1996). Several studies have tested the somatic marker hypotheses on humans who have prefrontal cortex damage (Bechara et al., 1994; Bechara et al., 1998).

A tool known as the Iowa Gambling Task was developed in order to detect and measure decision making impairment in individuals with damage to the VM (Bechara et al., 1994; Damasio, 1996). The gambling task requires subjects to make a series of 100 card selections from four decks of cards labeled *A, B, C*, and *D*. However, they are not told ahead of time how many cards they will be allowed to choose. A card may be selected from any of the decks, one at a time. Participants can choose which deck to pick from at any time. There is a preprogrammed schedule (unknown to the participant) designed to influence the selection decision through reward and punishment. Each time one selects a card from decks A or B he gets $100. When a card is selected from decks C or D the subject gets $50. Subjects also encounter unpredicted money loss (punishment). This punishment is designed to be greater in decks A or B. Decks A and B contain a total loss of $1,250 in every 10 cards, while in decks C or D there is a total loss of $250. Therefore, at the end of the 100 choices, decks A and B are disadvantageous because more money is lost. There is a total loss of $250 in 10 cards in Decks A or B, while Decks C and D result in a gain of $250 per 10 cards. This tool factors in uncertainty as well as reward and punishment in an attempt to mimic real life (Bechara et al., 2000).

The gambling test was administered to normal control subjects, patients with damage to the VM, patients with damage to the dorsolateral sector, and those with lesions outside of the prefrontal cortex. Patients with damage outside of the prefrontal area and those with damage to the dorsolateral sector performed similarly to the control subjects (Bechara et al., 1994; Bechara et al., 1998). Typically the normal subject will initially sample all decks and even repeat card selection from the “bad” decks A or B. However, they eventually choose to make more selections from the “good” decks C or D. The VM patients only mimic the control group, patients with damage outside of the prefrontal cortex and those with damage to the dorsolateral sector in the first selections. These patients selected from all decks and then decide to choose more and more from the “bad” decks.

The somatic marker hypothesis prompted other studies to seek out the impact that somatic signals experienced just prior to decision making had on the final decision (Bechara et al., 1996). To support the idea that emotion plays an integral part during the process of decision making, a subsequent study monitored the levels of psychophysiological activity during the administration of the gambling task by recording the measurement of skin conductive response activity. The results showed that normal controls and ventro-medial damaged patients both generate skin conductance responses in reaction to reward or punishment. However, the normal controls began to generate skin conductance responses in anticipation of the selection of a card while the ventro-medial damaged patient did not. The skin conductance responses became more pronounced in the control group just prior to choosing a card from the “bad” decks, but was absent from the ventro-medial damaged patient.

The researchers hypothesized that the absence of anticipatory skin conductance responses indicated an individual’s inability to enact a somatic state required to aid in the advantageous decision (Bechara et al., 2000). When subjects faced a situation that required factual knowledge to be categorized, the appropriate links were activated in the higher order cortices, as well as the emotional apparatus, leading to the recall of the necessary information in order to make an appropriate decision. It was the combination of these actions that prompted the reconstruction of previously learned data, or, in other words, pattern recognition. This would imply that emotions not only arise in response to a decision, but truly aid in the making of a decision. These results challenged previous theories that risky decision making was the result of cognitive cost-benefit analysis and that feelings were not an integral part of the process (Bechara et al.).

It is interesting that the majority of the literature assumes that emotion must be felt or recognized. Damasio (1996) provided powerful research to suppose otherwise when studying subjects with damage to the ventro-medial (VM) portion of the brain during a gambling task. To support the idea that emotion plays an integral part during the process of decision making, a subsequent study monitored the levels of psychophysiological activity during the administration of the gambling task by recording the measurement of skin conductive response activity. The results showed that both normal controls and VM patients generate skin conductance responses in reaction to reward or punishment. However, the normal controls began to generate skin conductance responses in anticipation of the selection of a card while the VM patient did not. The skin conductance responses became more pronounced in the control group just prior to choosing a card from the “bad” decks, but was absent from the brain damaged patient. This would imply that emotion not only arises in response to a decision, but also truly aids in the making of a decision. These results challenged previous theories such as those proposed by Rolls (2000a) that decision making was the result of cognitive analysis and that feelings were not an integral part of the process. Rolls hypothesized that the reason for the inability to choose appropriately by VM patients was due to a lack of association between the bad decks and long term punishments, rather than a lack of emotional pre-biasing. Rolls concluded that, although emotions can be motivating, it is the effect of the decision that is motivating.

Rolls (2000a) hypothesized that emotion is a state elicited by reinforcers such as rewards and punishment and it is not the reinforcer itself. The somatic marker hypothesis proposed by Damasio (1996), which argues for a bodily signal (skin conductance response) being sent to the somatasensory cortex thus causing an emotional biasing, is incompatible with Rolls' hypothesis. Rolls argued that the somatic marker hypothesis is a modified version of the James-Lange theory of emotions, which states the emotion precedes the interpretation of its meaning. Rolls hypothesized that the reason for the inability to choose appropriately by VM patients was a lack of association between the bad decks and long term punishments, rather than a lack of emotional pre-biasing.

However, in a subsequent study, Bechara et al. (1997), studied patients who had damage in the medial orbitofrontal cortex with a varied application of the gambling task, and the researchers determined that there was not a lack of association between the disadvantageous nature of the bad decks. This test would seem to refute Rolls' (2000a) argument in that the orbitofrontal cortex patients were aware cognitively of the nature of the decks but were unable to choose to their advantage. It further implies a disassociation of cognitive knowledge and decision making in the orbitofrontal cortex patients. Researchers seem to get bogged down in defining the contributions of an exact area of the brain involved in the particular impairments rather than what the presence of the impairment tells us about decision making deficits and the role of emotions in decision making. Rolls did not address the meaning of anticipatory responses prior to decision making and the absence of these in the VM patient.

Decision Making Within Nursing

The role of somatic emotion in decision making has been studied in the area of neuroscience research. Decision making research in nursing has focused on descriptive studies which primarily utilize written scenarios to gauge decision making. In other words, much of the literature relies on the subjective perception of nurses to determine if they use intuition (Aitken, 2003; Bakalis, 2006; Dalton, 2003; Girot, 2000; Lyneham, Parkinson, & Denholm, 2008; Ruth-Sahd & Hendy, 2005). The majority of these descriptive studies are exploratory in nature with a lack of seminal research (Rew & Barrow, 2007). Much of the nursing research focused on decision making is the reviewing of the literature. While these reviews enable researchers to know *about* intuitive decision making, it does not allow the researcher to *know* intuitive decision making (Bakalis; King & Appleton, 1997; King & Clark, 2002; McKinnon, 2005; Rew & Barrow; Rovithis & Parissopoulos, 2005; Smith et al., 2004).

Methods

Several studies utilized a method termed *think aloud* (Offredy, 2002; Redden & Wotton, 2001; Standing, 2007). The theoretical approach used in this type of study is information processing theory, which, briefly, proposes that decision making is prompted by information gathered first from the environment and secondly from long-term memory (LTM). This information is then converted to symbols and is passed to short-term memory (STM) which can hold only a limited number of symbols. It is theorized that this type of method taps into the STM.

Offredy (2002) compared the decision making of nurse practitioners (NPs) and general practitioners (GPs) using patient scenarios. The researcher also used a *think* *aloud* approach in which the subject would verbalize everything that went through their mind once they were given a task. Although the study found that NPs and GPs used the same decision making processes, there was greater use of cues by the NPs, which the researcher attributed to the NP requiring a longer procedural database in order to make a diagnosis.

Redden and Wotton (2001) performed a study using this *think aloud* method. They were concerned about clinical decision making in regard to third-space fluid shift and hypothesized no difference between intensive care nurses and gastrointestinal nurses. The researchers focused on the cues used to formulate the correct diagnosis. They found differences in the two groups in regard to amount of cues used as well as the types of cues. The ICU nurses used more relevant cues and were able to make the correct hypothesis more often than the GI nurses, which the researchers attributed to greater level of expertise. Although the researchers concluded that the nurses used primarily the hypothetico-deductive model in their decision making, they did recognize the use of intuitive modes of thinking as evidenced through pattern recognition. This study was severely limited by the small sample size and the discrepancies between the levels of education and experience of the two groups. The ICU nurses all had bachelor degrees and postgraduate study, while only 80% of the GI nurses had bachelor degrees and none had any postgraduate education. Another limitation of this study was the use of the *think aloud* method that allows a researcher only a glimpse into how the subject came to a particular decision. Forcing the subjects to talk may have required that them to use verbalization to justify a decision after the decision had already been made intuitively. This study as well as others that utilize the *think aloud* method (Offredy, 2002) did not address specifically the use of intuition, but rather label intuition as a pattern recognition process that develops with experience.

Tools

A study by Lauri et al. (2001) developed a tool and researched the clinical decision making of nurses in five countries utilizing CCT as the theoretical framework. They found that nurses in all five countries used both analytical and intuitive processes in decision making. However, the dominant mode of decision making in situations that required rapid response was intuitive (Lauri et al.). While this study further validated the role of intuition, it was hindered by the lack of actual decision making such as that which occurs in clinical situations. Surveys and questionnaires are inherently geared toward the analytical mind. These instruments do not allow the use of pattern recognition that relies on possible cues from all senses, which some have hypothesized takes place in intuitive decision making (Benner & Tanner, 1987).

Smith (2006) developed a psychometric instrument designed to measure the use of intuition by nursing students. While the instrument showed evidence of construct validity and reliability, all the questions focused on the physical feeling or sense that something was wrong or right. The author severely limited the use of this instrument because he assumed that intuition must be felt to exist. However, the instrument could be further explored by administering it in conjunction with objective measurements such are proposed in this study.

Intuitive

Intuitive decision making is addressed in the majority of nursing research focused on decision making. However, as mentioned earlier, there has been no attempt to discover a biophysical marker of intuition. The literature basically consists of concept analysis (Rew, 1986) and review of literature (King & Appleton, 1997; Rovithis & Parissopoulos, 2005).

Studies that attempt to compare intuitive decision making and critical thinking (Garwood, Engel, & Quilter, 1979; Narayan & Corcoran-Perry, 1997; Welsh & Lyons, 2001) are misleading because one rarely uses a purely analytical or intuitive mode of decision making (Hammond, 2000). Nursing needs to embrace the use of intuition and not shun it. If a marker of intuitive decision making were identified, it would help quantify the existence of intuition leading to a broader acceptance of its practicality and use in clinical decision making.

Hicks et al. (2003) looked at clinical decision making in critical care nurses, and found the intuitive mode of decision making to be superior to the analytical mode in relation to task complexity. The authors concluded that intuitive decision making only increased as task complexity increased and also produced better decisions. One limitation of the study was found in the instruments used. As with most nursing research on decision making, a written questionnaire was utilized, impeding the full exploration of intuitive decision making as mentioned earlier.

Summary

There is a varied body of research involving decision making in nursing. Studies have mainly focused on the subjective self-reporting of intuition use by nurses and students. This has resulted in a wide definition as well as numerous theories of nursing intuition (Banning 2005; Goebet & Chassey, 2008; Rew & Barrow, 2007).

Electrodermal Activity Recording

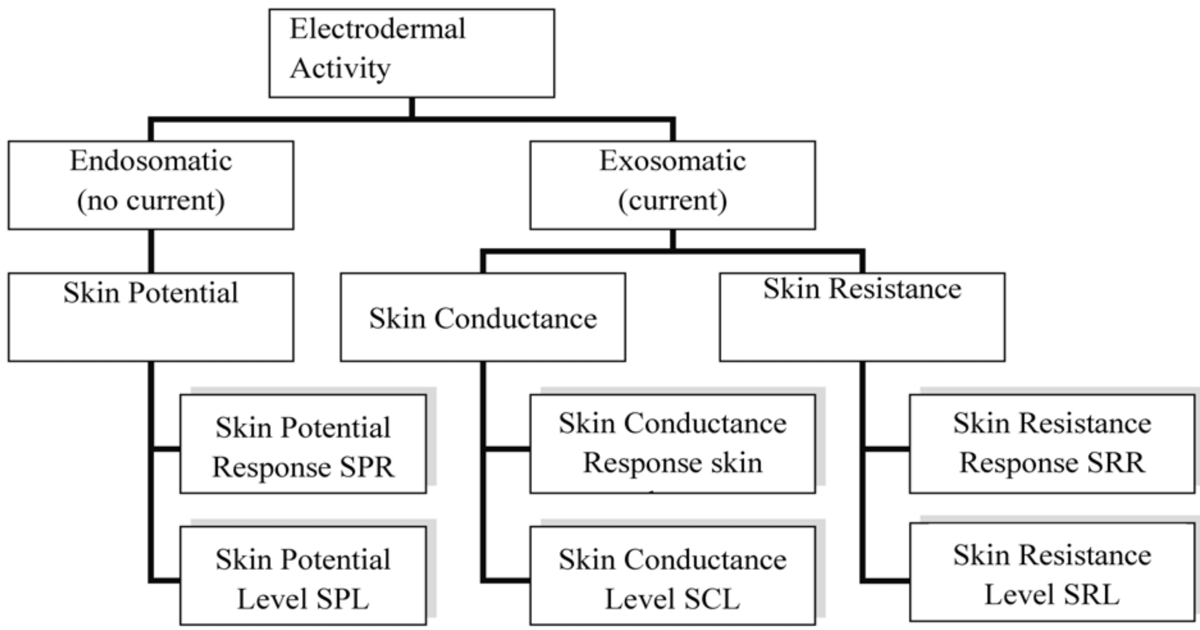
Introduction

Electrodermal activity recording is widely used in research today. While its use is relatively common in psychophysiologic studies, electrodermal activity recording is just beginning to be utilized in other areas of research. Electrodermal activity recording is relatively easy to perform; however, there are recommended methodologies that researchers need to follow. Studies that do not incorporate acceptable methodological techniques have a negative effect on the acceptance of electrodermal activity recording as a valid assessment tool. The purpose of this section is to present an overview of electrodermal activity recording and its role in research.

Electrodermal activity recording can be defined as the measurement of psychologically induced sweating (Critchley, 2002; Dawson et al., 2000). Psychologically induced sweating occurs in response to sympathetic activation, such as the fight or flight syndrome. When sympathetic activation occurs, sweat production is directly proportional to the level of stimulation. When sweat glands are stimulated, perspiration begins to fill the sweat gland ducts resulting in an increase in the conduction of electrical impulses that may be present on the skin surface. The measurement of change in skin surface conduction is termed *skin conductance response*. Subtle changes in levels of sympathetic activation result in subtle changes in sweat production, and, thus, produce measurable changes in skin conductance that may be captured by electrodermal activity recording. Skin conductance response is thus a measure of sympathetic activation (see Figure 2).

Figure 2

Electrodermal Activity Nomenclature



Most electrodermal activity recording studies today utilize one of two measurement methods: skin conductance response (often termed galvanic skin response) or its reciprocal skin resistance response. Skin resistance response is termed an endosomatic measurement due to the required application of tiny electrodes directly onto the sympathetic skin neurons. This results in a direct measurement of the electrical activity of the skin's neurons and does not require the external presence of current (Dawson et al., 2000; Fowles et al., 1981). This method is not widely used in today's research perhaps due to its invasiveness.

Skin conductance response measurements are termed exosomatic. It is the measurement of small voltage differences between two points on the skin surface. Exosomatic and endosomatic methods both show a strong correlation between skin neuron firing rates and skin conductance/resistance. As mentioned earlier, Fowles et al. (1981) concluded that constant voltage skin conductance response is superior to skin resistance response in the majority of scientific applications today that are concerned with magnitude of response.

It is imperative to maintain constant voltage during the measurement of skin conductance response activity. It is recommended that 0.5 volt be utilized in bipolar recordings. This, in essence, produces a potential difference of 0.25 volt across the skin between each site (Fowles et al., 1981). One must ensure that the voltage is accurate and constant in order to produce correct interpretations of the readings. Depending on the apparatus used, frequent tests of power sources and documentation of such testing may be needed in order to ensure appropriate levels.

The quantification of skin conductance responses consists primarily of the measurement of several key variables; skin conductance level (SCL), amplitude, latency, frequency, habituation, and nonsignificant or spontaneous skin conductance responses (NS-skin conductance response). All of these are present in a single measure of galvanic skin response. In order to understand the ramification of each variable, a researcher needs to be familiar with the definition and typical value of each variable. These variables are further discussed in the measurement section of this paper.

History

Although a thorough historical review of the origins of electrodermal activity can be found in Neuman and Blanton (1970), a brief history is offered here. Electrodermal activity has been measured since the late 1800s. The first empirical study of the electrical properties of the skin was conducted in 1888 by the French scientist, Vigoreaux, who with a colleague, Jean Charcot, a famous neurologist, began experimenting and measuring electrical properties of the skin as a potential sign of a clinical diagnosis. Following on their research, another French scientist, Fere, discovered in 1888 that one could measure the skin's electrical resistance by passing a small current between two points on the skin's surface. He has been credited with the discovery of the exosomatic (with current) method. Fere also found that the skin has momentary decreases in resistance (increases in conductance) in response to various stimuli. Similarly, in 1890, Tarchanoff, a Russian physiologist, built upon Fere's research, and found that it was not necessary to use external voltage to measure the skin's potential between two points. He is credited with discovering the endosomatic (without current) method. Electrodermal activity (EDA) has been widely used since these initial observations (Bauer, 1998; Dawson et al., 2000).

Since the 1900s, electrodermal activity has been theorized to be a marker of the psychophysiological concepts of arousal, attention, and emotion. While the first observations of connections between the electrical state of the skin and psychological factors were observed in 1879 by Vigoreaux, it was not until 25 years later that concentrated research began. In 1904, Carl Jung used electrodermal activity as a measurement variable when seeking responses to emotional stimuli invoked by words. He found a significant proportional relationship between level of skin response and type and degree of emotion elicited (Neumann & Blanton, 1970). Recent studies have further validated Jung’s findings (Campos, Marcos, & Gonzalez, 1999). For example, early pharmacological studies showed a relationship between electrodermal activity response and an increase in arousal (Boucsein, 1992; Edelberg, 1972; Neumann & Blanton, 1970). Burch and Greiner (1960) showed a S-curved relationship between the frequencies of skin conductance response activity in response to pharmacologically induced arousal (Burch & Greiner, 1960). Subsequent studies have further validated this premise (Collet, Petit, Priez, & Dittmar, 2005; Davidson & Smith, 1991). Recent studies have not only found similar connections (Bechara et al., 2000; Tranel & Damasio, 1994) but have formulated hypotheses based on this theory. Likewise, the Somatic Marker Hypothesis (Damasio, 1996) postulates that emotion (somatic state) plays an unconscious, active role in decision making by aiding in the decision. Studies have also used SCL and skin conductance response frequency to gauge the attentiveness of a subject (Blakeslee, 1979;

Freixa i Baque, 1983). A thorough review of earlier research can be found in Edelberg (1972) and Boucsein (1992).

Current Beliefs

Research has shown that the palmar sweat glands are enervated by the sympathetic nervous system (Fowles et al., 1981; Fredrikson et al., 1998; Shields et al., 1987). Thus, electrodermal activity measured on the palm is a marker of sympathetic stimulation. Similarly, studies have provided further validation of sympathetic control by measuring sympathetic action potential in the peripheral nerves and electrodermal activity simultaneously (Dawson et al., 2000). The results have shown that when there is normal temperature in the room and the subject is normothermic, there is a high correlation between sympathetic nerve activity and electrodermal activity, more specifically skin conductance responses (SCR) (Wallin, 1981).

Discovering which particular sympathetic pathway is involved in electrodermal activity is complex and theories abound. It has been postulated that there are three main pathways or systems that lead to the production of skin conductance responses: (a) the limbic system, (b) the cortical system (including the basal ganglion) (Harrison, 2001), and (c) the reticular formation in the brainstem (Dawson et al., 2000; Fedora & Schopflocher, 1984).

Neural control of sympathetic stimulation is classified as either inhibitory or excitatory and can take place in several different areas of the brain. Multiple research studies have been done in animals and few have been done in humans to attempt to correlate electrodermal activity to specific areas of the brain (Fredrikson et al., 1998; Mangina & Beuzeron-Mangina, 1996; Tranel & Damasio, 1994). It is interesting to note that the results of animal studies cannot always be generalized to humans. Research has shown strong connections between the left and right limbic structures of the cat, rabbit, and rat, resulting in equal bilateral electrodermal activity responses. Contrarily, Mangina and Beuzron-Mangina (1996) found that this did not hold true in their human study; they found higher electrodermal activity responses in ipsilateral skin conductance responses. Therefore, more studies involving direct electrical stimulation of the human brain are necessary before generalizations of the functions of specific systems can be made.

Methodology

Overview

Skin conductance response is a type of electrodermal activity measurement that records the level of electrical conductance of the skin. It is the reciprocal of skin resistance (SRR). Skin conductance responses are the most popular form of electrodermal activity measurement within scientific studies today. (Appendix B provides a brief summary of electrodermal activity articles.) This popularity is largely a result of the available devices that can monitor skin conductance responses without encumbrances to the subject. However, the devices must be placed in a position on the body that readily identifies changes in the skins conductive system.

The sweat gland of choice for the measurement of electrodermal activity is the eccrine gland as opposed to the apocrine. The apocrine glands are located at the base of a hair follicle, whereas the eccrine glands are located over most of the rest of the body with a high concentration on the palms of the hands and soles of the feet. While the primary role of most eccrine sweat glands is thermoregulation, it has been hypothesized that the palmar sweat glands may have greater sensitivity because of the role the hand plays in grasping behavior (Fowles et al., 1981; Freedman et al., 1994; Schulter & Papousek, 1992; Shields et al., 1987). It has also been suggested that palmar sweat glands have to be highly responsive to psychological stimuli as opposed to thermal stimuli. This is due, in part, to the number of sweat glands (Shields et al., 1987).

Monitoring

The decision on which recording device to utilize requires careful consideration of two factors. The most important factor is the use of constant voltage vs. constant current. When there is constant voltage, one can measure current that changes in response to the skin's conductance (the reciprocal of skin resistance). On the other hand, with constant current, one measures the voltage that varies with the skin's resistance. This difference is based on Ohm's law that deals with the relationship between voltage, current, and resistance. Voltage (V) can be defined as difference in the electrical potential between two points in a circuit (i.e., between two electrodes). Current (I) is the charge that flows between two points in a circuit. Resistance (R) determines how much current is able to flow through a circuit (i.e., skin). High resistance will allow a small amount of current to flow while low resistance allows a large amount of current to flow. Ohm's law states that resistance is inversely proportional to the amount of current flowing through a circuit ($R = V/I$). Similarly, voltage is equal to resistance multiplied by current ($V = IR$). When one is primarily concerned with the electrical characteristics of the skin conductance response, Fowles et al. (1981) recommended using a constant-voltage system, an opinion seconded by Schaefer and Boucsein (2000). While use of a constant voltage monitoring apparatus may the first step in standardizing the field of electrodermal activity recording measurement, one must consider the phenomenon of interest (Schaefer

& Boucsein). For example, if one is not primarily concerned with the precise electrical profile of a response, but rather the timing of the response, it may be more economical to choose a constant current recorder.

In addition to type of current, another factor to consider when choosing the monitoring apparatus is the use of a paperless or paper-based system. Dawson et al. (2000) described advantages and disadvantages of both devices. With the paper-based system, there is a constant paper recording of the entire session that makes it easy for the experimenter to mark significant occurrences. There is also no reliance on expensive computer components. On the other hand, paper systems require costly replacements of paper and ink, and there is significantly more time involved with data manipulation and interpretation. One of the biggest advantages of the paperless system is the ease of gathering and interpreting the data. The computer, along with individualized software, can easily provide statistics and computational or graphical output. Although paperless systems may be more costly, they save data management time. New and improved devices are consistently being developed (Colbert et al., 2004; Dawson et al., 2000).

Electrodes

Electrodes are another important consideration when configuring an electrodermal activity system. Electrode type, size, contact area, conductive medium or gel, and placement are five key variables involved with electrode choice. It is vital for the researcher to understand the ramifications of potential changes in output that subtle differences within these variables produce. One must factor in the research question when contemplating choices in electrodes. For example, if one is interested in hot flashes, she may choose to use a different size or placement of electrodes than one who is interested in the detection of lies.

Electrode type. According to Dawson et al. (2000), the type of electrode most often used in skin conductance response research is a silver-silver chloride (Ag-AgCl) cup. He posited that this is in part due to the fact that these types of electrodes minimize the occurrence of bias potentials as well as polarization. Accordingly, this type of electrode is the accepted and recommended choice (Fowles et al., 1981).

Electrode size. Little research has been done concerning the direct influence electrode size has on skin conductance levels. In one study, Mitchell and Venables (1980) looked at the relationship of area of contact produced by the size of electrodes and skin conductance response amplitudes using a range of sizes from .0159 to .786 cm^2. Although they hypothesized that skin conductance response amplitude would be linearly related to the size of the electrode, the relationship was found to be monotonic, that is, it does not follow the predicted line, even after performing a log transformation. In response to this, Mitchell and Venables recommended that skin conductance response amplitude be reported in terms of the actual electrode size used as opposed to specific conductance units (i.e., $\mu mhos/cm^2$). They also recommended the use of an intermediate size of electrode or 0.5 cm^2. In their recommendations for publishing, Fowles et al. (1981) provided scant research pertaining to the basis for their recommendation of maintaining an area of contact of 1.0 cm^2. Similarly, they argued that it is not the electrode size that matters, but rather the area of contact that is determined by the amount of medium used (Fowles et al.)

Contact area. Contact area is important in the measurement of skin conductance response activity, because it determines the amount of conductive or electrode gel that is used. Electrode gel is the medium between the electrode and the skin. The amount of gel used can affect the amplitude of skin conductance responses, and, thus, it is important to control the amount of gel that comes in direct contact with the skin (Dawson et al., 2000; Fowles et al., 1981; Mitchell & Venables, 1980). This is especially important when phenomena are defined in terms of skin conductance response amplitude. For example, objective hot flashes have been defined as a 2umho increase in skin conductance response within a 30-second period when using Meditrace S'offset silver-silver chloride electrodes (Dormire & Carpenter, 2002; Freedman et al., 1994). Because altering the electrode contact area can alter the amplitude of the skin conductance response increase associated with hot flashes, a change in electrode contact area would necessitate revalidating the criterion used to define objective hot flashes. Dawson et al. (2000) argued that the use of a double-sided adhesive collar can help to control the area of contact. Thus, some investigators choose to use electrodes with such collars.

Conductive medium or gel. Another vital aspect of electrodermal activity recording is the type of conductive or electrode gel used. While a variety of commercially prepared gels are available, gels that mimic the salinity of sweat are preferred according to Venables and Christie (1980). These researchers concluded that these types of gels will preserve the electrical properties of the skin, rendering a more accurate measurement. According to Dawson et al. (2000), the use of commercially prepared gels should be avoided due to the high level of sodium chloride. These types of gels tend to inflate measurement of skin conductance (Dawson et al.). Early researchers had recommended the use of Unibase® (no longer available) combined with normal saline as an electrolyte medium to measure the number of skin responses (Clements, 1989; Dawson et al.; Fowles et al., 1981; Fowles & Schneider, 1978; Grey & Smith, 1984). However, if one is interested in the magnitude of the response, a gel with potassium chloride is recommended (Fowles & Schneider). Strict control of type of gel used is imperative when comparing skin conductance responses between individuals.

Dormire and Carpenter (2002) conducted research to evaluate potential replacements for Unibase® after it was commercially discontinued. Their study compared the functionality of three creams to Unibase® and determined that Velvahol® was an effective replacement for Unibase® when evaluating sternal skin conductance responses. The differing creams were compared on their performance in the measurement of hot flashes. One cream was dropped from the study because it was not possible to combine it with glycol and potassium. The other two creams were evaluated on their functionality as well as the optimum skin conductance identification of hot flashes (Dormire & Carpenter). While this study was concerned with electrodermal activity in relation to hot flashes, the implications need to be considered when conducting other types of research utilizing electrodermal activity.

Electrode placement. The fifth variable pertaining to electrode use in skin conductance response research is placement of electrodes. Recommended placement sites for the electrodes vary depending on the phenomenon of interest. For example, electrodermal activity is recorded on the sternum in hot flash research that is primarily concerned with physiologic sweating. On the other hand, studies that are concerned with psychologically-induced sweating typically use the palms and fingertips, with the recommended electrode placement on the thenar and hypothenar eminences of the palms and the distal and medial phalanges of the fingers. Placement decision is also partially affected by the time that the electrode needs to be in place and the potential for disruption of daily activities.

Research has also shown that there are some differences among the four fingertips in relation to equality of skin conductance response activity (Venables & Martin, 1967) as well as differences between palmar and finger skin conductance responses and resting potential (Christie & Venables, 1972; Edelberg, 1967). Considering these factors, Fowles et al. (1981) posited that skin conductance response activity can still be recorded from any of these palmar sites. They further recommended using the same hand, and Venables and Christie (1980) suggested choosing sites within the same dermatone.

To summarize, recommendations for type, size, placement, and conductive medium used with electrodes in electrodermal activity research are founded in research. In conclusion, it is recommended that skin conductance responses measuring controlled stimuli be recorded from palmar surfaces using a medium sized silver-silver chloride electrode with a noncommercial gel that contains potassium chloride as the electrolyte (Dawson et al., 2000; Fowles et al., 1981; Scerbo, Freedman, Raine, Dawson, & Venables, 1992).

Measurement

The following section will discuss the variables involved with electrodermal activity research (see Table 1). A more thorough and detailed description can be found in Venables and Christie (1973).

Table 1

Skin Conductance Response Measures, Definitions, and Values

Measure	Definition	Value
Amplitude	Phasic increase in conduction	0.2 1.0µs
Latency	Interval between stimulus and skin conductance response initiation	1-3 Sec
Rise time	Interval between stimulus and skin conductance response Peak	1-3 Sec
Half recovery time	Interval between skin conductance response Peak and 50% recovery of skin conductance response amplitude	2-10 Sec
Habituation	Number of stimulus trials prior to two or more trials with no response	2-8 trials
NS-skin conductance response (frequency)	skin conductance response not initiated by stimulus	1-3 min

Note: Adapted from Dawson, Schell, and Filion (2000), p. 207.

Skin conductance. Skin conductance is generally the first measurement with which researchers need to be concerned. As mentioned earlier, skin conductance response is the most popular measurement used today; however, determining the subjects' baseline is required to establish significant skin conductance response activity. Skin Conductance Level (SCL) is the level of electrical conductivity of the skin in the absence of a stimulus. In other words, it is the skin's electrical resting potential. Microsiemens (μS) are the unit of measurement used in skin conductance response research. This level varies between subjects, dependent on the apparatus used, with typical values from 2-20 μS. In order to establish the SCL of a subject, a baseline recording is needed (Fowles et al., 1981; Lykken & Venables, 1971). While Fowles et al (1981) do not recommend a specific rest period prior to the introduction of a stimulus, prior research has used rest periods varying between 2-3 minutes (Birchall & Claridge, 1979; Schaefer & Boucsein, 2000) to up to 5 minutes (Naveteur, Buisine, & Gruzelier, 2005; Schulter & Papousek, 1992).

Skin conductance response. A skin conductance response is a relatively sudden phasic rise in electrical conduction of the skin. Skin conductance responses are usually interpreted in relation to amplitude and frequency. When quantifying skin conductance response occurrences, one can report the mean amplitude or mean magnitude. Mean amplitude is the mean of measurable skin conductance responses, whereas mean magnitude is the mean of all stimulus responses, even when there is an immeasurable response. For example, mean amplitude will only consider the nonzero responses following stimuli. On the other hand, magnitude is computed using all responses to stimuli and will include any zero responses. In other words, magnitude incorporates a "no response” to stimuli. Dawson et al. (2000) recommended the use of amplitude and frequency when assessing skin conductance response. They argued that magnitude can skew the data to infer that the response size is changing in instances where it is the frequency of response that is changing (Dawson et al.).

To determine amplitude, the skin conductance response is measured from the baseline (SCL) to the peak. Typical amplitude is 0.2-1.0 μS. The term *phasic*, as opposed to *tonic* (baseline), refers to activity that takes place during a specified time. When the skin conductance response takes place in response to an event or stimulus, it is thought to be significant and is reported as a skin conductance response. When a skin conductance response takes place for no apparent reason, it is termed nonsignificant (NS-skin conductance response). NS-skin conductance responses occur roughly 1 to 3 times per minute (Dawson et al., 2000; Venables & Christie, 1973).

An important concept in interpreting the presence of a skin conductance response or NS-skin conductance response is latency. Latency is the period between the introduction of stimuli and the initiation of a skin conductance response. Typically, the latency window is between 1 and 4 seconds (Dawson et al., 2000). Therefore, any skin conductance response that takes place within the latency window is interpreted as being in response to the introduced stimulus and is deemed significant. On the other hand, a skin conductance response that presents outside of the latency window is interpreted as nonsignificant; hence, it is labeled an NS-skin conductance response. It is important to establish an appropriate latency window and to ensure that it is applied to all subjects to avoid an unnecessary threat to internal validity secondary to instrumentation (Cort et al., 1978).

Habituation. An interesting phenomenon that occurs in skin conductance response research, habituation occurs when there is no response or a decreased response to repeated stimuli. For example, subjects will produce skin conductance responses in response to rays of light until they become habituated or used to the light. Habituation is reported in terms of the number of stimulus presentations before there is no response generated in 2 to 3 subsequent trials (Dawson et al., 2000). It typically takes 2 to 8 stimulus presentations before habituation occurs. Habituation is explored more fully in the section that deals with influences affecting skin conductance response occurrences.

Rise time/half recovery time. Two less commonly used skin conductance response variables are rise time and half recovery time. Rise time is the amount of time it takes for the skin conductance response to reach its peak. It starts at the beginning of the rise. Half recovery time is the amount of time it takes for the slope of the skin conductance response to descend half of the way to baseline (see Table 1). The implications of these variables are not widely understood and are not widely used. Dawson et al. (2000) posited that there may be an element of discriminating power in recovery time, however, more research conducted specifically on these variables is needed.

Artifact

Artifact is the appearance of elicited electrical activity of the skin caused by factors other than the stimulus, such as movement, mechanical pressure on the electrode, or electronic noise generated by the recording device. This type of interference can produce a response that resembles a skin conductance response, but, in essence, it is not a true skin conductance response. Artifact is different from an NS-skin conductance response, and it is important to be able to distinguish between the two. The establishment of a threshold based on the amplitude of the skin conductance response helps to discern artifact from true skin conductance responses. Recommended threshold levels based on research are not widely published. Wide variations in threshold levels exist in the literature ranging from 0.015 μS to 0.05 μS (Clements & Turpin, 1995; Fahrenberg & Foerster, 1982; Vossel & Zimmer, 1990). In addition, thresholds may vary by electrode placement site (e.g., palmar versus sternal). One must be careful in choosing a threshold to establish NS-skin conductance response. If a threshold is too high, NS-skin conductance responses may be disregarded as artifact. Likewise, if the threshold is set too low, there will be an increase in the occurrence of NS-skin conductance responses. As reported earlier, normal skin conductance response amplitude varies from 0.2-1.0 μS. The reason for this variation rests partially with differences in individual tonic levels of skin conductance. One who has a high tonic level of conductance is likely to have a higher amplitude in true skin conductance responses, whereas, one with minimal tonic levels may produce small amplitude skin conductance responses that end up being ignored. Fowles et al. (1981) recommend adjustable tonic level controls to aid in the proper identification of skin conductance response production. This can be accomplished by using an instrument that is capable of a tonic sensitivity adjustment of 1 μmho/cm (Fowles et al.). Computer programs are also available to aid in the identification of NS-skin conductance responses (Schulter & Papousek, 1992).

Reliability

Reliability is an important concern with the use of electrodermal activity recording. The most important avenue for strengthening the reliability of electrodermal activity measurement is to follow the recommended research-based methodology. Reliability can be viewed as the level of consistency of electrodermal activity among individuals and is generally determined by studying NS-skin conductance response production (Dawson et al., 2000; Freixa i Baque, 1983). Reliability has been established through several studies (Dawson et al., 2000; Fahrenberg & Foerster, 1982; Vossel & Zimmer, 1990). Researchers may need to control for artifact, stability, and lability between individuals in order to strengthen the interpretation of skin conductance response data (Freixa i Baque, 1982).

Stability and Lability

Stability within electrodermal activity research can be defined as temporal and amplitude consistency between NS-skin conductance response activity. Lability is defined as the variability between amplitudes. Determination of lability is dependent on the rate of NS-skin conductance response production while at rest. One who produces a high number of NS-skin conductance responses at rest is deemed to have high lability or high variability in skin conductance response responses. Stable lability is variability that is consistently maintained, whereas unstable lability is defined as inconsistent or erratic production of NS-skin conductance responses. Studies that are concerned with lability have posited that lability may be a measurement of arousal or is a psychophysiological trait (Crider et al., 2004; Dawson et al., 2000; Schulter & Papousek, 1992; Vossel, 1988). While studies that are primarily concerned with skin conductance response activity should be aware of the potential influences on lability in designing their study, lability has not yet been correlated with an increase or decrease in true skin conductance response production. However, while shown to be stable, lability is known to be higher in males than females and is shown to increase as the day progresses (Bull, 1972; Schulter & Papousek, 1992). In other words, there is a circadian influence on lability. Lability has also been shown to vary between different sleep stages (Freixa i Baque, 1983; Venables & Mitchell, 1996).

In conclusion, documentation of the reliability of electrodermal activity measurement is readily available in the literature. Researchers can further ensure reliability by choosing the correct threshold and controlling for tonic (baseline) differences. Researchers may also design a study to decrease potential influences on lability and stability (i.e., test same time of day or sleep stage, control for gender).

Confounding Factors

Skin conductance response activity can be influenced by several different variables including habituation, age, sweat gland count, hydration, gender, and psychological states. Understanding these influences is important when designing a research study and interpreting results in order to avoid misinterpretation of the data. Researchers may also need to control for these variables in order to strengthen the external validity of their research.

Habituation

One influence on skin conductance response is habituation. As mentioned earlier, habituation is essentially nonresponse after repeated exposure to stimuli. Researchers need to be concerned with this phenomenon to prevent unwanted occurrences from happening during their studies. Habituation to both simple and complex sequences of stimuli has been studied. Habituation to simple stimuli has been well documented in the literature with the average number of stimulation presentations required being 2 to 8 (Dawson et al., 2000; Fowles et al., 1981).

Habituation to complex stimuli was studied by Ben-Shakhar, Dymshitz, and Lieblich (1982). The researchers tested 95 subjects on a card task with the intent of exploring habituation to complex sequences of stimuli. Interestingly, the best theoretical model describing habituation in this study incorporated an active choice by the participants indicating that the act of choosing identified the stimulus that was the most important. This may imply that habituation is related to the level of importance placed on a task by the subject. For example, an active choice results in a lack of habituation. On the other hand, habituation (nonresponse) happens more quickly with insignificant stimuli. Habituation may also be dependent upon categorization of the task and not just simply on stimuli perception (Ben-Shakhar et al.). This study is further validated by animal studies that have shown habituation occurs quicker to nonrelevant stimuli (Deshmukh & Bhalla, 2003; Rose & CH, 2001). For an in-depth look, Stephenson and Siddle (1983) provided a more detailed account of habituation.

Age

Although prior research suggested that age may influence skin conductance responses, this seemed to be due to use of constant current systems rather than an age effect per se. Interestingly, more recent research using constant current systems has not validated an age effect. According to Catania et al. (1980), research has shown baseline skin conductance levels are higher, while skin conductance response is lower in older subjects when compared to younger groups. However, they did a study that found no age-related differences in skin conductance response magnitude or habituation. They posited that this was due to the use of a constant voltage recorder whereas the previous research on age-related differences utilized constant current (Catania et al.). Although this sounds plausible, they appeared to be using magnitude and amplitude interchangeably, whereas magnitude decreases can be due to a decrease in number of responses rather than the level of response. Interestingly, they report a significant difference in SCL with the younger subjects having a higher level at rest and at habituation. This highlights the need to be familiar with the semantics involved with electrodermal activity research.

Schulter and Papousek (1992) further demonstrated that age did not have an effect on the frequency of skin conductance responses. However, the older the participant, the lower the amplitude of skin conductance response. Lower amplitudes in older individuals may be related to differences in sweat gland count, hydration status, or age-related changes in peripheral mechanisms that govern autonomic responses (Catania et al., 1980; Christie & Venables, 1972; Garwood et al., 1979).

Sweat Gland Count

As mentioned above, sweat gland count (SGC) may have an influence on electrodermal activity. Catania et al. (1980) looked at the electrodermal activity of 24 subjects while being exposed to tone stimuli. They concurrently examined the relationship between electrodermal activity and sweat gland count, age, handedness, and gender. They found a significantly lower number of active SGC in the older (141.9) than the younger (390.1). Interestingly, they also found a significant relationship between handedness and active SGC in the younger group. The data showed that the nonpreferred hand had a higher SGC than the dominant hand. However, there was no significant difference in skin conductance response activity between the hands. The data also showed a significantly lower SCL level in the older patients, while there was no significant difference in skin conductance response magnitude. However, they did conclude that SGC and SCL (baseline) at rest were strongly correlated in the younger subjects (r = .74) and weakly correlated in the older subjects (2 = .22) (Catania et al., 1980).

Interestingly, when looking at skin conductance response amplitude, the reverse was true. The older patients showed high correlations between SGC and skin conductance response amplitudes (r = .63) while the younger population had a low correlation between SGC and skin conductance response amplitude (r = -.20). Further statistical studies showed that the variance found in the SCL was not significantly accounted for by age alone. Stepwise multiple regressions suggested that the variance accounted for in age was dependent upon the variance predicted by SGC. Interestingly, although there was a correlation between SGC and skin conductance response in the old, the young who had almost three times the number of active sweat glands did not have significantly higher skin conductance response amplitudes (Catania et al., 1980). Similarly, Freedman et al. (1994) found that the number of sweat glands had no effect on SCL or skin conductance response amplitude. However, they did find a relationship between number of sweat glands and NS-skin conductance response frequency and skin conductance response frequency. Interestingly, Freedman et al. (1994) did not control for age in this study, but suggested that differences were due to the number of open or active sweat glands rather than the number of existing sweat glands. Catania et al. (1980) posited that these findings may also have been due to the level of corneum hydration of each subject. The younger group may have been better hydrated, which has been shown by Edelberg (1971) to decrease skin conductance response amplitude.

Hydration. Garwood et al. (1979) found that hydration influenced in a unique way. Interestingly, these authors studied not only the SCL and skin conductance response of their subjects, but also the skin's *potential*. They looked specifically at both skin potential level (SPL) and negative and positive potential skin responses (SPR) (Springhorn, 1998). While they found no significant age difference between the effect of hydration and SCLs and skin conductance responses, they did find significant age differences between the effect of hydration and SPLs and SPRs. They found the largest SPR magnitude occurring in the young correlated with the least amount of hydration; on the other hand, the level of hydration in the aged did not affect SPR magnitude. In essence, although there may be a decrease in number of sweat glands as one ages, the skin's potential is also decreased, resulting in similar skin conductance response amplitude responses when compared with the younger population (Garwood et al.). As mentioned earlier, Catania et al. (1980) have challenged that these results may be partially due to the apparatus used for measurement, with Gardner et al. using constant current as opposed to constant voltage.

Gender

Another potential influence on electrodermal activity is gender. As evidenced by prior research, there is little to no difference in electrodermal activity at rest between men and women (Freixa i Baque, 1982; Roman, Garcia-Sanchez, Martinez-Selva, Gomez-Amor, & Carrillo, 1989; Schulter & Papousek, 1992, 1998; Venables & Mitchell, 1996). However, Eisdorfer, Doerr, and Follette (1980) found that although young to middle-aged women had lower SCLs than their male counterparts did, the young women produced higher skin conductance responses than males in response to a valsalva maneuver. The authors suggested that this was largely due to differences in response to stress between the genders. Similarly, other studies have validated gender-moderating physiological responses to anxiety and stress. Women have been found to have a higher response to a potential shock (Kopacz & Smith, 1971), are more responsive to environmental stimuli such as time of day and season (Venables & Mitchell, 1996), and have produced more NS-skin conductance responses in a public speaking task (Carrillo et al., 2001). It has also been suggested that women's electrodermal activity fluctuates in relation to their menstrual cycles (Gomez-Amor, Martinez-Selva, Roman, Zamora, & Sastre, 1990). In conclusion, one needs to be aware of the potential differences between gender responses and not attribute these differences solely to the introduction of stimuli.

Psychological States

Psychological states such as anxiety and depression have also been shown to be related to abnormal electrodermal activity. Tonic and phasic hypoactivity have consistently been found in schizophrenia, psychological states depression, and addictive disorders (Dawson & Schell, 2002; Dawson et al., 2000; Fowles & Missel, 1994). For example, unmedicated clinically depressed patients were found to have a significantly higher skin conductance response nonresponse than controls (Mirkin & Coppen, 1980). Similar studies have also been done in schizophrenic patients with similar findings (Dawson & Schell; Dawson et al.). The reliability of these studies has even led to the defining of a subgroup within the schizophrenic population for research purposes (Dawson et al.; Hazlett, Dawson, Filion, Schell, & Neuchterlein, 1997; Hazlett, Dawson, Shell, & Neuchterlein, 1997). The presence or absence of electrodermal activity has been a mainstay in psychological research for decades.

In conclusion, there are several potential influences on electrodermal activity that the researcher needs to consider. However, the most important aspect of electrodermal activity research is the interpretation given to the presence or absence of skin conductance response activity. One cannot interpret skin conductance response activity in isolation. Determining the significance or meaning of electrodermal activity is reliant on stimulus control as well as proper methodology, including the identification or control of potential confounding factors identified above.

Applications

One of the most familiar electrodermal activity applications is the guilt-knowledge test (GKT), popularly known as the lie detector or polygraph test. The theory underlying this and other applications is commonly known as discrimination classical conditioning. The premise of this theory rests on the importance of the stimulus significance as consciously determined by the subject. The more significant the stimulus is to an individual, the stronger the response. For example, a lie is usually considered more significant to a subject when compared to a truthful answer. The subject will respond accordingly to a set of questions with known answers which allows for deception detection (Dawson et al., 2000). The American Polygraph Association reports possessing 80 studies that have been done since 1980 on the validity and reliability of the polygraph. They boast up to 98% average accuracy (American Polygraph Association, as cited in Ben-Shakhar and Elaad (2003). These authors conducted a meta-analysis on 80 different research studies in order to estimate the validity of the GKT. Their results indicated that the GKT is valid in the detection of relevant information and distinguishing between subjects that have guilty knowledge and subjects that do not. They found the overall effect size to be 1.55 with a correlation coefficient of 0.55. However, they concluded that in an optimum circumstance the overall effect size can be 3.12 with a correlation coefficient of 0.8.

On the other hand, studies of prosopagnosic patients (patients with an inability to recognize others) have suggested that conscious awareness is not always necessary for the initiation of skin conductance responses. Tranel, Fowles, and Damasio (1985) researched skin conductance response to familiar faces and found significantly higher skin conductance response amplitude to familiar faces as opposed to unfamiliar faces in normal subjects. They built on this research by studying prosopagnosic patients. They established that, similar to their earlier study, prosopagnosic patients also showed a greater skin conductance response in response to familiar faces even though they were unable to consciously recognize the faces (Tranel & Damasio, 1985).

Electrodermal activity has been extensively used in psychophysiological studies as an indicator of the psychological processing of stimuli (Critchley, 2002; Dawson et al., 2000). Electrodermal activity has been used as a predictor of poor sustained attention performance in children with attention deficit hyperactivity disorder (ADHD) (O'Connell, Bellgrove, Dockree, & Robertson, 2004), a predictor or marker of poor outcomes in patients with schizophrenia (Dawson & Schell, 2002; Lopes-Machado, Crippa, Hallak, Guimaraes, & Zuardi, 2002), an indicator of psychopathy (Fung et al., 2005; Losel & Schmucker, 2004), a predictor of antisocial behavior (Herpertz et al., 2005), and a measure of arousal in subjects with fragile X syndrome (Miller et al., 1999).

While these studies were concerned with electrodermal activity in relation to psychophysiologic states, the implications for learning and identifying stimuli processing need to be considered when conducting other types of research utilizing electrodermal activity.

Electrodermal activity has also been used in a variety of ways to study learning (Edelberg, 1972). For example, Lachnit and Kimmel (2000) used skin conductance response as a tool in which to study Pavlovian conditioning in humans. Specifically, they were interested in the processes involved in the combining of associative strengths of stimuli during conditioning involving complex stimuli. They looked at both positive and negative patterning and used electrodermal activity response and latency as indices of conditioning. Electrodermal activity was used as an index of learning and of pattern discrimination in subsequent studies by Lachnit (Lachnit, Kinder, & Reinhard, 2002; Lachnit & Lober, 2001; Lachnit, Lober, Reinhard, & Kinder, 2001). Electrodermal activity has also been used as a predictor of learning in the avoidance of punishment (Waid, 1976). Other studies have used electrodermal activity as a measurement of working memory (Hinson et al., 2002; Jameson, Hinson, & Whitney, 2004). The implication of these studies focused in the different aspects of learning can be applied to other areas of research such as decision making. For example, the role that pattern discrimination may play in decision making could build upon the findings in these studies.

Decision making research has utilized electrodermal activity extensively and in a variety of ways. For example, electrodermal activity has been used as a marker and measure of decision making impairment in individuals with brain damage (Bechara et al., 1994; Damasio, 1996). The use of electrodermal activity within decision making research led to the development of the somatic marker hypothesis.

According to Dawson et al. (2000), electrodermal activity is perhaps the most widely used and abused biophysiological tool. He suggested that electrodermal activity is being used without the accepted methodology in differing applications, and thus, has become suspect. One of the most widely contested applications is termed *electrodermal testing* (ED testing). ED testing is an acupuncture-based method often used to identify allergies and improve homeopathic remedies. The technique, first developed in the 1950s by Voll (as cited in Dawson et al.), consists of measuring skin resistance between common acupuncture points. In essence, Voll wanted to build on acupuncture theory and develop a technique that did not require invasive insertion of needles. Lewith (2003) conducted a review of the literature on this subject and concluded that there was no scientific basis for the claim that ED testing is reliable for allergen testing. Further review can be found in Boucsein (2002).

Electrodermal activity has also been applied in the field of parapsychology. Schmidt and Walach's 2000 review of electrodermal activity in parapsychology revealed many limitations. For example, in checking the methodology of all parapsychological studies from 1995 to 1999, no studies adhered to standardized recommendations for using electrodermal activity. Thus, any conclusions from these studies may not be valid.

Summary

While used in some rather unique situations such as to gauge alertness in a driving situation (Collet et al., 2005) and as a biofeedback marker of impending syncope (Edwards, Benoit, & Schondorf, 2004), these studies have adhered to recommended methodologies. Studies that do not incorporate acceptable methodological techniques, such as the ones mentioned above, have a negative effect on the acceptance of electrodermal activity as a valid assessment tool. It is vital for all studies using electrodermal activity to use standardized methods and report the methods used.

Perhaps the most pivotal aspect of using electrodermal activity as a tool in research is interpretation. The presence or absence of electrodermal activity must be interpreted carefully and be based on the type of stimuli introduced as well as the environment. Almost any novel stimuli will produce a skin conductance response. Therefore, it is imperative to follow strict methodological guidelines in relation to interpretation of skin conductance response findings. While one may not be able to interpret the exacting psychological process or pathways that are responsible for the initiation of a skin conductance response, one can interpret the psychological meaning. This is dependent on the quality of research paradigm used with stricter controls yielding more conclusive interpretation (Dawson et al., 2000).

Preliminary Research

Pilot Study

Abstract

A quasi experimental design was undertaken to explore the possibility of utilizing electrodermal activity as a marker of intuitive decision making in nursing. This pilot study compared how 5 senior female nursing students to 5 female nurses with more than five years of nursing experience completed a clinical decision making task utilizing SimMan®. The overall theoretical basis that guided this research study was the Somatic Marker Hypothesis that suggests physiological markers are present during decision

making (Bechara & Damasio, 2002). The clinical decision making task was developed based on the cognitive continuum theory (Hammond, 2000). The study methodology was verified by performing the Iowa Gambling Task to replicate skin conductance response (SCR) activity prior to the clinical scenario task. An independent *t*-test was conducted comparing the total number of skin conductance responses generated in the card task and clinical scenario between the two groups.

A significantly greater number of skin conductance responses was generated by the nurses in the clinical scenario (p <0.05). No significant difference was found in magnitude of skin conductance response between nurses in the card task and clinical task. Findings suggested that skin conductance responses may be used as a marker for intuitive decision making in nursing.

Results

The mean number of skin conductance responses generated by the students in the card task was 32.6 and the mean generated by nurses was 29.4. The mean number of skin conductance responses generated by students in the clinical scenario was 4.8 and the mean for nurses was 12.2. An independent *t*-test was performed using SPSS software. Consistent with Hypothesis 1, the difference between the total number and mean amplitude of skin conductance responses generated during the card task was not significant between students and nurses (p >.05). Consistent with Hypothesis 2, the difference in the total number of skin conductance responses generated between the two groups during the clinical scenario was found to be significant, with experienced nurses generating a greater number of skin conductance responses (p < .05). However, a significant difference was not found in the mean amplitude of skin conductance response generation between the groups during the scenario. This study was unable to record precursory skin conductance responses in an objective manner.

Anecdotally, the investigator noted that both groups performed similarly on the card task, which was confirmed by the ability to correctly identify the advantageous decks. On the other hand, the nurses performed subjectively better during the clinical scenario. All nurses checked vital signs, heart rhythm, applied oxygen, called for the crash cart, and intervened accordingly. However, three of five nursing students failed to check vital signs in one or both of the clinical scenarios and only one student asked for the crash cart. Only one student asked for an EKG, which was an integral part of the scenarios. An interestingly common statement by nursing students was to *call the doctor*. They appeared to be either unable or hesitant to make any decisions without permission. Two nursing students stated they would call the doctor to *see* if they could apply oxygen. The nursing students also attempted to ask the patient many questions before making any decision; on the other hand, the nurses identified immediate interventions based on abnormal vital signs and then attempted to ask the patient questions.

Discussion

Nurses performed better during the clinical scenario and produced significantly more skin conductance responses. Both groups performed equally and generated the same number of skin conductance responses during the card task. This validates the Hypothesis that experienced nurses, who were using intuitive decision making (Benner & Tanner, 1987; Hammond, 2000), also produced more skin conductance responses confirming that skin conductance responses are markers of intuitive decision making. Interestingly, this also implies that intuitive decision making by nurses is guided by expected future outcomes (Bechara & Damasio, 2002; Bechara et al., 2003). For example, given that a patient is markedly hypotensive, the nurse will intuitively order a fluid bolus in anticipation of increasing the blood pressure not in reaction to the hypotension.

Future studies utilizing skin conductance responses in intuitive decision making by nurses are needed. The use of an actual clinical scenario proved to be cumbersome. Utilizing a clinical simulation program on a computer while recording skin conductance response activity is a viable option. The combining of qualitative and quantitative methods is also needed.

Limitations

This pilot study had many limitations. One significant limitation was the use of the AT64 electrodermal recorder by itself. While it provided output of when a skin conductance response occurred (P followed by amplitude), it does not tell us at what level it determines an increase in skin conductance to be a true skin conductance response. On the other hand, this allowed continuity in the reporting of the number of total skin conductance responses between individuals. Another limitation with this machine was the inability to record the total number of skin conductance responses. The principal investigator (PI) had to count the times the monitor reported a skin conductance response. While in statistical mode, it made it difficult and cumbersome due to the length of time it took to report the amplitude of each skin conductance response during the testing. However, following the testing time, it was very convenient to get the statistical analysis.

Another limitation was the inability to objectively quantify the performance of participants during the clinical scenario. While subjectively the nurses performed better than the students, an objective measuring of performance would enhance the study. The study would have been strengthened by video recording the sessions to allow for a qualitative analysis of the differences in decision making between the groups.

Tool Modification

Electrodermal Activity Recording Research

Based on the results of the pilot study, a change in the electrodermal activity recorder was warranted. The WaveRider 2cx made by MindPeak and distributed through its office in Petaluma, California, was chosen for several reasons. The device comes with its own computer software interface program that makes time-based recordings of the device's various input channel measurements and stores the data in software files on a personal computer. It also allowed for the creation of an event marker.

Upon receipt of the instrument, a small, hand-held button device was constructed to record the timing of the decision during the differing tasks. The event recorder created a 90uV spike (maximum channel reading) on the Channel A input when the button was pressed. The button device included a 9V battery for voltage supply, a momentary contact button and resistors that reduced the 9V of the battery to 90uV for use by the input Channel A on the WaveRider. The only use of Channel A during preliminary studies was to record the manual press of the button, serving as a marker. The button was pressed by the experiment administrator simultaneously with the participant's responses to the clinical scenario and modified Iowa Gambling Task software programs. This way, the continuous galvanic skin response recordings were marked in time by the occurrence of the participant's responses, allowing for quantification of the timing of skin conductance responses.

The WaveRider 2cx is a constant current device that records the Galvanized Skin Response (skin conductance level) measurements during each experiment and stores the data in an archive file that is created at the beginning of each experiment. An archive file was created for each experiment participant. The archive files were then exported in the form of a comma delimited text file, so that the text file could then be imported into Microsoft Excel for analysis. The data in the text file includes the time in seconds, the values of the marker channel A, and the Galvanized Skin Response data. The Galvanized Skin Response data in the text file was scaled by the WaveRider 2cx. Once the text files were imported into Excel, a conversion table provided by the distributor was used to convert the scaled Galvanized Skin Response data from the WaveRider 2cx into the actual Galvanized Skin Response readings in micro-Seimens per preferred publishing standards. While it has been reported that it is preferred to use a constant voltage recorder when studying skin conductance responses, this study was not focused on magnitude of the response but in the timing of skin conductance responses.

The GSR output from the device was recorded at a 1/8 sec. frequency, so there were eight readings per second for the IGT and both clinical scenarios. As presented earlier, SCRs have a typical amplitude of 0.2 mS (microSeimens). While the SCR amplitude varied from person to person, the average SCR amplitude in this experiment was 0.23 mS. In order to capture significant SCR responses, a filter was applied to the data that flagged any response with an amplitude of 0.1 mS or greater. The SCR amplitude was measured with respect to the GSR reading before the SCR initiated. This *baseline* reference point for SCRs tended to drift up or down throughout the experiments. The baseline drift varied with each subject and often changed at different times during each experiment. The equation used to flag these SCR responses was further edited manually on a SCR-by-SCR basis to assure only true SCRs were counted. The overall morphology of the rise and fall of the GSR reading was also considered in order to eliminate the occasional signal fluctuations caused by the subject moving her hand, or any other irregularity, such as the quality of the measurement device.

PreSCRs were filtered manually by counting only SCR responses that began within 3 seconds of the decision marker. SCRs that peaked within 3 seconds after a decision marker were not counted as a PreSCR for the next marker as a rule. The vast majority of the SCRs fit into this analytical methodology; however, some SCRs had a longer duration and were therefore disqualified as PreSCRs, even though they most likely were PreSCRs. This was done so that the data were analyzed in a consistent manner, and the result was that the PreSCR counts were slightly conservative but uniformly counted across all subjects.

The modified Iowa Gambling Task software was downloaded from the PEBL website and installed on a laptop to be used during the experiment. During the experiment, the modified Iowa Gambling Task software was run in the foreground for the participant, while the WaveRider software ran simultaneously, hidden in the background. In this method, galvanic skin response and marker inputs correlated with the participant actions in response to the modified Iowa Gambling Task program.

CHAPTER THREE

METHODOLOGY

Design

A quasi-experimental design was used with two groups and stratified subjects (nonrandom). This study was divided into two parts. In the first, methodology was verified through performing a modified computerized Iowa Gambling Task to replicate skin conductance response activity. In the second part of the study, decision making between groups of nursing students and experienced nurses was compared using a computer-based clinical decision making task based on the cognitive continuum theory.

Study Population/Sample

Volunteer senior female baccalaureate nursing (Population 1) students in their last clinical before graduation were compared with volunteer female nurses (Population 2) with at least 5 years of clinical experience

Inclusion criteria

Female baccalaureate nursing students, who were in their last clinical rotation comprised Population 1 while Population 2 comprised baccalaureate-prepared nurses with at least 5 years of nursing experience within the last 7 years.

Exclusion criteria

Population 2 did not include registered nurses with less than 5 years of nursing experience. Registered nurses with less than a baccalaureate, registered nurses with greater than a baccalaureate, and male nurses were excluded in this study.

Power Analysis

The PASS software program was used to perform a power analysis based on the standard deviations obtained in the pilot study on the total number of skin conductance responses generated during the clinical scenario. An equivalence test of means using two one-sided tests on data from a parallel-group design using sample sizes of 15 in both the student nurse and experienced nurse achieves 88% statistical power at a 5% significance level when the true difference between the two means is zero. However, due to a lack of interest by both nursing students and nurses, the study was ended early with 11 participants in the nursing students and 10 in the nurses. A discussion of the study participation is found in Chapter 5.

Setting

The setting for this study was the office of the investigator. This office is located within the UTHSCSA SON. The office is quiet, has one window which will have the blinds closed, and has a private door. All phones were turned off and a *Do Not Disturb* sign was placed on the outside of the door.

Tools

Iowa Gambling Task

For method verification, the Iowa Gambling Task was administered via the computer with software, Bechara's Gambling Test, an adaptation of Bechara's Gambling Task® from The PEBL Psychological Test Battery, downloaded from the PEBL website. The role of emotion is complex and can be assessed using the Iowa Gambling Task. The IGT is useful in a measure as it has been shown to explore the emotional aspect of executive function. Often, the *feeling* of knowing which card to choose is reminiscent of intuitive decision making. This use of a modified version of the original Iowa Gambling Task methodology has been validated by numerous studies (Catania et al., 1980; Turnbull, Evans, Bunce, Carzolio, & O'Connor, 2005; Wagar & Dixon, 2006).

MicroSim™

The computer-based clinical scenario used for this study was MicroSim™ by Laerdal. This computer program provided an emergent clinical scenario that would enhance intuitive decision making according to the cognitive continuum theory. The participants were required to make decisions for a critically ill patient in a timely manner. This program also provides a score between 1 and 100 based on preprogrammed parameters such as length of time to make a decision and the appropriateness of the nursing intervention chosen.

Each participant completed two clinical scenarios on the computer. These scenarios included visual clues as well as auditory sounds. For example, if a subject decided to initiate CPR, the program showed CPR being performed and provided realistic sounds. Both scenarios required an efficient and skilled level of decision making by the participant. For example, participants were not just expected to initiate ventilatory support, the program also required the participants to choose the method of ventilation. Likewise, the participants were required to decide not only to place an IV, but also where to place it. If participants chose to initiate cardiopulmonary resuscitation (CPR), they were also required to choose the ratios of compression to ventilation during CPR.

The first clinical scenario involved a witnessed syncopal patient in an emergency department waiting room. This scenario required participants to assess mental status, airway, breathing, and circulation. This patient was found to be in pulseless ventricular tachycardia (V-tach) and scoring was partly based on Advanced Cardiac Life Support (ACLS) protocol.

The second clinical scenario consisted of a nurse finding a patient unresponsive on a general medical floor. This scenario also required participants to assess mental status, airway, breathing, and circulation. This patient was found to be in V-fib. This scenario required very quick decision making in order to score well. To pass the second scenario, participants had to quickly apply the automatic defibrillator and initiate a shock.

The participants were deliberately not given a formal tutorial on the program in an attempt to enhance an intuitive mode of decision making according to the Cognitive Continuum Theory (Hamm, 1988). All participants were informed that possible interventions were found at the bottom of the screen and that they accessed these by using the mouse. The subjects read a brief one sentence synopsis of the situation before they proceeded. The SCR recording device was begun immediately after the subjects read the introduction to the scenario. All participants were instructed to hit the "transfer" box when they were done with the scenario. After the subjects hit the "transfer" box, SCR recording was halted, and the PI ended the scenario program and retrieved the score. The Laederol program provided both a numerical score from 0-100 and informed the participants whether they had passed the scenario. A score of 70% or higher was required to pass the scenario.

Electrodermal Activity Recorder

The device used in this experiment to measure Galvanic Skin Response (GSR) was the WaveRider 2cx made by MindPeak and distributed through its office in Petaluma, California. The device comes with its own computer software interface program that makes time-based recordings of the device's various input channel measurements and stores the data in software files on a personal computer.

Protection of Human Subjects

Institutional review board (IRB) approval was granted by both the University of Texas Health Science Center at San Antonio (UTHSCSA - Appendix C) and Indiana University School of Nursing (Appendix D).

Data Collection and Management Procedures

Overview

Flyers (Appendix E) were placed in common areas of the UTHSCSA School of Nursing and Nursing break rooms at University Hospital. When contacted by a student or nurse, the investigator explained the study to the potential subject and screened for acceptability (see inclusion/exclusion criteria). If a subject agreed to participate and signed the informed consent (Appendix C), a time was set to conduct the experiment.

The subject arrived at the nursing school at the preset time and was oriented to both the computerized tools and skin conductance recorder until they felt comfortable. After orientation, testing began with the computer-based modified Iowa Gambling Task. The finger probe from the WaveRider JR© monitor was attached to the second and middle finger on the left hand after hands were washed with soap and dried. According to the manufacturer's recommendation, gel that was supplied by the manufacturer was used on the finger probes. The participant then relaxed without any stimulation for two minutes while recording skin conductance activity in order to establish baseline levels of electrodermal activity.

Recruitment Protocol

(Recruitment: all contact with participants was done by this investigator)

1. Following IRB approval from both IUPUI and UTHSCSA, flyers (Appendix E) were placed in common areas of the UTHSCSA School of Nursing and nursing break rooms at University Hospital.
2. When contacted by a student or nurse, the PI explained the study to the potential participant and screened for acceptability (see inclusion/ exclusion criteria).
3. When a subject agreed to participate and signed the informed consent, a time was set up to conduct the experiment with each participant individually. Signed consent forms were kept in a locked filing cabinet in room 2.228 of the UTHSCSA SON, (investigator's office).

Experiment Protocol

(Experiment: all procedures measurements and tests were done by this investigator)

1. Participants arrived at the PI's office in the School of Nursing at the preset times and were oriented to the WaveRider and computer until they felt comfortable.
2. Participants were placed in a comfortable chair.
3. The WaveRider monitor and what it does was described to the participant.
4. The finger probe from the monitor was attached to the middle finger on the left hand.

5. The subject was allowed to relax without any stimulation for two minutes while recording skin conductance activity in order to establish baseline levels of electrodermal activity.
6. The computerized Iowa Gambling Task was started. Subjects were instructed to make their choice after the investigator told them. (This ensured adequate time between stimuli and potential skin conductance response.)
7. The investigator pushed the recorder button each time subject pressed a key on the computer and stated to the subject, “You may choose,” five seconds after the recorder button was pushed.
8. Following completion of the modified Iowa Gambling Task, subjects sat for two minutes to re-establish baseline current levels.
9. The computer-based clinical scenario was started. Participants were instructed to make their choice after the investigator told them it was OK.
10. The investigator hit the record button each time a choice was made by the participant.
11. The participant was thanked for participation and given the Target gift card.

Data Analysis

Descriptive Statistics

Descriptive statistics were used with the following variables: age, years of experience in nursing, and time required to complete the clinical scenario.

Inferential Statistics

Preliminary analysis of the variables was done to ensure the assumptions of normality and variance were met in order to use an independent *t*-test. If a test of normality was found to be significant, a Mann-Whitney nonparametric test was used.

Specific Aim 1 was explored using an independent *t*-test through the SPSS software program to examine the differences between nursing students and experienced nurses. Hypotheses 1a, 1b, and 1c were explored with the dependent variables being the total number of skin conductance responses generated, the number of precursory skin conductance responses generated, and score (money left) on the Iowa Gambling Task.

Specific Aim 2 was explored using an independent *t*-test through the SPSS software program to examine the differences between nursing students and experienced nurses. Hypotheses 2a, 2b, and 2c were explored with the dependent variables being the total number of skin conductance responses generated, the number of precursory skin conductance responses generated, and score given on the clinical scenario.

Specific Aim 3 was explored using a Mann-Whitney *U*-test through the SPSS software program to examine the differences between nursing students and experienced nurses on a self report of use of intuition and anxiety levels. Hypothesis 3a, 3b, and 3c were explored with the dependent variables being responses to Questions 1, 2, 3, and 4 as shown in Table 2.

This study provided much information about intuitive decision making in nursing, including insight into the methods and potential validation of the use of a skin conductance response recorder in this type of research. The results of the instrument (skin conductance response) recorder were reported according to published recommendations.

Table 2

Level of Intuition/Anxiety Tool

	Strongly disagree	**disagree**	**undecided**	**agree**	**Strongly agree**
1. I was anxious prior to the Iowa gambling task.	**1**	**2**	**3**	**4**	**5**
2. ***I was anxious prior to the clinical scenario.***	**1**	**2**	**3**	**4**	**5**
3. ***I used intuition during the clinical scenario.***	**1**	**2**	**3**	**4**	**5**
4. ***I used intuition during the Iowa Gambling task.***	**1**	**2**	**3**	**4**	**5**

CHAPTER FOUR

FINDINGS AND INTERPRETATION

The purpose of this study was to explore the validity of using skin conductance response as markers of intuitive decision making in nursing by comparing female nurses with 5 or more years of experience with senior baccalaureate nursing students who had finished with their last clinical rotation. It was hypothesized that nurses would generate a greater number of total and precursory SCRS and achieve a higher score during a computerized clinical scenario. It was also hypothesized that nurses would report a greater use of intuition than the nursing students during the clinical scenario. This chapter includes findings as well as interpretations of the data collected. All statistical tests were conducted using an alpha level of .05.

Findings

Description of Sample

The sample consisted of 11 female baccalaureate nursing students and 10 female nurses with greater than five years of nursing experience. The average age of the nursing student was 36.8 with a range of age between 21 and 52. The average age of the nurse was 36.8 with a range from 28 to 53 years. The average of years of nursing experience for the nurses was 11.2, with a range of 5-27 years.

Similarities and Differences of Groups by Variable

Results on selected variables are presented in Table 3.

Iowa Gambling Task Score. The score achieved on the Iowa Gambling Task by both groups was compared using an independent *t*-test program in SPSS after assumption of normality was confirmed through a Shapiro-Wilk test of normality (nurse p = .831;

Table 3

Statistical Summary of Select Variables

	NURSE		STUDENT			
VARIABLE	***M***	***SD***	***M***	***SD***	***T-TEST***	**MANN-WHITNEY**
Iowa Gambling Score	1920	854.38	1709.36	787.57	-.588	
Iowa SCRs	64.5	30.57	41.09	28.02	-1.832	
Iowa PSCRs	14.5	8.66	7.09	4.98	-2.423*	
Clinical Score	125.1	21.73	74.91	54.03	-2.839*	
Clinical SCRs	64.9	40.45	32.45	22.74	-2.295*	
Clinical PSCRs	16.5	10.32	8.45	5.54		-1.979*
Q1	12.9		9.27			36
Q2	10.85		11.4			53.5
Q3	11.75		10.32			47.5
Q4	15.1		7.27			15 *

*significance at $p < .05$

student $p = .283$). The difference between the two groups was not statistically significant ($p > .05$). There was homogeneity as evidenced by an insignificant Levene statistic.

Iowa Gambling Task skin conductance responses. The SCRs generated on the Iowa gambling task by both groups was compared using an independent *t*-test program in SPSS after assumption of normality was confirmed through a Shapiro-Wilk test of normality (nurse $p = .093$; student $p = .207$). The difference between the two groups was not statistically significant ($p > .05$). There was homogeneity as evidenced by an insignificant Levene statistic.

Iowa Gambling Task precursory skin conductance responses. The PSCRs generated on the Iowa gambling task by both groups was compared using an independent *t*-test program in SPSS after assumption of normality was confirmed through a Shapiro-Wilk test of normality (nurse $p = .534$; student $p = .085$). The difference between the two groups was found to be statistically significant ($p < .05$). There was homogeneity as evidenced by an insignificant Levene statistic.

Clinical Score

Combined. The score achieved on computerized clinical scenario by both groups was compared using an independent *t*-test program in SPSS after assumption of normality was confirmed through a Shapiro-Wilk test of normality (nurse $p = .415$; student $p = .173$). While there was heterogeneity as evidenced by a significant Levene statistic, the nurses had a significantly greater score ($p < .05$) than the nursing students.

Component 1. The score achieved on the computerized clinical scenario by both groups was compared using an independent *t*-test after assumption of normality was confirmed as evidenced by an insignificant Shapiro-Wilk test of normality (nurse *p* = .322; student *p* = .056). The difference between the two groups was still found to be statistically significant ($p < .05$). Nurses had a significantly greater score than the nursing students. There was homogeneity as evidenced by an insignificant Levene statistic.

Component 2. The score achieved on computerized clinical scenario by both groups was compared using an independent *t*-test program in SPSS after assumption of normality was confirmed through a Shapiro-Wilk test of normality (nurse *p* = .533; student *p* = .215). The difference between the two groups was found to be statistically significant ($p < .05$). Nurses had a significantly greater score than the nursing students. There was homogeneity as evidenced by an insignificant Levene statistic.

Clinical Skin Conductance Response

Combined. The SCRs generated on the combined clinical scenario by both groups was compared using an independent *t*-test program in SPSS after assumption of normality was confirmed through a Shapiro-Wilk test of normality (nurse *p* = .859; student *p* = .115). The difference between the two groups was found to be statistically significant ($p < .05$). Nurses had a significantly greater score than the nursing students. There was homogeneity as evidenced by an insignificant Levene statistic.

Component 1. The SCRs generated on Component 1 of the computerized clinical scenario by both groups was compared using a Mann-Whitney program in SPSS after normality was not confirmed as evidenced by a significant Shapiro-Wilk test of normality within the student group (nurse *p* = .548; student *p* = .011). The difference between the two groups was found to be statistically insignificant ($p < .05$). Nurses had a significantly greater SCR generation than the nursing students.

Component 2. The SCRs generated on Component 2 of the computerized clinical scenario by both groups was compared using an independent *t*-test program in SPSS. SPSS after assumption of normality was confirmed through a Shapiro-Wilk test of normality (nurse $p = .859$; student $p = .115$). While there was heterogeneity as evidenced by a significant Levene statistic, the difference between the two groups was found to be statistically significant ($p < .05$).

Clinical Precursory Skin Conductance Response

Combined. The SCRs generated on the combined clinical scenario by both groups was compared using a Mann-Whitney program in SPSS after normality was not confirmed as evidenced by a significant Shapiro-Wilk test of normality within the student group (nurse $p = .331$; student $p = .011$). The difference between the two groups was found to be statistically significant ($p < .05$). Nurses had a significantly greater PSCR generation than the nursing students.

Component 1. The SCRs generated on Component 1 of the computerized clinical scenario by both groups was compared using a Mann-Whitney program in SPSS after normality was not confirmed as evidenced by a significant Shapiro-Wilk test of normality within the student group (nurse $p = .871$; student $p = .038$). The difference between the two groups was found to be statistically significant ($p < .05$). Nurses had a significantly greater SCR generation than the nursing students.

Component 2. The SCRs generated on Component 2 of the computerized clinical scenario by both groups was compared using an independent *t*-test program in SPSS after assumption of normality was confirmed through a Shapiro-Wilk test of normality (nurse $p = .871$; student $p = .247$). The difference between the two groups was found to be statistically significant ($p < .05$). Nurses had a significantly greater PSCR generation than the nursing students.

There was homogeneity as evidenced by an insignificant Levene statistic. A tabular summary of the foregoing findings is shown in Table 3. Iowa and clinical scores of students and nurses are illustrated for SCR (Figure 3) and PSCR variables (Figure 4).

Findings and Interpretations by Specific Aim and Hypothesis

Specific Aim 1

Specific Aim 1 was to compare the skin conductive response generation, precursory and total number, and overall score during a computer-based Iowa Gambling Task between two groups: one group of fourth semester baccalaureate female nursing students who had successfully completed the last clinical rotation of their academic program and one group of female baccalaureate-prepared nurses with five years or more of work experience.

Hypothesis 1a. Hypothesis 1a stated there would be no difference in the total number of skin conductance responses generated by nursing students and experienced nurses while performing the modified Iowa gambling task. An independent *t*-test revealed no statistical difference between the two groups ($p > .5$). The two groups were also homogeneous as evidenced by an insignificant Levene's Test for Equality of Variances ($F = .830$; $p = .374$). Therefore, Hypothesis 1a is accepted; there is no statistically significant difference in the total number of skin conductance responses generated by nursing students and experienced nurses during the modified Iowa gambling task.

Figure 3

Scatterplot of SCR Variables

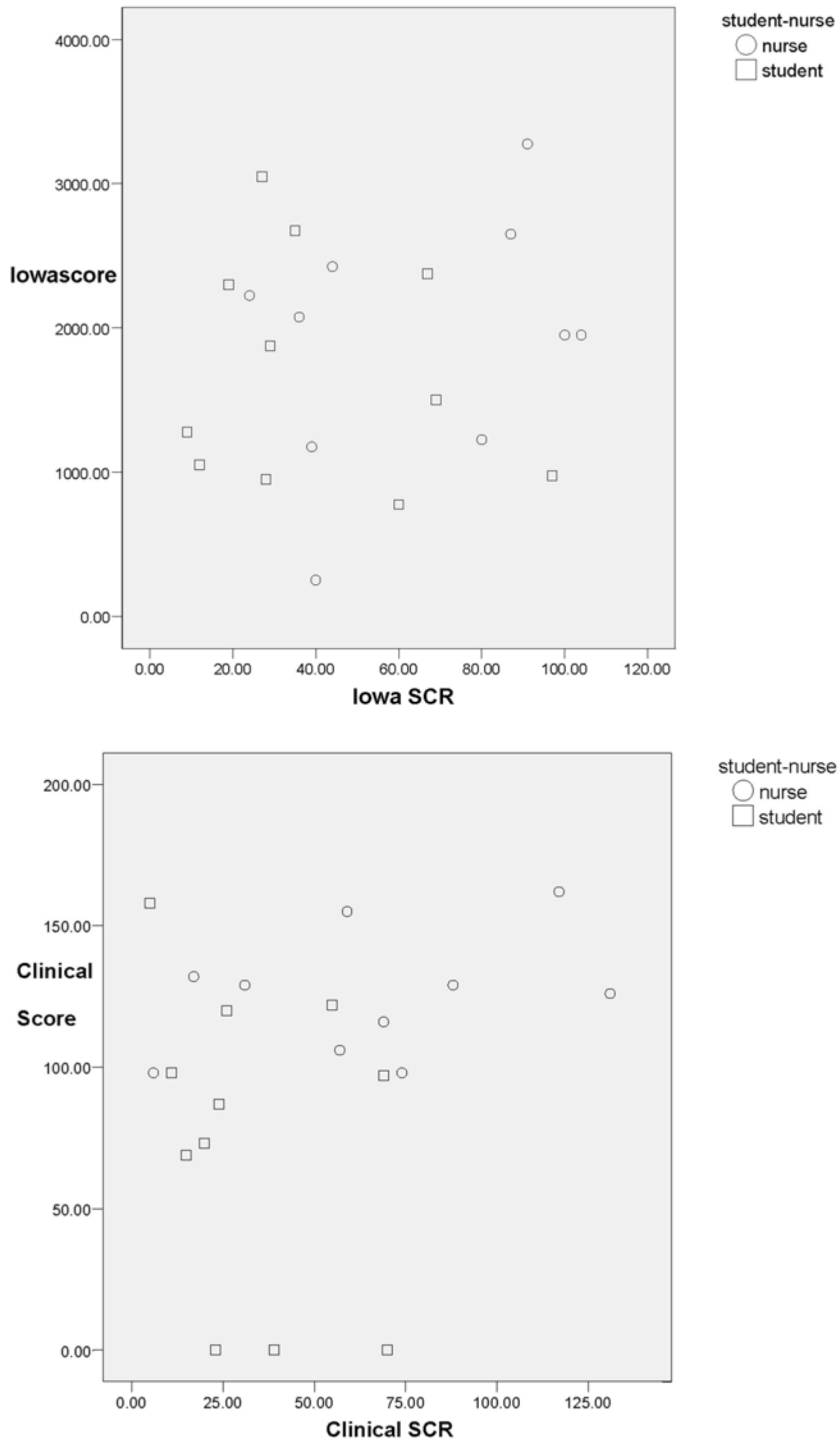
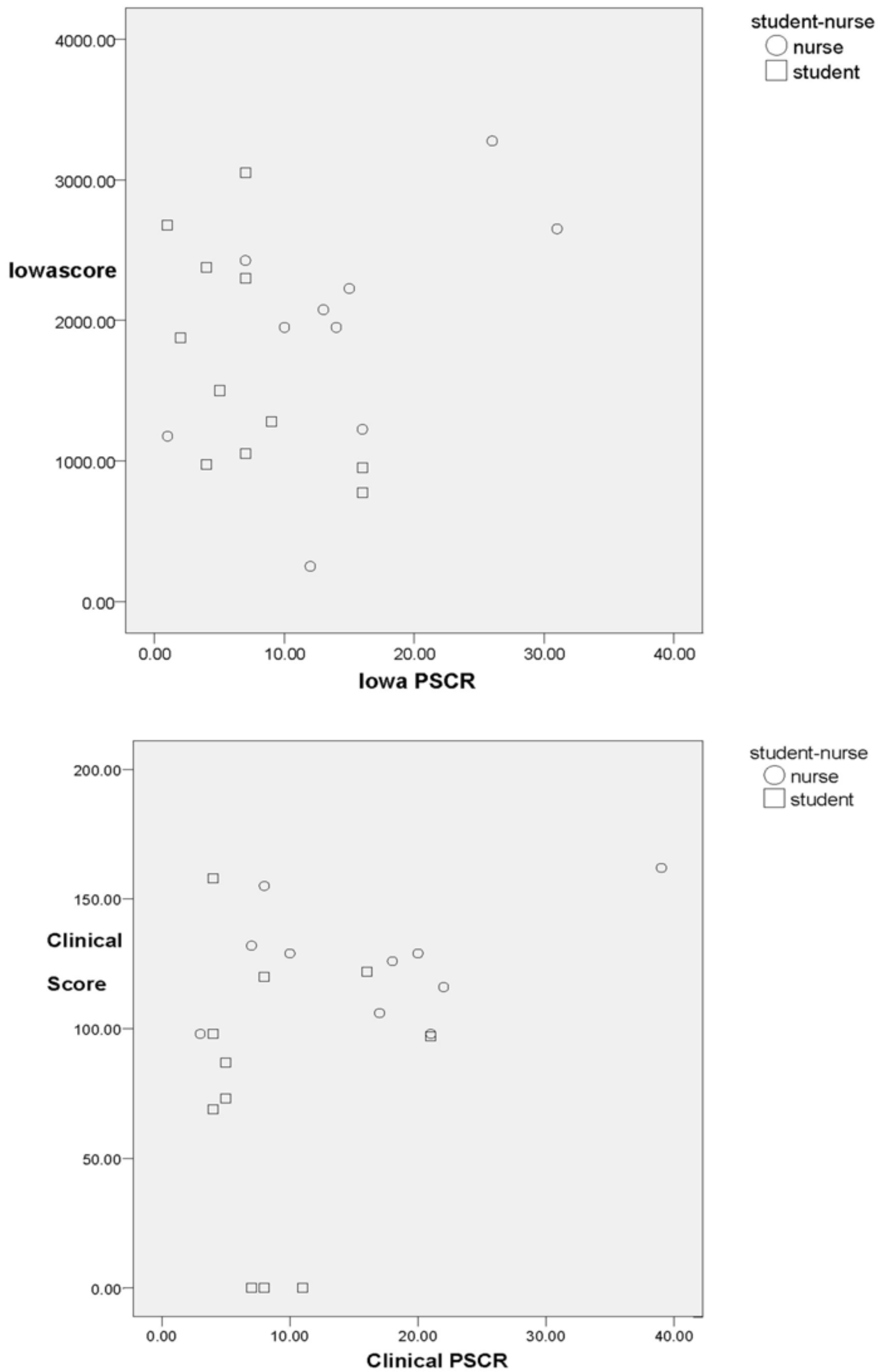


Figure 4

Scatterplot of PSCR Variables



Hypothesis 1b. Hypothesis 1b stated there would be no difference in the total number of precursory skin conductance responses generated by nursing students and experienced nurses while performing the modified Iowa gambling task. An independent *t*-test revealed a statistical difference between the two groups ($p <.05$). The two groups were also found to be homogeneous as evidenced by an insignificant Levene's Test for Equality of Variances ($F = 1.374$; $p = .256$). Therefore, Hypothesis 1b is rejected; there is a statistically significant difference in the total number of precursory skin conductance responses generated by nursing students and experienced nurses during the modified Iowa gambling task.

Hypothesis 1c. Hypothesis 1c stated there would be no difference in the overall score between nursing students and experienced nurses on the Iowa Gambling Task. An independent *t*-test revealed no statistical difference between the two groups ($p > 0.5$). The two groups were also homogeneous as evidenced by an insignificant Levene's Test for Equality of Variances ($F = .081$; $p = .779$). Therefore, Hypothesis 1c is accepted; there is no statistically significant difference between nursing students and experienced nurses on the modified Iowa gambling task.

Specific Aim 2

Specific Aim 2 was to compare the skin conductive response generation, precursory and total number, and overall score during a computer-based clinical scenario. One group was fourth semester baccalaureate nursing students who had successfully completed the last clinical rotation of their academic program and one group was baccalaureate-prepared nurses with five years or more of work experience.

Hypothesis 2a. Hypothesis 2a stated that experienced nurses would generate more total skin conductance responses than nursing students during a computerized clinical scenario. An independent *t*-test revealed a statistical difference between the two groups (p = .033). The two groups were also homogeneous as evidenced by an insignificant Levene's Test for Equality of Variances (F = 2.263; p = .149). Therefore, Hypothesis 2a is accepted; there is a statistically significant difference between of skin conductance response between nursing students and experienced nurses during the clinical scenario.

Hypothesis 2b. Hypothesis 2b stated that experienced nurses would generate a greater number of precursory skin conductance responses than nursing students during a computerized clinical scenario. An independent *t*-test revealed a statistical difference between the two groups (p = 036). The two groups were found to be homogeneous as evidenced by an insignificant Levene's Test for Equality of Variances (F = 2.410; p = .137). Therefore, Hypothesis 2b is accepted; there is a statistically significant difference between of precursory skin conductance response between nursing students and experienced nurses during the clinical scenario.

Hypothesis 2c. Hypothesis 2c stated there would be a difference in the overall score between nursing students and experienced nurses on the clinical scenario. An independent *t*-test revealed a statistical difference between the two groups (p = .013). However, the two groups were found to be heterogeneous as evidenced by a significant Levene's Test for Equality of Variances (F = 5.987; p = .024). Therefore, a Mann-Whitney *U*-test was performed resulting in a significant difference ($p < .05$).

Consequently, Hypothesis 2c is accepted; there is a statistically significant difference between nursing students and experienced nurses on the computerized clinical scenario.

Specific Aim 3

Specific Aim 3 was to compare the perception of nurses and student nurses on their use of intuition and anxiety levels in both the Iowa gambling Task and the clinical scenario. One group was fourth semester baccalaureate nursing students who had successfully completed the last clinical rotation of their academic program and one group was baccalaureate-prepared nurses with five years or more of work experience.

Hypothesis 3a. Hypothesis 3a stated that experienced nurses would agree with a greater use of intuition during the clinical scenario than the nursing students. A Mann-Whitney test was performed on students' and nurses' responses to question 3 on the Anxiety/Intuition tool (*I used intuition during the clinical scenario*). There was found to be no significant difference (p = .058) between the nurses and the students. Therefore, Hypothesis 3a cannot be accepted; there is no difference between agreement of use of intuition of students and nurses during the clinical scenario.

Hypothesis 3b. Hypothesis 3b stated that there would be no difference on agreement of use of intuition on the gambling task between the experienced nurses and nursing students. A Mann-Whitney test was performed on students and nurses response to question 4 on the Anxiety/Intuition tool (*I used intuition during the Iowa Gambling Task*). There was found to be a significant difference (p = .003) between the nurses and the students. Therefore, Hypothesis 3b cannot be accepted; there is a difference between agreement of the use of intuition of students and nurses during the gambling task.

Hypothesis 3c. Hypothesis 3c stated that there would be no difference in reported anxiety levels on the Iowa gambling task and the clinical scenario between the experienced nurses and students. A Mann-Whitney test was performed on the groups response to Question 1 (*I was anxious during the Iowa gambling task*) and Question 2 (*I was anxious during the computerized clinical scenario*) on the Anxiety/Intuition tool. There was no significant difference found between the two groups on either of the questions. Thus, Hypothesis 3c was accepted; there was no difference between nurses and nursing students on anxiety levels during the Iowa Gambling task and the clinical scenario.

Summary

In summary, although there is no significant difference between nursing students and nurses on total SCR generation on the Iowa Gambling Task, there is a significant difference between the groups on SCR generation and score during the complete clinical scenario leading to the acceptance of hypotheses 1a, 1c, 2a, and 2c. There was a significant difference between nurses and nursing students on precursory skin conductance response during the clinical scenarios which lead to the acceptance of Hypothesis 2b. However, there was also a significant difference between nurses and nursing students on the generation of precursory skin conductance response during the Iowa Gambling Task which lead to the rejection of Hypothesis 1b. Nurses and students agreed with the same level of anxiety and use of intuition on both the Iowa Gambling task and the clinical scenario leading to the acceptance of hypotheses 3c. Interestingly, the nurses agreed to a greater use of intuition during the IGT resulting in a rejection of Hypothesis 3b.

CHAPTER FIVE

DISCUSSION, CONCLUSION, RECOMMENDATIONS, AND SUMMARY

The final chapter provides a synopsis and discussion of the research results and conclusions drawn from these results in relation to the research questions. The relevance of findings to conceptual framework is explored as well as implications and recommendations for further scientific study.

Discussion of Research Questions

Research Question 1

Research Question 1 was "Do experienced nurses generate more total skin conductive responses than nursing students during a computerized clinical scenario?" It was found that the nurses did generate significantly more SCRs during the clinical scenario ($p < .05$). However, there was not a significant difference ($p > .05$) between the two groups during the Iowa Gambling Task. Skin conductance response is a measure of sympathetic activity (Critchley, 2002; Dawson et al., 2000), hence nurses had greater sympathetic activation than the nursing students during the clinical scenario and not during the Iowa gambling task.

Research Question 2

Research Question 2 was, "Do experienced nurses generate more precursory skin conductance responses than student nurses during a computerized clinical scenario?" It was found that the nurses did generate significantly more PSCRs during the clinical scenario ($p < .05$). However, there was also a significant difference ($p < .05$) between the two groups during the Iowa Gambling Task. Precursory skin conductance response is a measure of an individuals' ability to enact a somatic state required to aid in advantageous decision making (Bechara et al., 2000). Therefore, nurses had a greater ability to enact a somatic state to aid in the decision making process than the nursing students during both the clinical scenario and during the Iowa gambling task. While the nurses had statistically greater PSCRs during the gambling task, they did not have significantly greater total SCRs. The gambling task was administered to determine if there was a difference between the two groups in total SCR generation. Since PSCRs are a subset of SCRs, there was not significantly greater sympathetic activation between the two groups during the Iowa gambling task.

Research Question 3

Research Question 3 was, "Do experienced nurses perform better than nursing students on a computerized clinical scenario?" The research demonstrated that nurses did perform better as evidenced by achieving a significantly higher score ($p < .05$) than student nurses on the computerized clinical scenario. Nurses performed better than nursing students on a task in which they had greater experience, specifically nursing experience. However, the two groups performed the same on the gambling task in which neither group had greater experience. It was expected that experienced nurses would generate more SCRs than nursing students on the clinical scenario but not on the gambling task.

Research Question 4

Research Question 4 was, "Do experienced nurses report a greater use of intuition than nursing students on a computerized clinical scenario?" The research found that there was no significant difference ($p > .05$) between the two groups in reported agreement of the use of intuition during the clinical scenario. Interestingly, the nurses had a greater degree of agreement of intuition use on the Iowa Gambling Task that was found to be statistically significant ($p < .05$). They also produced significantly greater precursory SCRs than the nursing students on the gambling task, which would lend support to the validity of the self reported use of intuition. However, although it was expected that nurses would agree with a greater use of intuition during the clinical scenarios, they did not; but they did generate significantly greater SCRs than the nursing students, which quantitatively implies a greater use of intuition. This highlights the inherent problem with the use of self-report tools to report a potentially quantifiable phenomenon. The ability for one to recognize intuition is suspect. Did the students think they were intuitive during the clinical scenario because it is a socially desirable response? Perhaps the students knew that intuition was a goal during the clinical task and not the gambling task and wanted to be socially acceptable, thus agreeing to the use of intuition in the clinical task but not the gambling task.

Relevance of Findings to Conceptual Framework

Somatic Marker Hypothesis

The primary theoretical framework for this research study was the somatic marker hypothesis. The somatic marker hypothesis proposes that decision making is greatly affected by alterations in somatic emotion and feeling. Decision making is a process influenced by signals (Hinson et al., 2002) that arise from bioregulatory processes. These regulatory processes include those processes that can manifest themselves as somatic emotion and feeling. These influences can be conscious or nonconscious, and take place at multiple levels within the process of decision making (Bechara et al., 2000; Tranel & Damasio, 1994). The three main assumptions of the theory are as follows:

1. Human reasoning and decision making are dependent on many varying levels of neural activities both conscious and unconscious. The cognitive (conscious) operations are dependent on sensory input gained from interaction of early sensory neural cortices.

2. These cognitive activities (independent of their content) are dependent on support processes such as working memory, attention and emotion.

3. Reasoning and decision making are dependent on the availability of specific knowledge pertaining to the situation at hand, options for specific outcomes and actors. This knowledge is stored in implicit and nontopographically organized forms within the higher-order cortices.

It has been hypothesized that emotion, in the subconscious, provides a signal measured by skin conductance that may factor into the process of decision making (Bechara & Damasio, 2002). When subjects are faced with a situation that requires factual knowledge to be categorized, the appropriate links are activated in the higher order cortices, as well as the emotional apparatus, leading to the recall of the necessary information in order to make an appropriate decision. It is the combination of these actions that prompts the reconstruction of previously learned data, or in other words, pattern recognition.

Based on this theory, it was hypothesized that intuitive decision making in nursing results in part as a response to these biological signals. For the purpose of this study, intuitive decision making is defined as decisions that are influenced by pattern recognition based on experience as evidenced by the production of PSCRs. Thus, it can be inferred that the nurses and student nurses in this study used, at least in part, intuition in the process of making decisions as both groups generated PSCRs. It is also evident by the results of this study that nurses generated more total and precursory SCRs than nursing students on the computerized clinical scenario and also performed better. For that reason, it is evident that nurses, who have greater experience, were able to use intuition to their advantage more than the student nurses.

Cognitive Continuum

Hamm's cognitive continuum theory of judgment (CCT) provided the other theoretical framework that guided the overall design of this research (Hamm, 1988; Hammond, 2000). According to Hammond, "Various modes, or forms, of cognition can be ordered in relation to one another on a continuum that is identified by intuitive cognition at one pole and analytical cognition at the other" (p. 92). An important key feature of this theory is that the character of the task invokes a specific mode of cognition on the continuum. Hammond's modes are divided into six categories (as cited in Colbert et al., 2004). Tasks that are well structured tend to evoke an analytical mode of decision making while tasks that are ill structured lead to an intuitive mode (see Figure 1).

The character of both components of the clinical scenario were chosen based on Hamm's theory. CCT suggests that intuitive decision making is likely to result from scenarios that are loosely structured, pressed for time, and a have a high probability of manipulation. Both components were time sensitive (patient in real distress), loosely structured (many choices, no guidance given by researcher to subjects) and had a high probability of the subject changing the scenario or outcome by the decisions made. Thus, the computer-based clinical scenarios, according to this theory, invoked an intuitive mode of decision making.

Relevance of Findings to Discipline of Nursing

The presence of a bodily signal (SCR) found to occur statistically more in experienced nurses than student nurses during clinical decision making has wide implications. The significance of this study to the science of nursing is threefold: it provides quantifiable evidence of differences in sympathetic activity between nursing students and nurses during clinical decision making; it further validates existing and developing theories of intuition and clinical judgment in nursing (Agan, 1997; Benner & Tanner, 1987; Brooks, 1997; Rew, 2007, Standing, 2008); and it provides a manner in which to evaluate the effectiveness of pedagogies that attempt to teach intuition (Hogarth, 2001) or improve clinical decision making (Standing).

One of the most recognized constructs within nursing is found in Patricia Benner's *From Novice to Expert* (1984). Benner theorized that nurses develop a mode of intuitive decision making with experience. She also postulated that experienced nurses who use intuition make better decisions. Much of the nursing research on intuition relies on this theory to guide studies. The results of this study provide some quantitative validation of her premises. Experienced nurses made better decisions and also experienced a physiological phenomenon (SCR) at a statistically greater rate than that of nursing students.

Gobet and Chassey (2007) have attempted to provide an alternative to Benner's (1984) theory and provide some interesting ideas. The researchers attempted to establish an alternative framework to understanding intuition and propose that perception and conscious problem solving are closely related. This discussion paper includes exploration of the lack of awareness of physiological processes involved in intuitive decision making.

This research study provides physiological evidence of non-conscious processing taking place in decision making which needs to be included in future discussions on intuitive decision making in nursing.

According to Rew (2007), the majority of studies that look at intuition within nursing are of a descriptive, exploratory nature. Rew also stated that she found no physiological measure that attempted to correlate with self-reports of the use of nursing intuition in the literature. This study helps to fill that gap by providing a much needed alternate approach to the study of intuition. It explored the existence of intuitive decision making physiologically. Interestingly, this study found no significant difference between the reported use of intuition between nurses and students, which questions the strength of self-reported studies.

This research study also provides a potential avenue in which to objectively measure the effectiveness of interventions aimed at the development of intuition. Specifically, one could compare the effectiveness of experience (tacit learning) and explicit instruction on the development of SCRs. Simulation is just beginning to be viewed as necessary in nursing education. Several studies have reported simulation having a great impact on clinical decision making (Lasater, 2005; Starkweather & Kardong-Edgren, 2008; Wolf, 2008). Including the measurement of SCRs in future studies could enhance the argument for greater simulation use in nursing schools.

Hogarth (2001) provides a framework for the teaching of intuition. Although this philosophy is not specific to nursing, it provides some guidance for the development of intuition that can be applied to nursing. At the core of his premise is repetition. Nursing has long recognized that intuition specific to nursing is based on experience (Benner, 2004). Hogarth also took the view that intuition is domain specific; in other words, intuition is only helpful in areas that subjects have acquired great experience. Thus, educating intuition is accomplished by engineering the environment (simulation) to enhance specific experience. This research study supports this view as evidenced by a greater agreement of use of intuition by the nurses in the gambling task and a greater number of precursory SCRs in the gambling task without better performance. Although the nurses agreed with a greater use of intuition in the gambling task and had statistically more PSCRs, it did not help them perform better because they had no tacit knowledge.

Limitations of Study

One real limitation of this study is sample size. The goal was to compare 15 nurses and 15 nursing students, which according to a power analysis based on the pilot study would have yielded 88% power. However, due to poor responses to the IRB approved recruitment protocol, the small window of time for nursing student participation (length of time between end of clinical completion and graduation), and the significant results generated on subjects tested thus far, it was decided to end the study early. The use of power analysis is to derive an appropriate sample size for a future study. Post-hoc power analysis is sometimes utilized when researchers do not get significant results as an attempt to explain why they did not detect a significant difference between groups as opposed to the insignificance being related to a flaw in their theory. This study, although it had fewer subjects, still detected significant differences when theorized there would be differences. Therefore, the researcher has deliberately not performed post-hoc power analysis based on recommended statistical procedures (Goodman & Berlin, 1994; Lenth, 2001; Levine & Ensign, 2001).

The nature of documenting the timing of the decision making resulting in potential manipulation by the researcher is another limitation. Although this researcher pushed the event marker as close to when the actual decision was made by each subject, there was still a momentary delay that could have lead to an increased number of precursory SCRs being documented. However, to control for this, the study also looked at total number of SCRs which cannot be manipulated by the researcher. Lack of blinded data is another limitation. The researcher was aware of the hypothesis when interpreting the data which could lead to biased results. Although this was controlled for by using a formula to identify SCRS, the study could have been strengthened by having someone completely blind to the hypothesis interpret the data.

Another limitation of this study is external validity. This study looked at female nursing students from one nursing program in the southwest. Other nursing programs may incorporate different pedagogies or differing clinical hours resulting in an increase or decrease in use of intuition by nursing students. The results may also differ if males were included. However, the overall goal of this research study was to determine the ability to use SCR generation as a marker of intuitive decision making in nursing.

Using five years experience as a proxy for development of intuitive decision making in nursing is also a limitation. Although Patricia Benner (1984) labeled levels of nursing practice, she did not give an explicit time frame for the achievement of expert.

The tool used for the agreement of use of intuition and presence of anxiety is a also a limitation. It is a self reported attempt to gauge the subject’s perception of use of intuition. This tool has not been statistically validated.

Implications

SCR can be used to quantitatively measure sympathetic activity during decision making in nursing. This will allow for more quantitative analysis of the way in which nurses make decisions. This study also hints at which part of the brain is utilized in situations that generate skin conductance response.

This study also provides a tool that validates the use of the somatic marker hypothesis as well as the CCT as a theoretical base for further studies interested in intuitive decision making in nursing. The measurement of SCRs may also be important in further studies that are looking to decide which mode of decision making (analytical or intuitive) is superior.

Another implication of the results of this study is the ability to develop a cohesive theory of intuition. Through the combining of this research and other qualitative and quantitative research on the subject, researchers will be able to study the physiological component involved with intuitive decision making in nursing in conjunction with what is already known about this phenomenon.

Recommendations for Future Research

This research study needs to be replicated with a larger sample size in order to further validate the use of skin conductance as a marker of intuitive decision making in nursing. A larger sample size may also discover a linear relationship between number of SCRs and clinical performance that this study was not able to do. This in turn could allow for a comparison between analytical and intuitive decision making. Increasing sample size may also produce a significant number of outliers, providing an avenue in which to examine these outliers qualitatively. Increasing sample size could potentially provide answers for the following research questions:

1. Is there a linear relationship between SCR generation and score on a clinical task?
2. If or when is intuitive decision making superior to analytical decision making in nursing?
3. What differences exist between outliers and normal responders?

A second recommendation for further research is to compare SCR generation across time within a group of nurses. It would be very interesting to measure SCR generation of newly graduated nurses over a period of years. Measuring SCR generation over time could provide answers for the following research questions:

1. Does SCR generation increase over time?
2. Is there a linear relationship between years of nursing experience and SCR generation?

Another recommendation for future research lies within the realm of nursing education. It would be interesting to see if methods of teaching produce variations in skin conductance on nurses or students. In other words, can intuition be taught? If intuition is pattern recognition based on experience, nursing students need to have a plethora of clinical experiences. It would be interesting to measure SCRs and score on a clinical task among students who complete the minimum variety and number of required clinical hours and those students who complete an enhanced, and/or greater, number of clinical hours. Perhaps we need more clinical hours in nursing education.

Summary

Intuitive decision making in nursing has been studied almost exclusively using subjective descriptive studies that utilize written scenarios to gauge decision making. This has resulted in a good description of the phenomenon, but science has not yet studied ways to measure the presence or absence of intuitive decision making. Thus, the purpose of this study was to evaluate a physiological marker of nurses' intuitive decision making. Based on the Somatic Marker hypothesis (Bechara & Damasio, 2002), it was hypothesized that intuitive decision making in nursing results in part as a response to measurable biological signals. Fourth semester baccalaureate nursing students ($n = 11$) and Baccalaureate prepared nurses ($n = 10$) skin conductance was measured during a computerized clinical scenario and the Iowa Gambling Task.

It was found that the nurses generated significantly more SCRs during the clinical scenario ($p < .05$). However, there was not a significant difference ($p > .05$) between the two groups during the Iowa Gambling task. Skin conductance response is a measure of sympathetic activity (Critchley, 2002; Dawson et al., 2000), hence nurses had greater sympathetic activation than the nursing students during the clinical scenario and not during the Iowa gambling task.

For the purpose of this study, intuitive decision making was defined as decisions that are influenced by pattern recognition based on experience as evidenced by the production of PSCRs. Thus, it can be inferred that the nurses and student nurses in this study used, at least in part, intuition in the process of making decisions as both groups generated PSCRs. The results of this study also show that nurses generated more total and precursory SCRs than nursing students on the computerized clinical scenario and also performed better. For that reason, it is evident that nurses who have greater experience were able to use intuition to their advantage during the clinical scenario.

Based on the results of this study, it can be concluded that the nurses in this study enacted a somatic state as evidenced by a greater number of precursory and total SCR generation than the nursing students and achieved a significantly higher score on the clinical scenario. According to the Somatic Marker Hypothesis, the researcher's definition of intuition, and the results of this experiment, SCR generation shows promise as a marker of intuitive decision making in nursing.

Appendix A

Hinds Criteria for Definition

Hinds Criteria for Definition

Definition of ***emotion***	Essence is provided, not accidental attributes	Not circular: (does not contain subject to be defined)	Stated in positive terms	Not expressed in obscure or figurative language	Indicates the context of the construct	Reflects a continuum
Rolls, 2000a: …states elicited by rewards and punishments, including changes in rewards and punishments (p. 178)	+	+	–	+	+	+
Heilman & Gilmore, 1998: …one of the most pervasive aspects of 'humanness' (p. 2) ...emotional experiences can be transient (happy, sad, angry, frightened, surprised) or more enduring (p. 2)	–	+	+	–	–	–
Cacioppo & Gardner, 1999: …short label for a very broad category of experiential, behavioral, sociodevelopmental, and biological phenomena (p. 3)	–	+	+	–	–	–
Davidson & Smith, 1991: …are inextricably entwined with their expression (p. 317) …unlike most other psychological processes, are instantiated in both the brain and the body (p. 331)	–	+	+	+	+	–
Damasio, 1996: ...I see emotion as expressing itself most importantly, though not solely, through changes in the representation of body state… (p. 1414) ...I designate emotional changes under the umbrella 'somatic state' … by somatic, I refer to musculoskeletal, visceral, and internal milieu components of the soma… a somatic signal or process, although related to structures which represent the body and its state does not need to originate in the body in every instance (p. 1414)	–	–	+	– (obscure)	–	–

Appendix B

Select Electrodermal Activity Articles

Author	Focus	Study	Conclusions	Concerns
Amiez, Procyk, Honore, Sequeira, & Joseph, 2003	Application/ validation/ history	Measured skin conductance responses in primates in reward tasks *Animal Research*	Physiological processes indexed by the skin conductance responses correlated to anticipatory appetitive behavior. skin conductance responses do not reflect cognitive processes associated with recognition	Not generalized to humans
Bauer, 1998	Application-Physiologic measures in emotion research	History of electrodermal activity Vigouroux, 1888	Theories surrounding use of skin conductance responses in emotion research (as well as other feedback, importance of nature of stimulus in interpretation of skin con-ductance response response: skin conductance response directly correlated with sympathetic nervous system	Does not provide much info on debatable ideas and theories just provides facts: we decide.
Ben-Shakhar et al., 1982	Application-habituation responses to multidimensional sequences of stimuli	Card task-tested three different models	Habitation dependent on task not time	No definition of habituation
Ben-Shakhar & Elaad, 2003	Application-validation uses of skin conductance responses	Validity of the Guilty Knowledge Test (GKT with the electrodermal measure.	Electrodermal activity valid in detection of knowledge of guilt	Conducted in labs: inaccurate effect size estimate, treatment diffusion
Birchall & Claridge, 1979	Methodology/ Application-looked at effect differing levels of stimuli had on EEG and electrodermal activity	10 participants were subjected to differing light flashes, 4 tests	confusing	Does not take into account the indicial psycho state in augmenting or reducing.
Blakeslee, 1979	Application-changes in performance and vigilance in correlation with electrodermal activity	Subjects presented with irregularly presented visual signals and told to detect-skin conductance responses measured pre and post detection	Skin conductance responses higher pre and post detected signals	Viewed skin conductance responses as measure of attention—what about measure of pattern recognition
Bonnet & Naveteur, 2004	Application-looked at skin conductance response in patients with chronic pain and depression	electrodermal activity examined in two groups of chronic low back pain patients, one group also from depression.	electrodermal activity recorded in chronic pain patients be analyzed separately, non-depressed patients had increased electrodermal activity	Sample size, depression scales

Author	Focus	Study	Conclusions	Concerns
Brand & Jacquot, 2001	Applications-differences in olfactory responses as measured by electrodermal activity	"The aim of this study was to investigate variations in psychophysiological measurements (bilateral electrodermal recordings related to the quality of odors".	Predominance right hemisphere not depending on the type of odor,. Trigeminal nerve stimulation separate	Theory behind use of skin conductance response not explored enough-Generalizeability-tested on all right-handed individuals
Brand, Millot, Jacquot, Thomas, & Wetzel, 2004	Continuation of above study	Looked at difference in the right and left nostril and quality of odors and electrodermal activity	No differences between the two nostrils	Incorporated a lot of previous article
Burch & Greiner, 1960	Concurrent recordings of EEG and electrodermal activity	Measured after introduction of pharmacy agents	electrodermal activity coincides with increased alertness shown on EEG	Interpretation questionable, homogenous subjects
Campos et al., 1999	Application-relationship of qualitative descriptions of imagery and emotional components and skin conductance responses	Measured the skin conductance response elicited by word.	30% of variance in skin conductance response explained by imagery and subject-rated emotionality. Imagery alone explained 24% of variance.	Validity of tool used to measure subject and emotionality
Carrillo et al., 2001	Influences-explored the existence of gender differences in the CV and electrodermal activity between genders participa-ting in a public speaking task-qualitatively looked at anxiety and moods experienced	Recorded 10 data points for each variable-rest, prep, task, recovery	No sig dif between men and women in state anxiety, woman showed sig higher amplitude in task skin conductance response, baselines; no difference in frequency	Could difference be due to differences in vasoconstriction or hormones?
Catania et al., 1980	Influences-looked at sweat gland counts and skin conductance response and habituation	Correlated SGC and skin conductance response and SCL-In old and young, induced habituation with tones	SGC and SCL correlated in young: SGC and skin conductance response highly correlated in old, no age related differences in habituation or skin conductance response-+ difference in SCL	Different from other studies; hydration could have been a factor
Christie, 1981	Guide to nomenclature of electrodermal activity, psycho-pharmacology	Scant review of the literature	Interesting study presented on cholinergics. Good model!	Superficial-per author

Author	Focus	Study	Conclusions	Concerns
Christie & Venables, 1972	Looked at values found in palmar sites	Some differences between fingers and palms	Electrodes should be placed in same place on all subjects	Homogenous sample
Colbert et al., 2004	Applications- validate and characterize an electrodermal activity screening device using skin resistance	Tested Prognos device that was developed at university,	States established reliability of device	Repeatedly tested same area, tested SCL which is not recommended, reported measure-ment in unrecom-pensed way
Collet et al., 2005	Application-study drivers' performance on a critical avoidance situation used skin conductance re-sponse as measure of arousal	Recorded skin conductance response activity during a driving task	Those that avoided the crash had higher skin conductance responses	Skin conductance responses averaged every 30 seconds, no specific precursory activity noted
Cort et al., 1978	Methodology	Differences in amplitude and recovery time	Good overview of theory of relationship between amplitude and OR	Didn't control for variances from age, sex, stimuli etc
Crider et al., 2004	Methodology- stability, consistency	Looked at differences in skin conductance response lability between adult male twins; used SEM,	Several interesting concepts—1: a lack of shared environment influences on EDR –only environments unique to the individual are significant- phenotype if responsible	Generalizeability
Critchley, 2002	Application-theory what electrodermal activity represents	Looked at electrodermal activity and brain activity in patients with lesions—similar to Tranel et all	"electrodermal activity is a sensitive psychophysiological index of changes in autonomic sympathetic arousal that are integrated with emotional and cognitive states"	MRI used, nothing new here
Davidson & Smith, 1991	Application- hypothesized that caffeine raises arousal	Subjects given caffeine or placebo, white noise or no noise and two "Backwards Recall Tasks"	Caffeine increased arousal as measured by electrodermal activity, slowed habituation. Enhanced the effects of novel	Didn't explore elec-trodermal activity his-tory very much, weakened theoretical base
Dawson & Schell, 2002	Applications- hypothesizes that electrodermal activity can be a marker or predictor of poor outcomes	Reviews evidence that electrodermal activity dysfunctions may carry prognostic value	Abnormally high electrodermal activity is predictive of poor outcome; frequent (NS-skin conductance response is most often associated with poor outcomes in schizophrenic patients).	Good discussion on theoretical implications
Dawson et al., 2000	History/ Methodology	Overview of the ED system	Recommendations for methods, uses, physiological basis	Good resource list
Dormire & Carpenter, 2002	Methodology- Electrolyte medium	Compared functionality of three creams to Unibase *Research*	Velvachol effective replacement for unibase	None, excellent—brilliant article

Author	Focus	Study	Conclusions	Concerns
Edwards et al., 2004	Application-use of electrodermal activity in syncope	Monitored 70 syncopal patients including electrodermal activity	Electrodermal activity preceded any change in BP, PCO (2 or CBV and persisted past the hemodynamic recovery following syncope	EDA undetectable in 25% of patients-higher than norm-WHY
Eisdorfer et al., 1980	Eda of age and sex	Measured electrodermal activity at rest and during a Valsalva maneuver between sex and age groups	Young have lower SCL, higher skin conductance response: age and sex are interactive variables-need to control for	Homogenous group
Fedora & Schopf-locher, 1984	Application-relationship of area of brain and electrodermal activity	Looked at different areas of brain and skin conductance response activity	Nothing new found	
Fowles et al., 1981	Methodology Recommendations for electrodermal activity measurements	Accepted methodology for use of skin con-ductance response by consensus of experts	SC better than SP: SC recorded from palmer sites with silver-silver chloride: Electrode bias potentials and polarization should be recorded: Use constant 0.5 volt: Need to control tonic level when measuring amplitude.	GOLD
Fowles & Schneider, 1978	Methodology	Electrolyte medium effects on measure-ments of palmar skin potential		
Freixa i Baque, 1983	Application-use of electrodermal activity to determine sleep patterns	10 healthy male electrodermal activity were recorded during sleep	"reliability of electrodermal activity varies as a function of sleep stages for both frequency and amplitude parameters" paradoxical sleep appears to be the most reliable stage for both frequency and amplitude variables	Low sample size-question recording
Garwood et al., 1979	Influences-age and hydration	Young and old men-presoaked sites to hydrate skin	Largest amplitude occurs with the least hydration in young, no change in old, baseline differs with the least negative SCL occurring in the lease hydrated. Postulate that decrease in sweat glands may be responsible	Small sample size
Gomez-Amor et al., 1990	Application-looking at electrodermal activity in menstru-ating and non-menstruating females	Two experiments	Sig increase in skin con-ductance response amplitude in ovulation phase than other phases of cycle in test one,	Results varied between the two test—wide variation of results
Grey & Smith, 1984	Compared electrode gel		Avoid commercially prepared gels,	

Author	Focus	Study	Conclusions	Concerns
Hazlett, Dawson, Filion et al., 1997	Differences in glucose in schizo-phrenics-continuous per-formance task	Pilot study-looked at Difference between responder and non responder	Lower glucose and metabolic Rates in non responders	No control, pilot
Lachnit & Kimmel, 2000	Applications-Unique cues in pattern training	Students were shocked while looking at flashing lights Pavlovian style. Attempted to look at negative and positive patterns of learning *Research*	Positive and negative patterning resulted in equal acquisition, unique cue had no influence - skin conductance responses greater immediately, cue for upcoming shock.	Did not provide theo-retical basis for skin conductance re-sponse measure-ment as indicator of learned behavior
Lachnit et al., 2002	Application-are there general responses or outcome specific	Pavlovian skin conductance response experiment *Research*	Rules involved in solving patterning tasks are specific to outcomes and/or response systems; conditioning impaired when large amount of stimuli is used	No control for participants historical training similarities;
Lachnit & Lober, 2001	Application-associative learning	Pavlovian skin con-ductance response experiment *Research*	Participants used an unique cue to aid in positive and negative learning	Nonsignificance due to lack of power of stimulus
Lachnit et al., 2001	Application-Investigated interference ef-fects in positive and negative patterning discriminating		Without pre-experience "participants seem to utilize a specific numerosity-rule in positive patterning and a separate/together rule in negative patterning"	
Lewith, 2003	Application-looked at EDT for allergy identification	Electrically charged acupuncture points used to id allergies-overview of three studies done on EDT	No scientific basis for changes in EDT	
Lyken & Venables, 1971	Methodology-Standardization of skin conductance response measurement	Overview of EBP, quoted research	Recommend the use of skin conductance response not resistance, use micro-Siemens (us, average resting levels, amplitude most widely used measurement	
Magliero, Gatchel, & Lojewski, 1981	Influences-produce an OR after habitua-tionUsed log of scr measurements	Auditory tones introduced in a pattern with introduction of stimuli at various times	Skin conductance responses decrease to different stimuli following habituation, stimulus change does not always lead to OR	Good sample size
Mangina & Beuzeron-Mangina, 1996	Defining-Correlate specific areas of brain structures with electrodermal activity	Correlate areas of the brain to electrodermal activity using direct electrical stimulation *Research*	Ipsilateral limbic stimulation produces strong bilateral electrodermal activity: Cortical stimulation produced weak and bilaterally equal skin conductance responses	Small sample (5)

Author	Focus	Study	Conclusions	Concerns
Mitchell & Venables, 1980	Methodology-electrodermal activity and electrode size	Compared size .15-1cm electrodes and skin conductance response amplitudes *Research*	Skin conductance response amplitudes should be reported in terms of actual electrode size: large disk electrode not suitable for fingers: very small electrodes may respond disproportionately due to seepage (report bigger spikes : SCL higher on hypothenar eminence than thenar eminence	Small sample size (8,8,5): did not control for gender
Moller & Dijkster-huis, 2003	Application/ validation. Will different odors produce different skin conductance responses, olfac-tory primarily con-trolled by right hemisphere,	Looked at skin con-ductance response response to pleasant and unpleasant odors-looking to see if skin conductance response response is contra laterally governed	Data consistent with ipsilateral system of control; responses larger significantly on right hands, humans produce an skin conductance response in relation to an odor, but type of odor not sign.	Low sample size, generalization
Naveteur et al., 2005	Methodology/ influences	Measured first response 1-3 sec post stimuli,	Mild to moderate anxiety may increase mastery of situations; electrodermal activity reactivity may be lower in self-reported highly anxious humans vs low anxious. Emotional distractors caused scrs to be even lower in high anxious patients.	Unsure whether tool used to classify as high or low anxious is valid
Neumann & Blanton, 1970	Historical Research	Origins and development	Synopsis of early studies, beliefs, apparatus	Excellent resource
O'Connell et al., 2004	Application-attempting to predict response error by skin conductance response in ADHD	Compared 15 ADHD and control children in a sustained attention task while measuring skin conductance responses	ADHD participant had lower skin conductance response and higher error rate; however, error awareness comparable, sustained attention errors were predicted by skin conductance responses	Generalize low sample size-good report of use of skin conductance response-detailed
O'Keeffe, Dockree, & Robertson 2004	Application-looked at impaired error awareness in TBI	Looked at TBI and Controls in a go-no go task, SART Sustained attention to response task	Baselines were same for TBI and control, mean skin conductance response response to errors was lower in TBI, response to correct choices were not sig different	Area of brain injured not controlled for
Schaefer & Boucsein, 2000	Methodology-phase angle-constant current vs constant voltage	20-trial habituation series RESEARCH	Use of alternating current prevents skin and electrode polarization. Using phase angle as measurement equalized the use of CV and CC.	Reliability and validity not established

Author	Focus	Study	Conclusions	Concerns
Schulter & Papousek, 1992	Methodology-Reliability of electrodermal activity	Explore short and long term stability of individual responses patterns in electrodermal activity *Research*	Stability of skin conductance response is reliable: laterality interpretation is iffy: no report of age affects on frequency but sig correlate for age and amplitudes (old = lower) Men have higher freq of skin conductance responses but no sign amplitude differences	EDA not measured during task, electro-dermal activity measurements were in a relaxed, stimulus free environment
Tranel & Damasio, 1994	Defining-Correlate specific areas of brain structures with electrodermal activity	Study electrodermal activity of participants with lesions to specific regions of the cerebral hemispheres *Research*	R and L ventromedial frontal, R inferior parietal region, and R an L anterior cingulate gyres associated with decreased electrodermal activity	Amygdala not tested

Appendix C

Institutional Review Board Approval - UTHSCSA

The University of Texas
Health Science Center at San Antonio
Mail Code 7830
7703 Floyd Curl Drive
San Antonio, Texas 78229-3900

Institutional Review Board
IORG0000312
Federalwide Assurance #FWA00005928

(210) 567-2351
FAX: (210) 567-2360

March 14, 2008

TO: Leslie K. Payne, MSN, RN, ACNP
Acute Nursing Rm 2.210
UTHSCSA

FROM: Institutional Review Board

SUBJECT: **FINAL EXPEDITED IRB APPROVAL**

IRB Protocol #HSC20080250H
The use of skin conductance as a marker of intuitive decision making in nursing

IRB Approval Date: March 14, 2008
Next IRB review: February 1, 2009
IRB Expiration Date: March 14, 2009

This minimal risk protocol was approved, including 1 consent form and 2 recruitment fliers, for Expedited Review under the following DHHS Regulation:

> **45CFR46.110(b)(1) Category 4:** Collection of data through non invasive procedures routinely employed in clinical practice, excluding procedures involving x-rays or microwaves.

It was determined that this study will pose minimal risk to subjects participating and that continuing review will occur annually.

Rhonda Barnard, MS, Expedited Reviewer

Study Sites: (UTHSCSA)
Please retain this document in your IRB correspondence file

Consent to be part of a Research Study
Title of Study: The Use of Skin Conductance as a Marker of Intuitive Decision Making in Nursing

The University of Texas Health Science Center at San Antonio (UTHSCSA)
Institutional Review Board (IRB)
To be conducted at
University of Texas Health Science Center at San Antonio
School of Nursing

Information about this form

You may be eligible to take part in a research study. This form gives you important information about the study. You will be asked to sign in more than one place in this document. Please take time to review this information carefully. You should talk to the researchers about the study and ask them any questions you have. You may also wish to talk to others (for example, your friends, family, or a doctor) about your participation in this study. If you decide to take part in the study, you will be asked to sign this form. Before you sign this form, be sure you understand what the study is about, including the risks and possible benefits to you.

Please tell the researchers or study staff if you are taking part in another research study.

Taking part in this study is completely voluntary. You do not have to participate if you don't want to. You do not have to participate in this study in order to get standard medical treatment. You may also leave the study at any time. If you leave the study before it is finished, there will be no penalty to you, and you will not lose any benefits to which you are entitled.

General Information – "Who is conducting this research?"

Principal Investigator
The Principal Investigator (PI) is the researcher directing this study; the PI is responsible for protecting your rights, safety and welfare as a participant in the research. The PI for this study is Leslie K. Payne, RN MSN ACNP-BC, Clinical Instructor, Acute Nursing Department, UTHSCSA.

The Co-Principal Investigator for this study is – Dr. Sharon Simms RN PhD. Chair, Department of Family Health, Indiana University. Dr. Simms is the faculty advisor for the PI, and will only assist with the results of the research and writing the final paper. She will not have access to any of your information which could identify you.

Purpose of this study – "Why is this study being done?"

You are asked to participate in this research study of skin conductance responses in nurses. We are asking you to take part in this study because you are a baccalaureate nursing student or a baccalaureate prepared nurse.

The researchers hope to learn if there is any connection between knowing the correct action without thinking about it (intuitive decision making) and sweating which is caused by your thoughts (electrical conduction).

Consent to be part of a Research Study
Title of Study: The Use of Skin Conductance as a Marker of Intuitive Decision Making in Nursing

Information about Study Participants – "Who is participating in this research?"

Who can take part in this study? You are being asked to be a participant in this study because you are a baccalaureate nursing student or a baccalaureate prepared

How many people are expected to take part in this study?
This study will enroll approximately 30 study participants.

Information about Study Procedures – "What will be done if you decide to be in the research?"

If you decide to take part, you will be asked to sign this consent form, and you will:
1. Participate in a computerized mock gambling task (Iowa Gambling Task or IGT). This computerized task is like a video game. The objective is to choose cards on the computer with the hope that you will finish with the most amount of mock money at the end of the task as possible. This entails choosing a card from four decks with the intent of not losing money. During this time, you will have your skin conductance responses (SCR) measured using a sensor placed on one of your fingers.

2. Participate in two mock clinical scenarios using a computerized clinical scenario (choosing nursing interventions based on a scenario given to you via a computer) while having your skin conductance responses (SCR) are measured using a sensor placed on one of your fingers.

While you are taking part in this study, you will be asked to attend 1 visit with the researchers or study staff. Your participation in the study will take about thirty minutes.

Study Procedures - as a participant, you will undergo the following procedures:

1. You will arrive at the PIs office in the school of nursing at the preset time and be oriented to the SCR device and computer until you feel comfortable.
2. You will be placed in a comfortable chair.
3. The Waverider© monitor and what it does will be explained to you.
4. A finger probe from the monitor will be attached to your middle finger on the left hand.
5. You will be allowed to relax without any stimulation for two minutes while recording SCR activity in order to establish baseline levels of electrodermal activity.
6. You will begin the computerized Iowa gambling task (IGT).
7. The PI will push the recorder button each time you press a key on the computer.
8. Following completion of the IGT, you will sit for two minutes to re-establish your skin conductance response (SCR) baseline.
9. You will begin the computer based clinical scenario.
10. Upon completion you will be given your Target gift card.

Consent to be part of a Research Study
Title of Study: The Use of Skin Conductance as a Marker of Intuitive Decision Making in Nursing

Risks – "What are the risks of participation in the research?"

Risks from the research
While participating in the study, the risks of completing the tasks are being uncomfortable making a decision or the possible loss of confidentiality.

Are there Risks related to withdrawing from the study?
If you decide to withdraw from this study early, please discuss your decision with the principal investigator.

Are there risks if I also participate in other research studies?
Being in more than one research study at the same time, or even at different times, may increase the risk to you. It may also affect the results of the studies. You should not take part in more than one study without approval from the researchers involved in each study.

What if a research-related injury occurs?
There are no known risks of injury associated with this study.
If you are injured as a result of the research procedures, your injury will be treated. You will be responsible for any charges. We have no plans to give you money if you are injured.

If you sign this form, you do not give up your right to seek additional compensation if you are harmed as a result of being in this study.

Benefits – "How could I or others benefit if I take part in this study?"

You may not receive any personal benefits from being in this study.

Alternatives – "What other options are there to participation in this study?"

Not participating in this research is an option. The researcher will discuss all of your options with you.

Compensation – Will there be any compensation for participation?

You will be given a $10 gift card to Target.

Costs – Will taking part in this study cost me anything?

You will not have to pay any money to take part in this study.

Contact Information – Who can I contact if I have questions or concerns?

If you have questions now, feel free to ask us. If you have additional questions later or you wish to report a problem which may be related to this study please contact:

Primary contact:
Leslie K. Payne MSN RN ACNP-BC can be reached at 210-567-0941.

If primary contact cannot be reached at the number above, contact
Leslie K. Payne via her cell phone at (210)838-3847 or e-mail at Paynel2@uthscsa.edu

Consent to be part of a Research Study
Title of Study: The Use of Skin Conductance as a Marker of Intuitive Decision Making in Nursing

The University of Texas Health Science Center committee that reviews research on human subjects (Institutional Review Board) will answer any questions about your rights as a research subject. You can contact the IRB by calling 210-567-2351, or by mail to IRB, UTHSCSA, Mail Code 7830, 7703 Floyd Curl Drive, San Antonio, TX 78229-3900.

Research Consent Signature Section

If you agree to participate in this research sign this section. You will be given a signed copy of this form to keep. You do not waive any of your legal rights by signing this form.
SIGN THIS FORM ONLY IF ALL OF THE FOLLOWING ARE TRUE:

- You have voluntarily decided to take part in this research study.
- You have read the above information.
  Your questions have been answered to your satisfaction and you believe you understand all of the information given about this study.

Printed Name of Subject	Signature of Subject	Date	Time
Printed Name of Witness	Signature of Witness	Date	Time
Printed Name and Title of Person Obtaining Consent	Signature of Person Obtaining Consent	Date	Time

INSTITUTIONAL REVIEW BOARD
MAR 14 2008
Date Approved by IRB
UTHSCSA

Form D - UTHSCSA Consent(RB2) (2) (2).doc

Attention Baccalaureate Prepared Nurses

A study is being done involving intuitive decision making. The study is taking place in the school of nursing. It will take approximately 30 minutes to complete and you will receive a $10 gift card to Target. If you are a female baccalaureate prepared nurse with 5 years of nursing experience you may be able to participate.

If interested please contact Leslie Payne at Paynel2@uthscsa.edu or 567-0941

INSTITUTIONAL REVIEW BOARD
MAR 1 4 2008
Date Approved by IRB
UTHSCSA

Attention Fourth semester nursing students

A study is being done involving intuitive decision making. The study is taking place in the school of nursing. It will take approximately 30 minutes to complete and you will receive a $10 gift card to Target. If you are female *and a 4th semester* baccalaureate nursing student, you may be able to participate.

If interested please contact Leslie Payne at Paynel2@uthscsa.edu or 567-0941

INSTITUTIONAL REVIEW BOARD
MAR 14 2008
Date Approved by IRB
UTHSCSA

MAR 18 2008

HUMAN USE
AMENDMENT REQUEST

Study Title: The Use of Skin Conductance as a Marker of Intuitive Decision Making in Nursing	

UTHSCSA Amendment Identification Section

1. **IRB #:** HSC20080250H
2. **Date UTHSCSA Amendment Request Form Completed:** March 18, 2008
3. **(If applicable) Sponsor Amendment Number:** **and date:**

4. Current Principal Investigator					
Principal Investigator (First name, Last name)	Leslie Payne				
Dept/Division	Acute Care Department School of Nursing				
Salutation/Degree (e.g., MD, PhD, RN)	MSN RN				
Work Phone/Pager/Fax	Phone: 567-0941	Pager: 838-3847		Fax: 481-7611	
E-mail (if other than UT Outlook)					
Does the address to which all correspondence is sent for this study need to change?	☑	No	☐	Yes. If yes, add correction to the table with title "Other Changes"	

5. Which Type of Review is Requested?	
☑	**Expedited** review for minor, non-substantive changes to the study.
☐	Review by the **convened IRB** for substantive changes to the study.

6. Changes in Response to UPIRSO (Unanticipated Problem Involving Risk to Subjects or Others)
Are any of the changes proposed in this amendment in response to a UPIRSO?

☑	**No.**						
☐	**Yes.** (When completing the detailed description in item 9 - clarify which changes are related to the UPIRSO)						
	If Yes, provide a brief description of the UPIRSO **here→**						
	If Yes, was a UPRISO report previously submitted?	☐	Yes	☐	No	☐	Included with amendment
	If Yes, has the UPRISO issue been resolved?	☐	Yes	☐	No		
	If No, provide a explanation **here→**						

1 of 2

For IRB Office Use Only
For Expedited Review Use Only:
If Eligible for Expedited Review, sign below.

Signature
Name of Reviewer:
Joseph Schmelz, Ph.D., R.N., C.I.P.
Director, Institutional Review Board

UTHSCSA IRB Approval Stamp

INSTITUTIONAL REVIEW BOARD
04/09/08
UTHSCSA

Human_Amendment_Form.doc

Appendix D

Institutional Review Board Approval - Indiana University

INTERDEPARTMENTAL COMMUNICATION
Research Compliance Administration (RCA)
Indiana University - Purdue University Indianapolis

DATE: February 18, 2008

TO: Sharon L. Sims
Family Health
NU 318
IUPUI

FROM: Michele Garvin
Research Compliance Administration

SUBJECT: Final Approval

Study Number: 0801-61B
Study Title: The Use of Skin Conductive Responses as a Marker of Intuitive Decision Making in Nursing - Sponsor: N/A

The study listed above has received final approval from the Institutional Review Board (IRB-01) under Expedited Categories 4 and 7. Please note that subjects must be provided with and sign a current informed consent document containing the IRB approval stamp.

Special requirements for the inclusion of prisoners: Please note that unless your study has received approval for the inclusion of prisoners, you may not enroll and/or otherwise involve a prisoner in your study. Special requirements apply if an individual enrolled on the study either is a prisoner or has become a prisoner during the course of his/her study participation (and the study has not been previously granted approval for the enrollment of prisoners as a subject population). If the investigator becomes aware that a subject is a prisoner, all research interactions and interventions with the prisoner-participant must cease. If the investigator wishes to have the prisoner-participant continue to participate in the research, Research Compliance Administration (RCA) must be notified immediately (317-274-8289). In most cases, the IRB will be required to re-review the protocol at a convened meeting before any further research interaction or intervention may continue with the prisoner-participant. Refer to the IUPUI/Clarian Standard Operating Procedure (SOP) on *Involving Prisoners in Research* for further information. The SOP can be found at http://www.iupui.edu/~respoly/human-sop/human-sop-index.htm.

As the principal investigator of this study, you assume the responsibilities as outlined in the SOP on *Responsibilities of Principal Investigators*, some of which include (but are not limited to):

1. **CONTINUING REVIEW** - No less than annually, a status report must be filed with the IRB. The RCA staff will generate these reports for your completion. This study is approved from **February 13, 2008** to **February 13, 2009**. **If your study is not re-approved by this date, the study will automatically expire, which means that all research activities, including enrollment of new subjects, interaction and intervention with current participants, and analysis of identified data, must cease.**

2. **STUDY AMENDMENTS** - You are required to receive prospective approval from the IRB for ANY changes to the research study, including changes to protocol design, dosages, timing or type of test performed, population of the study, and informed consent statement, prior to implementation. This request is made via an amendment form, which can be obtained at: http://www.iupui.edu/%7Eresgrad/spon/download2.htm.

3. **UNANTICIPATED PROBLEMS INVOLVING RISKS TO SUBJECTS OR OTHERS AND NONCOMPLIANCE** - You must promptly report to the IRB any event that appears on the **List of Events that Require Prompt Reporting to the IRB.** Refer to the SOP on *Unanticipated Problems Involving Risks to Subjects or Others and Noncompliance* for more information and other reporting requirements. The SOP can be found at: http://www.iupui.edu/~respoly/human-sop/human-sop-index.htm. NOTE: If the study involves gene therapy and an event occurs which requires prompt reporting to the IRB, it must also be reported to the Institutional Biosafety Committee (IBC).

4. **UPDATED INVESTIGATIONAL BROCHURES, PROGRESS REPORTS and FINAL REPORTS** - If this is an investigational drug or device study, updated clinical investigational brochures must be submitted as they occur. These are submitted with an amendment form. Progress or final reports must be provided to the IRB with your written assessment of the report, briefly summarizing any changes and their significance to the study.

5. **ADVERTISEMENTS** – You can only use IRB-approved advertisements to recruit participants for your study. If you will be advertising to recruit study participants and the advertisement was not submitted to the IRB at the time your study was reviewed and approved, a copy of the information contained in the advertisement and the mode of its communication must be submitted to the IRB as an amendment to the study. These advertisements must be reviewed and approved by the IRB PRIOR to their use.

6. **STUDY COMPLETION** – You are responsible for promptly notifying the IRB when the study has been completed (i.e. there is no further subject enrollment, not further interaction or intervention with current participants, including follow-up, and no .further analysis of identified data). To notify the IRB of study completion, please obtain a close-out form at http://www.iupui.edu/%7Eresgrad/spon/irb_submit.htm and submit it to the RCA office.

7. **LEAVING THE INSTITUTION** - If the principal investigator leaves the Institution, the IRB must be notified as to the disposition of EACH study.

PLEASE REFER TO THE ASSIGNED STUDY NUMBER AND THE EXACT TITLE IN ANY FUTURE CORRESPONDENCE WITH OUR OFFICE. In addition, SOPs exist which cover a variety of topics that may be relevant to the conduct of your research. See link http://www.iupui.edu/~respoly/human-sop/human-sop-index.htm. All documentation related to this study must be neatly typed and must also be maintained in your files for audit purposes for at least three years after closure of the research; however, please note that research studies subject to HIPAA may have different requirements regarding file storage after closure. If you have any questions, please call Research Compliance Administration at 317/274-8289.

Enclosures:
- ☒ Documentation of Review and Approval
- ☐ Authorization Form(s)
- ☒ Informed Consent Statement(s)
- ☒ Advertisement(s)
- ☐ Assent(s)
- ☐ Other:

IUPUI/CLAR... INSTITUTIONAL REVIEW BOARD (...) REVIEW

STUDY AMENDMENT

****** FOR OFFICE USE ONLY ******
☐IRB-01; ☐IRB-02; ☐IRB-03; ☐IRB-04; ☐IRB-05

IRB STUDY NUMBER: 0801-61B
AMENDMENT NUMBER: 1

SECTION I: INVESTIGATOR INFORMATION

Principal Investigator: Sharon Sims **Department:** Family Health
(Last, First, Middle Initial)

Building/Room No.: NU 318 Phone: 374-4300 E-Mail: ssims@iupui.edu

Contact Information:

Name: Leslie Payne Address: 48 Champions Run Phone: 210-481-2617

Fax: 210-481-7611 E-Mail: Paynel2@uthscsa.edu

Project Title: **The use of skin conductance as a marker of intuitive decision making in nursing**

Sponsor/Funding Agency:________ Sponsor Amendment No.________

SECTION II: AMENDMENT DESCRIPTION

This form must be typed and submitted via http://www.iupui.edu/%7Eresgrad/spon/irb_submit.htm for submission to IUPUI IRBs or to the Methodist IRB Office at Methodist Hospital, Academic Affairs, 1630 N. Capitol, B Building, Room 349 for submission to the Methodist IRB. Note: To check a box on this form, double-click the box and select "Checked" under "Default Value."

1. Provide a complete description of the proposed change(s) included in this amendment:
   Subject will be asked to respond to four statements upon completion of the study.

   \# Looks okay
   TB 3/20/08

2. State the justification/rationale for this amendment: ?
   This will help to identify if experienced report the use of intuition during the study. Will help to strengthen the study.

Please circle your response to the following statements.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I was anxious prior to the Iowa gambling task.	1	2	3	4	5
I was anxious prior to the Clinical scenario	1	2	3	4	5
I used intuition during the clinical scenario.	1	2	3	4	5
I used intuition during the Iowa Gambling task	1	2	3	4	5

3. Is the study sponsored?
   ☒ No.
   ☐ Yes. Check the appropriate line below and provide with this amendment, as applicable:
   - ☐ a copy of the sponsor's amendment, if the amendment came from the sponsor.
   - ☐ a copy of your notice to the sponsor of this change, if you initiated the amendment.
   - ☐ a copy of the approved amendment will be sent to the sponsor.

4. Do the proposed change(s) described in this amendment alter the risk to benefit assessment?
   ☒ No.
   ☐ Yes. Please describe how the assessment is altered:

5. Do the proposed change(s) described in this amendment affect any of the following documents?

V03/01/08

☐ Summary Safeguard Statement ☐ Authorization
☐ Advertisement ☐ Protocol
☐ Clinical Investigator's Brochure (CIB) ☐ Other. Please describe:

NOTE: Any document selected above must be included with the submission of the amendment.

6. Do the proposed change(s) described in this amendment require changes to the informed consent and/or assent document(s) or process?
   - ☐ No. Informed consent, written documentation of informed consent, and/or assent has been waived for this study.
   - ☒ No. Skip to item 6 below.
   - ☐ Yes. Answer items A. and B. below.

   A. Check the appropriate line below.
      - ☐ The new informed consent and/or assent document(s) are in addition to the current one(s).
      - ☐ The new informed consent and/or assent document(s) replace the current one(s).

      If there are multiple consent and/or documents for this study, please indicate which consent and/or assent document(s) are to be replaced.

   B. Will enrolled subjects be informed of the change(s) described in this amendment?
      - ☐ No. Please explain why not:
      - ☒ Yes. Will enrolled subjects be re-consented and/or re-assented?
        - ☐ Yes.
        - ☒ No. Please explain how enrolled subjects will be notified:

7. Amendment includes:
   - ☐ Informed Consent and/or Assent, dated:
   - ☐ Summary Safeguard Statement, dated:
   - ☐ Sponsor's Amendment, dated:
   - ☐ Clinical Investigator's Brochure, dated:
   - ☒ Other, dated:
   - ☐ Authorization, dated:
   - ☐ Protocol, dated:
   - ☐ Notice to Sponsor, dated:
   - ☐ Advertisement, dated:

NOTE: Only include documents that were checked in items 5 and 6 above (as being changed because of the amendment).

Note: listing document dates are optional and only necessary if required by the investigator or sponsor.

NOTE TO INVESTIGATORS: Study amendments *may not* be instituted until approval from the IRB is given.

Please indicate the type of amendment you are submitting. See Guidelines for Determining an Amendment Type for additional information (http://www.iupui.edu/~resgrad/spon/amend-guide.htm). **Please note, however, that the IRB makes the final determination with regard to whether or not the amendment is acceptable for expedited review or if it requires review at a convened IRB meeting.**

x☒ **Minor Amendment.** Change(s) do not significantly affect the safety of subjects and is acceptable for expedited review per 45 CFR 46.110(b)(2)/21 CFR 56.110(b)(2).

☐ **Major Amendment.** Changes potentially involve increased risks or discomforts or decrease potential benefit. The amendment requires review at a convened IRB meeting.

E-MAILED MAR 18 2008

Signature of Investigator: Leslie K. Payne________________ Date: 3/18/2008

SECTION III: IRB APPROVAL

This amendment, including documentation noted in item 7 above, has been reviewed and approved as meeting the criteria for IRB approval as outlined in 45 CFR 46.111(a) by the IUPUI/Clarian IRB. I agree with the investigator's assessment above regarding whether the amendment is a minor or major amendment unless otherwise noted.

Authorized IRB Signature:________________ IRB Approval Date: 3-26-08

Recorded in the Minutes of: May 2, 2008

Recorded in the Minutes of: ____________

2

v03/01/08

Appendix E

Recruitment Flyers

Attention Fourth semester nursing students

A study is being done involved with intuitive decision making. The study is taking place in the school of nursing. It will take approximately 30 minutes to complete and you will receive a $10 gift card to Target. If you are a female 4th semester baccalaureate nursing student you may be able to participate.

If interested please contact Leslie Payne at Paynel2@uthscsa.edu or 567-0941

IRB APPROVED

February 13, 2008

Attention Baccalaureate Prepared Nurses

A study is being done involved with intuitive decision making. The study is taking place in the school of nursing. It will take approximately 30 minutes to complete and you will receive a $10 gift card to Target. If you are a female baccalaureate prepared nurse with 5 years of nursing experience you may be able to participate.

If interested please contact Leslie Payne at Paynel2@uthscsa.edu or 567-0941

IRB APPROVED

February 13, 2008

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