

The Shared Affective Experience: Understanding Induced Affect and Affect Contagion
in Military Advanced Practice Nursing Students through Social Network Analysis

By

Patricia M. Schmidt

Dissertation submitted to the Faculty of the Daniel K. Inouye
Graduate School of Nursing Uniformed Services University of the Health Sciences
In partial fulfillment of the requirements for the degree of
Doctor of Philosophy 2015

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ABSTRACT

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Patricia Schmidt, M.S., 2010

Dissertation directed by Christine Kasper, Professor, Graduate School of Nursing

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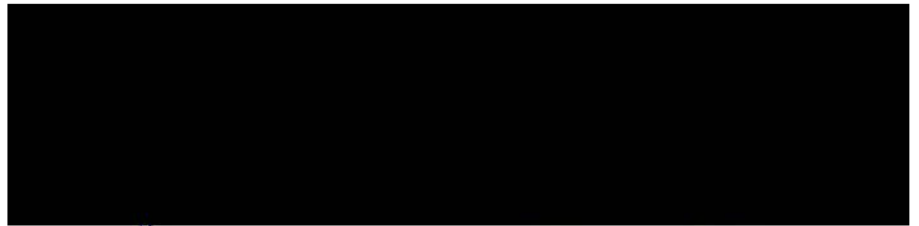
There were 35 participants from a network of 60 students. Social network surveys established relationships among the participants. Student's affect was surveyed twice daily 14 times during the semester to measure changes in affect. Affect expressivity and susceptibility to the affect of others was measured. An affect influencing stimulus determined primary and secondary effects of exposure and correlations with the occurrence of affect contagion.

There were three findings of interest for specific aim 1, affect contagion on four data collection days, stimulus exposure on three data collection days changed the affect of exposed participants, and expressivity is correlated with trait and state affect. There were three findings for specific aim 2. Affect scores differed for stimulus exposure groups at 5 timepoints, there was a negative secondary affective effect for one timepoint, and affect evolved over time.

The Patient Caring Touch model for inpatient nursing care peer feedback component could integrate a model for self-evaluation that assesses nursing unit affect and allows nurses to evaluate themselves as a team. The model could reveal situations where affect scores are strong and facilitate healthy work environments or identify circumstances or personnel that need support. Applying an affective model will facilitate self-awareness and may improve the affective work environment leading to improved patient care.

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Chapter 1: Background and Significance

INTRODUCTION

Hospitals spend thousands of dollars each year to hire and train new staff (47, 106, 121, 143, 205, 208, 234). Because healthcare workers spend a significant percentage of time at work, including weekends and holidays (261), heavy workloads and long hours, burn out, and turnover are a concern; workplace affect (mood or emotions) can be of critical importance (20, 66, 244, 261). Affect is the ability to experience moods or emotions and includes the capability to associate meaning with environmental stimuli (150, 256). Others around an individual can influence the individual's affect while at work and the concept of “affect contagion,” the transfer of affect between individuals, is well documented. This transmission of positive and negative affect has been studied extensively in healthcare (30, 35, 65, 69, 72, 88, 136, 178, 183, 189, 191, 199, 231, 238, 241, 265, 272). In a health care setting, positive affect transmission improves communication between coworkers and patient outcomes (122, 206, 267), while negative affect increases work stress, burnout, turnover, and adverse patient events (30, 35, 49, 69, 70, 135, 136, 183, 189, 191, 233). A recent study demonstrated the impact of negative affect transmission and resulting negative work environment at a U.S. military hospital in the form of horizontal violence or coworker bullying, which included behaviors like verbal abuse, nurse-nurse aggression, and incivility (2). Whereas this study occurred in only one facility, a problem with employees’ sharing their negative affect through horizontal violence exists. A better understanding of the impact affect has on nurses may lead to improved methods to reduce horizontal violence and similar phenomena in the nursing workplace.

The purpose of this study was to observe the evolution of affect contagion within a cohort of advanced practice nursing (APN) students at the Daniel K. Inouye Graduate School of Nursing, Uniformed Services University of Health Sciences (USU) through exposure to affect influencing stimuli (see Ch. 3 Methods) using social network analysis (SNA) and computational modeling methods.

ORGANIZATION OF CHAPTERS

Chapter 1 provides the conceptualization and rationale for developing a computational model of affect contagion. The significance of the study, problem statement, the purpose of the study, theoretical paradigm and model, specific aims and research questions, and possible study limitations and assumptions were presented. In Chapter 2 the existing scientific literature regarding the use of SNA and computational modeling is reviewed. Presented in Chapter 3, are the methodology undertaken and procedures for data collection and analysis. Chapter 4 presents the results of data analysis, answering the presented research questions, and Chapter 5 discusses the implications of the results and future research directions.

BACKGROUND AND SIGNIFICANCE

Affect contagion research in healthcare has occurred on the dyadic (between individuals) level or as a single time point assessment of the social network (26, 222, 238, 259). These studies establish the presence of a collective affect but do not account for the dynamic capabilities of affect to evolve and change over time. Through the use of theoretical frameworks, empirical observations can be integrated to create a computational model simulating affect contagion and measuring the direct effects of a shared affective experience (34, 54, 104, 142, 176, 242). Informing an agent based model (ABM) through social network analysis (SNA) provides a method for visualizing relationships and their significance. Agent based modeling, a

form of computational modeling that derives generalized parameters to describe the occurrence of a phenomenon, can be intentionally manipulated with various conditions to forecast potential outcomes applicable to the real world (85). Social network analysis (SNA) is a form of nonlinear statistics that identifies and describe important individuals, relationships among individuals, channels of affect flow, the dynamics behind positive and negative self-reinforcement, and the impact of various network topologies on the effectiveness of affect-oriented experiences (7, 266). SNA acts as a conduit to visualize and understand affect contagion as an environmental phenomenon. To date, research integrating computational modeling to study affect contagion has occurred in controlled settings, but not as a model with an application of stimuli in a work environment (14, 104, 180, 263, 273). Such modeling could become an integrated decision making tool used to improve work environments based upon the particular needs of the particular setting. Healthcare organizations could use this information to make simple changes to the workplace as a means to improve the affect of employees, patients, and families. For example, a simple candy dish or flowers on the desk have demonstrated positive influences on affect (20, 86, 150).

Affect can influence employee turnover, absenteeism, decision making abilities, productivity, and safety (39, 51, 83, 181, 234, 235, 244, 250). Although everyone has trait characteristics that are a part of our daily affect, in general, affect is not a static state. Individual experiences, interactions with others, and parameters of the environment influence workplace affect (150), including company policies and physical working conditions. When an employee's affect changes because of the influences of others or the environment, it is considered to be a contagion effect (90, 150, 246, 258, 259). Observations of affect contagion have been documented for at least the last 100 years but have only been systematically studied in natural

environments since the 1970s (115, 162). Affect contagion research is challenging because of the spontaneity of affect contagion's occurrence in natural conditions (115). Affect contagion has been reproduced numerous times in controlled academic settings (115, 116, 225) and observed in the work environment (50, 150, 246, 258, 259). Workplace affect contagion studies have confirmed its existence but scientists have not systematically observed the contagion over time to understand the emergence of affect contagion as an evolutionary process. Emergence is the ability to produce new, unexpected patterns, structures, or processes within an environment through self-organization (172).

In the nursing workplace affect contagion was studied at a single time point, related to a specific population, and related to a particular work related metric (76, 84, 130, 165, 182, 186, 210, 238, 287). Affect contagion was also studied as vicarious traumatization, the process in which a nurse's personal affect is impacted negatively through empathetic engagement with patients or family members experiencing a traumatic event (26, 57, 222, 238). Affect contagion related to work metrics includes job satisfaction and absenteeism (30, 113, 130, 151, 159, 185, 210, 241, 287). These affect contagion studies document the transfer of affect among nurses or from patients to nurses but have not observed affect contagion as a continuum among nurses and patients. The role of affect contagion causing changes in an individual's affect that impacts the nursing work environment is not well understood (72, 241). Affect contagion is of particular interest to nursing because of the relationships nurses form with the patients and family members they care for and relationships with other nurses and healthcare workers (113, 264). In patient centered models of healthcare delivery, healthcare providers work together as a team to provide care. The nursing work environment needs a method for visualizing and explaining affect

contagion as a means to better understand how affect contagion in this unique setting might occur.

Studies of affect contagion included experiments with participants located in labs where situations were staged by the investigator with the specific intent to cause affect contagion occurred in academic settings (18, 115, 225). However, a review of the literature suggests that limited information regarding affect contagion in the academic environment exists, especially for nursing.

STATEMENT OF THE PROBLEM

Limited research has been conducted to develop an agent based model (ABM) that applies to a natural work environment and for that matter, to an environment with healthcare workers in general. A literature search of published affect contagion studies with a population from the U.S. military health system (MHS) was conducted. Currently, no scientific literature has been published. The present doctoral research project adds to the body of knowledge about the affective environment for students in a military advanced practice nursing (APN) education program at the Daniel K. Inouye Graduate School of Nursing (GSN), Uniformed Services University of Health Sciences (USU). APN students in the GSN become advanced practice clinicians for the MHS. Graduates from the program have represented a significant proportion of providers in the deployed MHS setting. The majority of graduates from the APN program at USU have deployed to theaters of operation during the conflicts in Iraq and Afghanistan. This population has similarities with the active duty advanced practice nurses in the MHS and their previous experience working as nurses in the military healthcare setting. Both simulation-based training methods and problem-based learning have demonstrated crossover from the academic environment to clinical practice (154, 184). Therefore, a study of military APN students in this

specialized academic environment provided a preliminary understanding of the affective environment for this group and how they respond to affective changes.

The purpose of this study was to observe the evolution of affect contagion within a cohort of advanced practice nursing students at the Daniel K. Inouye Graduate School of Nursing, Uniformed Services University of Health Sciences through exposure to affect influencing stimuli (see Ch. 3 Methods) using social network analysis and computational modeling methods.

MILITARY NURSING RELEVANCE

This study is significant to military nursing because positive affect (PA) decreases, and negative affect (NA) increases in environments with the higher turnover leading to poorer patient outcomes than environments with lower turnover (195). Military nursing has inherent absenteeism and turnover for military members putting the workplace at a higher risk of decreased PA and increased NA than more stable work environments. Every 2-3 years military nurses are mandated to move for what is called a permanent change of station (PCS). Furthermore, absenteeism occurs frequently on nursing units with military staff. Although they cannot call in sick without a doctor's note, military nursing staff members can receive last minute assignments that remove them from patient care unexpectedly. When military nursing personnel are reassigned for their duty day, the rest of the nursing unit must balance the workload without the expected staff member. Understanding the affective environment is the first step toward developing methods to increase PA and decrease NA in a military nursing work environment.

The computational model of affect contagion may become a method to assist in assessing and improving workplace affect in the military health system. Such a model might be integrated into the already adopted inpatient patient care delivery model, Patient Caring Touch (PCT). PCT

is the U.S. Army Medical Command's inpatient healthcare delivery system that aims to improve the quality of care through decreasing clinical variance, and implementing standardized clinical best practice policies and procedures (204). All Army in-patient facilities within the MHS use the PCT system. If integrated into PCT, then nursing staff could review their unit's ABM as a component of the peer feedback element to identify triggers influencing affect specific to their unit (204). The model provides a means to quantify the interactions and relationships between staff members and patients. Quantifying affect using this computational model would integrate the relationships of the people within the nursing unit with the physical environment. The integration with the physical environment allows for quantification of how changes to the environment may influence affect of the people.

The computational model can be used for decision making at many levels within the organization. At the tactical level, it can apply to staff members, helping them understand their work environment and assisting them with identifying ways to influence their personal workspace. It can also be used to make strategic level administrative decisions because of its forecasting capabilities. Leaders can use the computational model to test potential changes and forecast possible outcomes and make informed decisions prior to implementation. An ABM may also be used to quantify and visualize the existing affectivity. Determining individual unit affect assessments inform decisions about management changes to improve the affect within hospitals.

STUDY RATIONALE

Affect influences components of the work environment that not only influence individual behaviors at work but also impact the tone of the group and decisions made by other members of the environment (51, 72, 91, 145, 201, 241, 290). A work environment that promotes high PA and low NA is more productive and safer than a low PA high NA environment (20, 21). Affect

contagion studies occurred in various work environments, including nursing (258, 259). However, these studies were one time observations or used methods that could not be used to demonstrate the emergence of affect contagion in a work environment. The present study used a group of military APN students at USU to understand the evolution of affect contagion within a small academic network with the goal of conducting future studies that will use the ABM as the cornerstone for deployment of an affect contagion model in a military clinical environment. Therefore, the underlying goal of this study was to use mathematical computational modeling to inform an ABM of affect contagion for a group of APN students in a natural academic environment.

THEORETICAL FRAMEWORK

Major advances in computer technology have allowed for the expansion of methods for studying affect contagion. Qualitative methods are the most encompassing for understanding affect contagion in natural settings but require teams of investigators and prolonged data analysis. Traditional quantitative methods are faster than qualitative methods for understanding affect contagion. Most traditional quantitative methods are next to impossible for capturing an encompassing understanding of affect contagion because of the variability and spontaneity associated with affect contagion's natural occurrence. The proposed complexity paradigm integrates the detail of a qualitative study conducted with fewer investigators in a shorter amount of time. The investigator expects that quantitative type affect contagion observations in the presence of the noise and variability that exist in a naturalistic setting are possible using complexity methods.

Complexity Paradigm

Complex adaptive systems (CAS) science is a paradigm for understanding social systems (125, 177). Social systems have many working parts that not explained through dissection to their smallest component. Complexity uses methods that examine the phenomenon as a whole (177, 188). The nursing work environment is a CAS (8, 52, 125, 173). Explanation of interactions among nursing students, the environment, and faculty requires a holistic lens that accommodates the variance of human nature. Affect contagion, which is the spread of moods and emotions in a social setting (115), is a phenomenon that can occur in a complex adaptive system (48, 94, 119, 138).

Complexity explores whole systems to understand causes or mechanisms that lead to the occurrence of patterns and outcomes (53, 177). Complexity defines the environment where nurses practice as an organic, continually changing, living system that adapts to its surroundings using self-organization, self-creation, and creativity (172). Complexity allows for the development of understanding how factors work together to create an outcome instead of identifying regularities of outcomes through controlling the environment. The system has a complicated arrangement of parts that can best be explained when analyzed together.

In CAS, agents (in the present study people), may work individually, but also interact and are interdependent (9). Investigations of the interactions and interdependencies on both the agent level and the system level provide holistic insight and understanding of the properties and functions of an organization. For affect contagion, observation of the evolutionary processes of a contagion could demonstrate interdependencies that lead to the implementation of a shared affective experience to modify affect in nursing work environments. Complexity science application allows for understanding of interactions, interdependencies, and unification of the observed system (172). As adaptive systems emerge and evolve, the patterns within the system

may change over time (7–9). The emergence of patterns and adaptations assist in understanding behaviors within a CAS. Complexity science involves embracing details, context, and overall uniqueness of a social group when trying to understand what is going on within the group by asking a question concerning actions of members, interactions, or other behaviors. Complexity recognizes the uniqueness of each system. It also accounts for the openness of systems and the nonlinearity that occurs.

Social network analysis (SNA) and ABM are methodologies that explore research questions within the complexity paradigm. Social network analysis has its origins in sociometry and examines the relationships among people (25, 89, 114, 170, 192). It involves creating maps and measures that represent relationships and exchanges between people. It can be used to understand groups based upon different characteristics or demographics. Description of support systems for populations like new mothers or recovering addicts are examples of SNA utilization. Nodes in a network represent the people, and the links between them show the relationship and flow of information. SNA can visual and mathematically analyze human relationships. The ABM is a computer representation of a phenomenon that occurs in the real world. Computational models that integrate SNA into an ABM is a valuable method to analyze behaviors within a social system (176).

Computational models coupled with SNA of affect can represent various motivations and relationships that may be undetected using traditional linear methods (27, 248). A pragmatic theoretical model is ideal when developing a computational model because it can be used to build the framework for agents' interactions that is accurate to the actual work environment. Workplace affect derives from a combination of individual affect and non-affective components. This method analyzes the relationships among coworkers, identifies individuals within the

network, and offers overarching group level analysis (14, 44, 82, 104, 105, 118, 180, 193, 198, 220).

Middle Range Theory

In their paper detailing the middle range theory, “Mood and Emotions in Small Groups and Work Teams,” Kelly and Barsade (2001) propose that affect contagion includes both human behavior and interaction within the work environment. The theory provides parameters that include the individual, interactions with the environment, interactions with others, and formal organizational guidelines that influence affect. In a collective climate, individual group members share a similar perception of their work environment (144). The shared aspects of collective climates are relevant to the spread of affect. The collective climate is a result of shared meaning that arises from work-related and social interactions among group members (227). The affect of individuals within a small group or team influences the affect of other individuals with whom they work. Workplace affect is known to influence performance and job satisfaction (20) (refer to Figure 2).

The ability for affect to spread among and between nurses and patients is well documented (72, 83, 183, 191, 238, 241). Some studies compare workplace metrics including stress, intent to leave, job satisfaction and burnout with staff affect using surveys (183, 191, 241). While other studies examined the impact of the workplace social structure and norms and their impact on staff affect (72, 83, 241). The third group of studies explored the effects of negative empathetic encounters with patients on nursing staff affect (76, 238). However, these studies did not use SNA or computational modeling methods. Research with healthcare groups has demonstrated that affect in the form of empathy and vicarious affect transmission influence both nurses’ and patients’ affect (76, 238). Results from multiple studies indicate the importance of

workplace affect in terms of PA transmission and the fact that it improves communication between coworkers as well as patient outcomes (123, 206, 267). Negative affect transmission increases work stress, burnout, turnover and adverse patient events (4, 35, 49, 69, 70, 135, 136, 183, 189, 191, 195, 233). The collective affect influences the affect of individuals in a work group or team.

As previously indicated, collective affect in the workplace influences multiple outcome metrics in corporate, industry, and retail environments. The affective reactions that occur when group members interact is called the group affective tone (58). Groups with lower absenteeism and higher customer service ratings have homogenous and consistent group affective tone (96, 97). Studies conducted in corporate, industry and retail environments found that groups with affective tone diversity have decreased cooperation, financial performance, cohesion, group satisfaction, and increased absenteeism and social loafing (22, 80). Limited research has been done on the phenomenon of affect contagion with health care providers. Affect directly influences individual behaviors that translate into workplace outcomes. Therefore, affect needs to be considered when developing and maintaining a healthy productive work environment.

Workplace affect develops bi-directionally (150). Individual affect and group norms influence group outcomes. Mean level affect is the affective tone the group displays. Members bring affective dispositions (trait affect), history, context, and personal goals to the group. Individuals share attributes to influence the group's affective composition. Affect expression, group norms (the rules determined by the system that dictates appropriate displays of affect), and organizational norms shape the environmental context and dictate affective etiquette, beliefs for which emotions are appropriate to express or hide in the workplace. Group level rules constrain or encourage affective behaviors shared among group members (Figure 1).

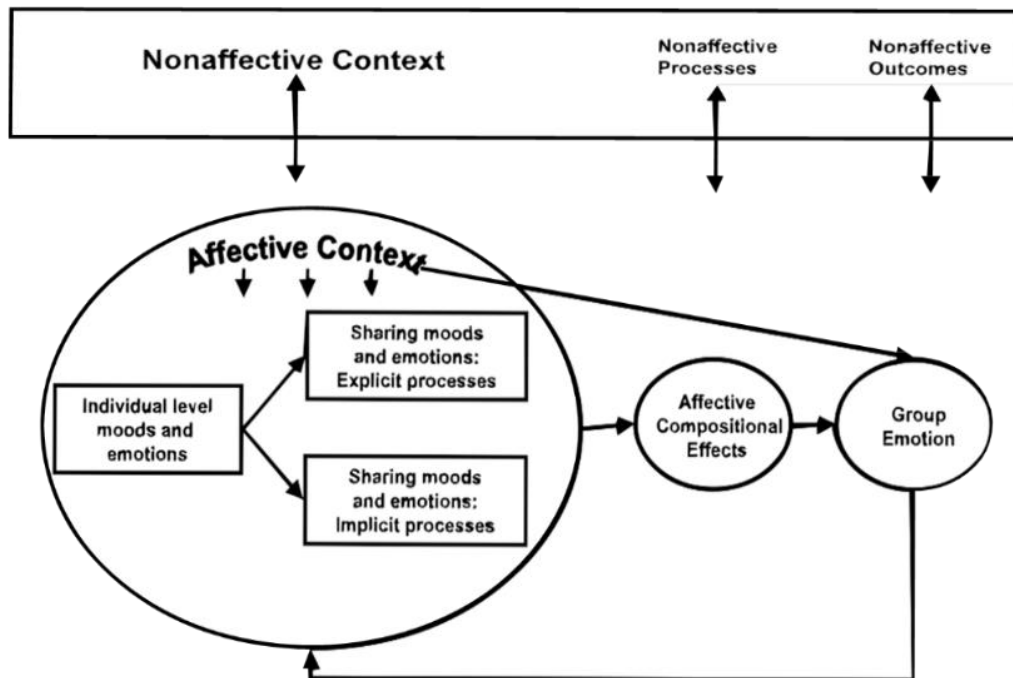


Figure 1. Mood and emotions in small groups and work teams (150)

STUDY DEFINITIONS

The terms used in this study derive from the Middle Range Theory of Mood and Emotions in Small Groups and Work Teams (150). See Figure 1 to visualize the theoretical placement of the terms of the model. Kelly and Barsade's definitions include both the theoretical definitions and the operational definitions for this study. Chapter 3 includes complete descriptions of instruments used, including psychometric properties and ABM equations. The theoretical model has three main concepts: the individual mood, the shared affective experience, and the affective compositional effects. Each concept shares a relationship with the constructs group emotion and affective context.

Affective Context

Conceptual Definition: The affective context is composed of the individual affect, the shared affective experience, and group emotion (150). The crux of this model revolves around the interplay between affective context and group emotion.

Operational Definition: The operationalization of affective context occurs through operationalizing individual affect, the shared affective experience, and group emotion. These terms are further defined and operationalized in the sections below.

Individual affect

Conceptual Definition: Individuals bring their underlying trait and state affect, experiences, and skills to the group. Three general factors that are components of the affective state of the individual include dispositional affect, mood, and acute emotion. Each of these factors has been shown to have group level affective influences, reinforcing the importance of individual affect to the group affect. Dispositional Affect refers to a person's perception of his or her environment as positive or negative (161, 247). Affective disposition is the lens through which individuals view their experiences; it provides a context for consciousness (103, 279). Moods are diffused feeling states that are low-intensity with unclear antecedents (93). They are unstable and short term in nature (252). Moods differ from emotions in that individuals may not be aware of their mood nor realize that moods influence their behavior (92). Emotions have a clear cause or object, are short term in nature, and more focused and intense than moods or dispositional affect (95). Emotions are more likely to disrupt activity as well as change beliefs (161, 228). Emotions have the potential to influence group cohesion, commitment, and performance (80). A person's moods and emotions influence interactions with others and behaviors. Mood and emotions (state affect) are the affective circumstances transferred through contagion and what this study aims to measure.

Operational Definition: The Iowa Personality Questionnaire measured participants' dispositional affect. State affect was operationalized in the ABM variable affect value using

scores from the International Positive Affect Negative Affect Schedule Short Form (I-PANAS-SF). Psychometric properties for the I-PANAS-SF are in Chapter 3.

The mood and emotions of individual members of the group are the initial input for the group's shared affective experience.

Shared Affective Experience (Explicit and Implicit)

Conceptual Definition: Individuals share affect through either implicit or explicit methods (150). Implicit modes of affect sharing include emotional contagion, vicarious affect, and behavioral entrainment, also known as interaction synchrony. Emotional Contagion is the process of transferring individual moods and emotions to nearby individuals (150). Contagion occurs when the emotional behavior in others manifests (115). Examples are mimicry and synchronization of body language, facial expression, posture, movement, and vocalization when led to an emotional convergence (115). Physiological feedback due to mimicry shapes an individual's emotional state to align with the affect of the model (249). Contagion of positive affect improves cooperation, decreases conflict, and increase the perception of task performance. Negative affect contagion elicits a reverse response (22). Concurrent mood associations have been recorded among nurses who work together (258), as well as in small work groups, and sports teams (23, 257). Vicarious Affect is the sharing of affect through experiencing the affect of others (150). Frequently, social interactions involve displays of emotion; observing the emotional reaction of an individual can evoke an emotional response from the observer (17). Empathy is another mode of implicit sharing. Empathy differs from the vicarious affective modeling because the observer places oneself psychologically in the circumstance of the model (161). The observer must have the ability to conceptualize the circumstance in a multidimensional manner; including various perspectives, imagining self-involvement, and

emotional response (17, 68). The final implicit affect transmission method is behavioral entrainment or interaction synchrony. These processes refer to the nonconscious behavioral adjustment or modification to coordinate or synchronize with another. When synchrony occurs, coordination of micro and macro body movements or postures, and coordination of affect and attitudes is observed between the interacting individuals (237). Positive affect is an outcome of behavioral entrainment and interaction synchrony related to the encounter between individuals (45, 276).

An explicit sharing of affect is conscious and intentional. Intentional affective inductions and affective influences occur when deliberately manipulating the affect of other group members. Affect manipulation occurs through conscious, intentional actions intended to influence the affect of the recipient individual who may or may not be aware of the manipulation (150). Strategic and authentic manipulation of affect can be used as strong, influential mechanisms (100). All group members can attempt to influence the affect of other group members (97). Mood induction literature also addresses non-interpersonal mechanisms for inducing a particular affect. Examples of non-interpersonal mechanisms include music, unexpected gifts or rewards, and movies (139). Non-interpersonal mechanisms generally do not have the reciprocal and reinforcing capabilities that interpersonal stimuli offer (149).

Operational Definition: The sharing of affect both explicitly and implicitly was operationalized through the variables of expressiveness of “sender,” measured by the Berkeley Expressivity Questionnaire, and susceptibility of the “receiver” as measured by the Emotional Contagion Scale. Psychometric properties of the Emotional Contagion Scale are in Chapter 3.

The components of the affective context (individual affect and the shared affective experience) are the input for the affective compositional effects.

Affective Compositional Effects

Conceptual Definition: The concept affective compositional effects are the outcome of sharing individual affect (22) and composed of the group's affective mean. The homogenous affect of a group, known as the group affective tone, occurs when a group obtains affective consistency (96). The group affective tone influences various work outcomes to include organizational spontaneity and absenteeism (98, 99). Group cohesion, as measured by central tendency (group mean), is significantly related to group performance (194). Members of groups with high levels of cohesion report higher satisfaction and enjoyment from group membership, and less anxiety and nervousness (112, 124, 221). In this study, group cohesion was measured using network density and the group emotion score described in the next section.

Operational Definition: Affective compositional effects are represented by the strength of connection variable, measured using the social network surveys as well as the state affect of individual network members measured by the International Positive Affect Negative Affect Schedule Short Form.

Group Emotion

Conceptual Definition: Group emotion describes the affective context of mood and emotions in small groups and teams. Groups consist of both task and social/emotional component groups (107). Affective influences are a component of group interactions that bear upon group outcomes (150). The affective context includes subjective feeling states that can range from diffuse moods to intense emotions (12). The members bring subjective feelings to the environment (150). A stimulus in a group's environment has the potential to change the affective context. Group Emotion receives input from the affective compositional effects and the affective context (112). Furthermore, the feedback loop from group emotion to the affective context construct (150).

Operational Definition: Group emotion is operationalized using the mathematical equation $\frac{dq_R}{dt} = \gamma_R(q_R^* - q_R)$. Chapter 3 explains this equation (24). The equation for group emotion uses the scores derived from participant responses to the International Positive Affect Negative Affect Schedule Short Form, Social Network Surveys, Contagion Susceptibility questionnaire, and Berkeley Expressivity Questionnaire to calculate a score for the group emotion. Chapter 3 contains descriptions and psychometric properties of the instruments used in the mathematical equation.

Nonaffective Influences

Conceptual Definition: Collective affect, and nonaffective influences interact and have relationships with each other (150). Nonaffective influences are processes that are not a work groups' own affective context (150). This construct consists of three concepts: intergroup context, physical context, and technological context. Intergroup context describes the group's relationship with other groups with whom they interact (150). Examples of intergroup context include interactions with faculty members, course work deadlines, and exam causing stress. Physical context includes subtle manipulations of the environment (150), this could be a bouquet of flowers at the front desk or the choice in music playing. The final concept is technological conditions. Technological conditions include use of email and text messaging to communicate; these methods of communication influence social cues but do not allow individuals to be able to assess social cues during the communication (150).

Operational Definitions: Faculty participation responses and stress levels of participants measured with Perceived Stress Scale measures intergroup context (55). The Life History Calendar captured physical context nonaffective influences (13). Explicit description of the technological conditions and their interaction with affective variables is beyond the scope of the

present study. Documentation of intergroup context and physical context identifies expected relationships among the affective and nonaffective influences. The affective and nonaffective influences have the potential to initiate a spontaneous affect contagion response in the network and, therefore, need to be accounted to explain the occurrence of unplanned affect contagion. Psychometric properties of the Perceived Stress Scale and Life History Calendar are in Chapter 3.

SPECIFIC AIMS

There were two specific aims for the study: The first aim was to characterize affect contagion in a social network to represent military APN students. The ABM, social network analysis, and linear statistical methods described and visualized the mechanisms that allow the contagion to occur in a social network. The instruments used in this study provide numerical values for variables in the mathematical model. Relationships among the instruments utilized were determined and provide insight into the characteristics of the network and network members. The second aim was to determine the effect size of an affect altering the experience in the form of humorous video stimuli introduced into the work/school environment of the students. Measuring effect size determines the existence of multiple layers of affective effect, individuals directly exposed to the stimuli constitute the primary effect size and individuals who interact with the exposed group but were not exposed to the stimuli constitute the secondary effect size. Together these aims provide mechanisms for understanding and visualizing the occurrence of affect contagion.

Specific Aim 1

Characterize affect contagion in a social network to represent military APN students.

Research Question 1.1: What is the relationship among network members with similar affect and what are their social interactions?

Rationale: Collective climate is a result of shared meaning that arises from work-related and social interactions among group members (227). In previous studies, a convergence of interaction and affect groups occurred, correlating the affect of network members based upon their reported interactions (259).

Hypothesis: Convergence will occur in the student group based upon the community structures within the network.

Research Question 1.2: Do individual's with strong ties with other network members have greater affect similarity?

Rationale: Group affect is the convergence of affect communicated between individuals in a group (203). The strength of convergence should have a relationship with the proximity of group members measured by network distance (203). A contagion effect should be more likely among individuals with stronger ties.

Hypothesis: Individuals who interact both in and out of the classroom will have a higher propensity for convergence of affect than individuals who interact minimally.

Research Question 1.3: What are the system mechanisms influencing affect within the network?

Rationale: Various phenomena occur within a social network on multiple levels. There are individual interactions, small group interactions, and whole system interactions. System – subsystem analysis allows for peeling the layers of the environment apart to examine and understand its processes (27, 72, 229, 251). Analysis of the whole network examines the total system. Subsystem analysis teases out the network based on heterogeneous characteristics of

network members identified by their demographics (251). Measurement of contagion based on placement within the network, network connections, and density of the network can all be analyzed both as a whole system or a parsed out network group (259). Through the multilayer analysis, it should be possible to identify members of the network who highly impact affect contagion within the network (64, 206, 211, 230, 251). The effects of different affective states should also be identifiable. For example, is a positive affect more contagious than negative affect or does an affective influence only effect the person directly exposed to the affective influence?

Hypothesis: Individual and small group interactions impact the affect of the entire network.

Research Question 1.4: *What is the relationship between network topology and ECS scores?*

Rationale: Situational similarity, group membership, intimacy, and social power have all demonstrated relationships with contagion susceptibility (209). Social network analysis can explore each of these factors. The chosen network was divided into variables related to each of these factors: centrality, betweenness, and academic program. Situational similarity and group membership were studied through academic program membership. Intimacy and social power were explored through comparing acknowledged relationships in the network to the responses from the ECS.

Hypothesis: Central members of the network will have higher ECS scores than peripheral members (social power). ECS scores will be similar based on an academic program (group membership, situational similarity).

Research Question 1.5: What is the relationship between network topology and BEQ scores?

Rationale: Susceptibility to contagion and expressivity of affect demonstrate a relationship (75), and that a relationship exists between ECS and BEQ scores, therefore, it would be expected that variations in expressivity within the network would also be observed. Like ECS scores, BEQ scores may be correlated with situational similarity, group membership, intimacy, and social power (109, 209). Exploration of these relationships used demographic variables of experience, and academic program and a comparison of acknowledged relationships in the network to BEQ scores (209).

Hypothesis: Central members of the network will have higher BEQ scores than peripheral members (social power). BEQ scores will be similar based on an academic program (group membership, situation similarity).

Research Question 1.6: What is the relationship between ECS and BEQ scores?

Rationale: Previous work to understand contagion susceptibility has found that people who are more likely to express their affect are more likely to participate in a contagion effect; while people who are less likely to express their affect are less susceptible to the contagion (209). The Emotional Contagion Scale and Berkeley Expressivity Questionnaire instruments have not been previously measured together in the same study. This study utilizes both instruments. It is possible that there are correlations between a participant's susceptibility to affect and their ability to express affect. Based on the findings of the previous studies that exclusively used the emotional contagion scale (74, 75, 209).

Hypothesis: Participant ECS scores correlate with their BEQ scores.

Research Question 1.7: What is the relationship between IPQ and ECS scores? What is the relationship between IPQ and BEQ scores?

Rationale: Previous studies explored the relationship between contagion susceptibility and state affect (209). The priming of participants to experience a certain mood or emotion did not change their susceptibility to affect contagion. Trait affect correlates with situational state affect.

Hypothesis: No relationship exists between the IPQ and ECS scores.

If BEQ scores correlate with ECS scores, then it would be expected that there would also be no relationship between the BEQ and IPQ scores.

Research Question 1.8: What is the relationship between gender ECS scores? What is the relationship between gender and BEQ scores?

Rationale: When assessing emotional contagion with regards to demographics, previous studies have shown mixed results for relationships between age, education, or years of service (73–75, 209). However, some occupations demonstrate a difference in emotional contagion susceptibility related to gender. Doherty et al. (1995) measured emotional contagion among undergraduate students, Marines, and physicians in Hawaii. The students and Marines demonstrated significant gender differences for emotional contagion susceptibility while the physicians did not demonstrate a difference by gender. The physicians in the study worked at Tripler Army Medical Center or the public hospital in Honolulu (75). The students enrolled in this study are most similar to the physicians in Doherty's study because they have experience working in clinical medical situations. Doherty et al. (1995) also found gender difference to responsiveness to contagion but did not investigate the responsiveness by profession. This study uses the Berkeley expressivity questionnaire to assess responsiveness to affect contagion.

Hypothesis: There may not be a difference among participants based on gender for their susceptibility to contagion, or expressivity of affect because of their chosen profession, nursing.

Research Question 1.9: *What is the relationship between age and ECS scores? What is the relationship between age and BEQ scores?*

Rationale: Exploration of emotional experience, expression, and control has demonstrated that the older participants exhibit more emotional control than younger participants, but the literature regarding expression has mixed results. Age either negatively correlated with expressivity or does not seem to differ by age (109).

Hypothesis: Participants will show less susceptibility to emotional contagion as they age, there will be a negative relationship between age and ECS score. While expressivity will not have a relationship with age; there will be no significance in the relationship between BEQ and age.

Specific Aim 2

Determine the primary and secondary affective effect size of an affect influencing stimuli for USU graduate nursing students.

Determination of the affective effect size provides a way to measure exposure to an affect influencing experience on network members and demonstrates the experience's potential to cause affect contagion. Participant responses to the stimuli provided values for the affect variable of the mathematical equation that informs the ABM. If exposure to an affect influencing event leads to affect contagion in the network, then it would be visualized in the ABM.

Feedback loops within the network could potentially influence the ability to identify the primary and secondary effects of the stimuli. Network members exposed to the affective

experience stimuli should exhibit the primary effect. However, it is possible that after sharing their affect with members who did not experience the stimuli that their affect may change from the other network members. The data collection methods used for this study are unable to discriminate between primary effect and the possible tertiary effect that occurs from a feedback loop. A feedback occurs when network members change their affect to be more similar and pressure other network members to also align their affect with the group model of diffusion (1, 148, 175). There may be a point of critical mass for affect contagion in which if enough individuals change their affect to be more like the group affect then adoption of the new affect by the remaining members of the network occurs (202). The new affect for the group becomes self-sustaining. In the case of a feedback loop or reaching the point of critical mass in an affect contagion situation, primary and secondary effects may be blurred. It may be possible to identify members first exposed but may not be possible to determine whether their change in affect is from the original exposure or the feedback.

Research Question 2.1: *What is the primary effect size of a shared affective experience for USU graduate nursing students?*

Rationale: Primary effect size is the change in affect on data collection days experienced by participants exposed to the stimuli. Measuring the primary effect size change in affect over time has not been previously documented using a humorous video stimuli. A similar study used stimuli sent via text and email to demonstrate a cumulative affect effect over a five-day period although it did not demonstrate a statistically significant change between daily affect scores (240). If the network members exposed to the stimuli do not exhibit a change in affect related to exposure (primary effect size), then association of the stimuli to changes in affect of the non-exposed network members (secondary effect sized) can not be established.

Hypothesis: Exposure to the shared affective experience will change the affect of the exposed individual when compared to participants not exposed to stimuli.

Research Question 2.2: *What is the secondary effect size of a shared affective experience for USU graduate nursing students who do not participate in the experience?*

Rationale: Secondary effect size is the change in affect on data collection days experienced by participants who do not participate in the event but who spend time with individuals who participate in the event. Christakis found happiness to spread among network members varying amounts depending on the strength of relationship (94). Spouses who live together had the strongest influence while neighbors and siblings who lived in proximity had a lesser influence. Spouses who do not live together and siblings who live apart have no demonstrable influence on happiness (94). Because these students spend a minimum of three days a week in classes together either as a whole or partial network, it was expected that their influence on each other falls somewhere between the influence of a spouse and a neighbor, about 9.8% (94). Affect changes through secondary exposure confirm the presences of affect contagion within the network.

Hypothesis: Interaction with individuals exposed to the shared affective experience will change the affect of non-exposed network members when compared to the non-exposed member's affect on a day without any exposure to stimuli.

Research Question 2.3: *How does network location of the primary exposure group influence the secondary effect size of the stimuli?*

Rationale: Similarities in individual characteristics may exist among influential network members. Identifying the amount influence of network member has with relationship to their network topology could be used for later studies to focus and target affect interventions for

participants who are most susceptible and have the network location that maximizes the ability to share their affect with others (42, 46, 108, 126, 158, 223, 267, 282).

Affect spreads as a mechanism of contagion within the network based on ties between individuals and the ability to influence others (259). A higher number of ties should be more influential than fewer ties (259). Network members with similar numbers of ties, even if not to each other should have similar affects because the similarity of their ties converges through communication and comparison (164). A network member who is a bridge between two other members with a high number of ties may also contribute significantly to the spread of affect even with a small number of personal ties. If the network member who is between two highly central network members freely shares their affect, then *both* groups connected through that network member could be “infected” with affect (164, 179, 248, 259).

A group member’s affect partially depends on network location and size. Centralized network location related to workflow and communication demonstrates greater influence within the network (36, 37). Centrality or betweenness provide access to and control over resources. Associations between increased responsibility related to control and higher work demands exist (277). Controlling the work environment is associated with enthusiasm and positive affect (PA). Anxiety and negative affect (NA) related to work demands are also associated with the control (277). Greater centrality or betweenness evokes either a PA or NA and influences the organization to mediate affect. Students in leadership roles, like the class representatives, should be more central to the network and have more affective influence within the network.

Dense workplace networks promote communication, trust, and cooperation (3, 245). Density is the total number of existing relationships divided by the total number of possible relationships (38, 259). The density of an interpersonal environment within a network and stress

reactions have a negative association (146). Higher density reduces reactions, lower density magnifies reactions. Therefore, the job-related strain should be reduced through a dense network related to the individuals affect. The network of nursing students should be highly connected and, therefore, dense.

Hypothesis: Affect, like communication, trust, and cooperation, will be promoted by this network of students. Furthermore, confirmation of the negative association between the interpersonal environment and stress may be present if the affect contagion is less present during high-stress data collection days.

Research Question 2.4: *Are there cumulative affective effects that occur during the study?*

Rationale: A study of affect influencing stimuli delivered via text and email demonstrated no significance between individual stimuli exposure, but demonstrated a cumulative significant change in affect when comparing pre-exposure measurements to half way through the study and at the conclusion of the study (240). Although the stimuli used in this study were delivered once a week, a cumulative effect may occur.

Hypothesis: Cumulative affective effects will occur. The change in group affect will be visualized using the ABM. The linear plot of group affect overtime should demonstrate either an increase or decrease, not a flat horizontal line.

POTENTIAL LIMITATIONS

Applicability: Population

One concern with conducting a study on a single network is that the results may not apply to other networks. Frequently military nursing applies scientific results from studies conducted in a civilian population because the body of literature about military nursing practice is much smaller and focuses on combat care. Although the population included in this sample was one of

convenience and availability that does not represent the entire population of nurses working in military hospitals, study results might still be transferrable to similar groups of U.S. military nurses who are working and functioning in academic or health care groups. Graduates of the USU APN programs integrate into the MHS and are future MHS healthcare providers. Future application of study results could include similar military and non-military academic environments.

Computational Model Methods

A limitation to using computational modeling was that the results can only represent the variables included in the model. The model depends on the design and complexity to accurately portray the phenomenon of interest. The model mimics human interactions and systems behaviors but is bound by the parameters of the computational model. This model only partially captures the intricacies of human interactions and the spread of affect contagion. The theoretical model proposed by Kelly and Barsade (2001), is well represented by the mathematical model chosen for data analysis although not an exact representations. Affect contagion is a complex, multifaceted phenomena, focused attention on the key identified components found in the computational model can identify patterns and provide a rich explanation to affect contagion when compared to methods that do not consider affect contagion in a holistic manner (15). Factors including implementation of new policy, conflict with family members, a rigorous course schedule, and surprise mandatory events could all mediate the affective effects of the stimuli. To account for mediators, the investigator used the life event calendar method to record other possible affect influencing events like due dates for major projects, exams, and mandatory training days (13). The life event calendar was cross-referenced with the PSS and I-PANAS-SF scores to identify affective influences that are not from the shared affective experience induced

by the study. The combination of the life event calendar, PSS, and I-PANAS-SF can clarify naturally occurring affective changes in the network. Although the computational model differs slightly from the computational model, it is an encompassing method to consider the many interplaying variables that lead to affect contagion.

Effective Stimuli

If the stimuli are not big enough to overcome the natural affective influences (noise) of the network and modify the affect of the network members, then it is not possible to make modifications to the ABM mathematical equation that account for stimuli. Conclusions about the type of stimuli injected are made based on the stimuli impact. If the stimuli have no effect, then conclusions about affect contagion within the network are limited to a generalized understanding of the network as CAS.

ASSUMPTIONS OF THE STUDY

Self –report Measures

The instruments used to quantify the variables in the mathematical equation that represents affect contagion in the computational model are self-report from the participants, so the research depends on study subjects answering honestly and to the best of their ability.

Social Network Surveys

The social network surveys capture the existence of relationships within the network; they do not capture individual interactions. The possibility for a network members to have an interaction with another network member that has an extreme effect on their affect; but reflection of the interaction was limited if they individuals have indicated in the surveys a weak relationship.

This study used traditional statistical methods, SNA, and computational modeling to describe affect contagion of APN students at USU. This marriage of various analysis methods provided a rich understanding of the occurrence of affect contagion in a natural setting. The population included in this study was APN students with patient care backgrounds as military nurses. Chapter 2 summarizes the scientific literature pertaining to affect contagion studies with similar methodologies to the methods used for this research study.

Chapter 2: Applying Complexity Methods to Affect Contagion

INTRODUCTION

This chapter describes the evolution of affect contagion, from the natural setting to complex systems methodologies and demonstrate how the current project builds on these works. The scientific origins of affect contagion are known through the early accounts of the phenomenon discussed by Le Bon (162), and the advancements in the field over the last 50 years by Schachter and Singer, Hatfield, Barsade, and Totterdell, and their research teams. These scientists dedicated their careers to studying aspects of affect contagion, their work is foundational to the progression of affect contagion research (18, 115, 116, 257–259). The science of affect contagion is based on a quantitative interpretation of the natural world that involves demonstrating the impact of affect contagion behavioral outcomes. Currently, affect modification methods for improving outcomes in occupational settings and determining ways to identify characteristics of people in relationships or situations that may influence contagion are of great interest to social scientists and organizational business scientists interested in understanding the social science of the workplace. Influencing affect is viewed as a way to improve the ways in which people interact and perform their jobs. There is limited understanding of mechanisms for improving the affect of healthcare providers. Although affect contagion has been established in healthcare environments, methods for changing or improving an affective environment are lacking. Continued research in the area may develop methods to improve the affect of healthcare providers leading to improved patient care.

This chapter begins with a review of selected foundational affect contagion and social network analysis (SNA) research. It continues with a summary of the affect contagion studies that use SNA research methods. There has been a recent proliferation of affect contagion studies utilizing social networking websites and virtual models. The final section discusses the the

application of computational models to affect contagion studies; some also utilize SNA methods, while some do not. The chapter concludes with a discussion of the scientific advancements in the field of affect contagion research and translation of results.

A BRIEF HISTORY OF AFFECT CONTAGION

The origins of affect contagion are unknown but have been recorded throughout history. The concept is referenced as early as Plato and Plutarch during the first century, B.C.E. (115). Formal scientific investigation of affect contagion has is ongoing and continues to evolve. For this evolution to continue, an understanding of the scientific origins is necessary. The following is an overview of the major contributions to the study of affect contagion.

Advancements in the understanding of affect contagion are relatively recent, but acknowledgement of its existence in scientific writings can be found in the writings of LeBon, a nineteenth century sociologist interested in what he termed group mind or the madness of crowds (162). Based on observations, Le Bon concluded that with crowd membership, individual identity is absorbed leading to enlargement of the ego, a release of impulses, and heightening of suggestibility. These early observations stimulated later more formal investigations of the mechanisms involved in the occurrence of affect contagion.

Psychologists, Schachter and Singer investigated the physiological mechanisms involved in an affect contagion scenario. They believed that both mind and body contributed to a person's affective experience (226). Schachter and Singer hypothesized that when a person is emotionally aroused they will appraise the situation and determine an appropriate label for what they are experiencing. To test the hypothesis, Schachter and Singer conducted a series of experiments to manipulate physiological arousal, appropriate explanation of the arousal, and emotional assessment. The experiments demonstrated the occurrence of affect contagion for both the

emotion of euphoria and anger, confirming both a physiological and psychological component to affect contagion. When a person experiences affect contagion, there is a physiological response and a thought processing response.

The explorations of affect contagion by Hatfield and her colleagues has spanned decades and made many contributions to understanding the phenomenon. To truly comprehend the physiologic response, Hatfield and her colleagues conducted a series of experiments. Her studies of mimicry found that people adopt facial expressions from the people with whom they interact and feel emotions consistent with the adopted facial expression. Furthermore, people find it challenging to adopt an affect that is inconsistent with the facial expressions of the person with whom they interact (117). Her research expanded to include vocal feedback, muscular contraction feedback, mismatched emotion with responses, and the influence of stress in relationship with affect contagion (115–117, 131, 132). This research has led to the development of the emotional contagion scale and understanding of susceptibility to the emotions of others (74).

During the past two decades, the scientific research of Totterdell, Barsade, and their colleagues has taken affect contagion research out of the controlled lab setting and applied it to workplace interactions. Their work has associated workplace behaviors and outcomes with the sharing of affect (6, 150, 187, 257, 258). Both scientists have examined workplace social structures and hierarchies and the role of affect contagion (19, 21, 22, 216, 259). Totterdell and his colleagues applied methods of collecting data from participants for use in social network analysis to the workplace environment (259). Barsade's work provides theoretical models of affect contagion in the workplace that explain workplace behaviors and outcomes (19, 150).

Affect contagion research has confirmed its existence, the linkage of the physical and cognitive responses and affect contagion's impact on outcomes in natural settings. Currently, the application of social network analysis or computational modeling methods to understand the dynamics of affect contagion in natural settings is limited. Like the studies of affect contagion, these methods of analysis are relatively new and have become more popular as technology became mainstream.

THE ORIGINS OF SOCIAL NETWORK ANALYSIS

Social network analysis has its origins with sociometry and the sociogram developed by Moreno and Jennings (192). Sociometry is the study of group structures and the position of individuals within groups using quantitative techniques. Sociograms are a form of visualization of individuals within groups and existing relationships (192). On a parallel track with Moreno and Jennings, Kurt Lewin suggested that coexisting factors to perceptions and behavior could be given a structural perspective through representing individuals and groups topologically as vectors within space (169, 171). Lewin's students carried on his research. At the Massachusetts Institute of Technology (MIT), the Group Networks Laboratory, led by Alex Bavelas conducted research that explored the diffusion of information and network structures. The key concept of centrality was developed by this group (25). Festinger and Cartwright teamed up with a mathematician, Harary, at the University of Michigan where they also built upon their mentor, Lewin's work. Together they developed theories and methods for understanding structural balance based on graph theory (41, 89). Their work provided the foundation for developing the concepts of clustering, network structures, and cliques (212). These contributions to SNA brought about methods for visualizing and quantifying relationships found within groups.

SOCIAL NETWORK ANALYSIS OF AFFECT CONTAGION

Applying social network analysis methods to understand affect contagion has occurred in the workplace, academic, and community environments. The studies have established the existence of affect contagion in these environments, described the characteristics of network members, network member roles in affect contagion, and the use of an intervention to intentionally change affect. This section describes the research studies that use social network analysis and their relevance to the current study.

Affect Contagion in the Work Environment

In two studies published as one article, Totterdell et al. explored sharing affect in the workplace (259). Their objectives were to evaluate the relationship between organizational networks and shared affect and personal work networks and affect. The first study was conducted in a closed network at a car factory. Participant affect formed a greater consensus based upon their identified work groups when compared to the whole sample. This consensus affect meant that employees who had similar job-related affect experiences reported similar affect scores. Reported affect scores did not have a relationship with identified work unit, but did have a relationship with reported interaction groups. Although most interactions were reported with members of the same work unit, the *interaction* itself, and not the organizational *identifier* was the determining factor for sharing affect. Affect sharing between employees was found to be a function of structural equivalence, network members sharing an identical number of relationships with other members of the network. Centrality, the number of relationships a network member has with others within the network, was found to be partially correlated to affect. The density of participant networks had a significant negative association with the low

PA and high NA dimensions, but no association was identified with the high PA and low NA dimension.

Based on the results of the first study, Totterdell et al. explored the relationships between employee affect and size and density of work tie (relationships) in networks and how organizational changes to the social network structure may impact the affect of employees. The second study followed two separate networks that were involved in an organizational merger into one network for a 10 week time period. The network experienced a reduction in density because of the merger. Employees no longer had the cross-divisional relationships that had existed prior to the merger. An increase in network density significantly predicted increased social support which in turn significantly predicted happiness. Social support changes mediate the relationship between change in network density and happiness. Participants who had greater numbers of work ties prior to the merge experienced reductions in calmness, enthusiasm, and happiness. An increase in network size was negatively associated with happiness scores (259).

These studies were some of the earliest to use SNA statistical methods to understand affect contagion. They provide foundational information for data collection methods including multiple methods for capturing social network relationships and the importance of the relationships to understanding affect contagion in a work environment (259). The studies are descriptive in nature, they do not attempt to change the affect, nor do they make any predictions regarding the affect of the population. As foundational work, the studies establish the ability to use SNA techniques for improved understanding of affect contagion among coworkers.

Academic Affect Contagion

Social Networks and Positive and Negative Affect

Moving to an academic environment, Vukadinovic Greetham and colleagues describe affect contagion among undergraduate students at a university in England (270). A study of 100 undergraduate students described short term PA and NA in an existing social network and the main effects of selection and influence processes. For PA within the network, there was a negative feedback relationship and a tendency toward the middle scores. When PA increases, the likelihood of change toward higher affective scores was smaller and when PA levels decreased the tendency to decrease affect scores was smaller. While NA was drawn toward extremes, students with low NA were attracted to other low values and students with high NA were attracted to other high NA values.

This study of affect in an academic environment was the first to describe affect contagion using SNA in a student population. The researchers used open networks in which not all students participated in the study, and the scientists do not define or confine which participants included in the network. This differs from Totterdell et al. studies which used closed networks (259). The closed networks only included people with whom the study participants worked. Through the open network method, Vukadinovic Greetham and colleagues were able to describe relationships among students including the likelihood of communicating with others (270). Cluster analysis also provided new insight into the characteristics of the affect network; students with similar affect were more likely to interact with each other. Interestingly, the effect size of the change in affect for participants was related to their starting affect and differed related to positive and NA (270). The findings imply that modifications that change NA scores may be more effective for an affect contagion than modifying PA.

Social Networks and Affect Intervention

Two studies using interventions were conducted with university students (271). In the first study, all participants received the intervention of free ice cream and identifying three things in their life for which they are grateful on days three and four of the four day study. Participants recorded their PA and NA using the Positive Affect Negative Affect Schedule (PANAS) and kept a journal of interactions with others (271). In general, scores for both PA and NA decreased with a larger decrease in NA over the four days. As in the previous study, PA and NA tended toward extremes, but affect contagion was not evident. Participation in the intervention statistically increased PA. When analyzing the characteristics of the network, neither centrality nor betweenness was correlated with network communication or average PA and NA. The study found that participants with the lowest NA were better broadcasters of affect based on the duration of interactions. This study demonstrated that an intervention has the ability to change the affect members, it also identified which participants had the greatest change in affect and, therefore, may be the ideal for targeting an intervention to cause affect contagion.

In the second study, participants were selected for intervention groups based on their NA scores on study day one. There were two intervention groups; the first group had the lowest NA scores and the second had the highest NA scores. A contagion of PA was significantly present in the group of low NA participants while the opposite contagion effect was present in the high NA group. No day to day difference in PA and NA scores were present with the introduction of the intervention, but PA and NA scores were significantly lower when pre- and post-scores were compared. For the high NA group, the intervention further increased their NA. The results support the need to plan carefully targeted interventions and consideration of the emotional state of participants when the intervention is administered.

These two studies introduce an intervention to intentionally modify affect of participants and observe affect contagion. Based on the findings of the first study, affect profiles, instead of network topology location, and were used to target participants in the intervention groups for the second study. Targeting the intervention based on affect profile instead of affect location differs from the findings of both Totterdell (259) and Fowler and Christakis (94) who associated physical location within the network with affect scores and influence to change affect within the network. The intervention did change affect, but unexpectedly (271). Determining which intervention to use for changing the affect of a network warrants continued research. It seems that various characteristics of participants may identify them as more or less susceptible to a change in affect.

Network Spread of Happiness

In their retrospective analysis of the Framingham heart study population, Fowler and Christakis used SNA to determine whether happiness spread within the network over twenty years from 1983 to 2003 (94). Happiness spread through the network three degrees; happiness was shared with friends of friends, and friends of friends of friends. The percent of happiness transferred was influenced by physical location and the amount of interaction. Mutual friends and spouses who lived together shared the most happiness while close family members, participant nominated friends, and neighbors had more happiness sharing than family members who lived far away. Location within the network also impacted happiness. Participants who were more centrally located were happier than participants who were less central. Gender influenced the spread of happiness; same gender relationships spread happiness significantly more than opposite gender relationships.

Fowler and Christakis used SNA and developed a model that forecasts the likelihood of happiness exchange among network members. The happiness study confirms that affect in networks is transferable and predictable. But this study used retrospective data and, therefore, the conclusions are limited because the data were not originally collected for understanding affect contagion. Fowler and Christakis' primary findings concluded that physical proximity has a large impact on the ability for affect contagion to occur. The data analyzed in this study was collected in 1983 and 2003. The study concluded as the proliferation of cell phones and online social networking modalities began. The virtual world has changed the way the world interacts and communicates. The analysis of the happiness in the Framingham network is an early description of a large open social network, the fact that the likelihood for affect to spread among network members based upon their identified relationships is predictable and consistent provides a starting point for developing future predictive models of affect contagion.

AFFECT CONTAGION MODELS

There is a small body of literature using computational modeling to understand affect contagion. Because affect contagion is a complex and dynamic process, computational models are used a way to explain further the phenomena. Unfortunately, most of the computational models only use computer-generated data for validation. These models utilize various theoretical models to develop the parameters for the computational model. Although the models have similarities as well as variations, they often do not have validation with empirical data collected from study participants or use validated instruments; hypothetical data is generated by a computer for various conditions that aim to represent real life. The simulated models are mathematically valid and can be informative, but would benefit from "real world" validation.

Four contagion models have been validated using retrospective data. The susceptible – infected – susceptible, possible spontaneous infection, (SISa) infectious disease model examines affective states longitudinally (119), the Durupinar model infectious disease model of affect contagion verified through human verification of the simulation (81, 263), the Mixed Agent / Social Dynamics for Emotion Computation (MA/SDEC) model utilizes data from the Ripple Effect study (18) to model affect contagion in small groups (224), and the multi-agent model for mutual absorption of emotions was verified using evacuation scenarios (34, 263).

SISa model of Happiness

With the information from the Fowler and Christakis study of happiness (94), an agent based model using an epidemiology SISa was developed. The infectious disease model of emotions was validated using the Framingham Heart Study Network. The model predicts the likelihood an agent will become happy based on ties with other agents within the model (119). The model was able to describe the change of affect among neutral, content and discontent affective states and the likelihood of a person changing from one affective state to another. The randomly generated start conditions accurately modeled outcomes similar to the actual data. The model demonstrated relationships of changes in affect longitudinally over months and years (120). When tested in short term affect contagion environments (crowd conditions) the infectious disease models were inaccurate (263). Infectious disease modeling follows the same principles that are used to model the spread of diseases like influenza. When validating the infectious disease models of affect contagion, they were found effective only for longitudinal forecasting over months and years (263).

Durupinar Model

Models of affect contagion that represent crowds and mass incidents are also common. These models attempt to model the behavior of individuals based on emotional decisions. Durupinar recommends model application for studying affect longitudinally in contrast with the other models that examine short-term affective states (81, 263). The Durupinar model of crowd behavior included affective states. Participants were asked to view scenarios in the model and answer questionnaires regarding the cognitive, perceptual, and psychological observations of agents as model validation (81). The participant responses were correlated with the model settings for each of the observations for validation. Although the model includes an affect contagion component, it is not the primary focus or function of the model. Also, when the model was tested for validation by Tsai et al. using the different affect contagion scenarios from those developed by Durupinar the model was found to have some glaring flaws related to using the infectious disease parameters (263). These flaws demonstrate inconsistency in the model with social psychology observations and unrealistically correlate affective exposure time with the likelihood of changes in affect (263).

Ripple Effect Computational Model

Saunier and Jones developed a computational model of affect contagion (224). The computational experiments conducted were compared to the results from Barsade's Ripple Effect (18) for verification. The results of running their computational model were consistent with the results from the empirical data reported by Barsade (224). The authors discuss the use of their model for temporal dynamics of emotions, as a computer interface program, but not application for real world affect contagion situations.

It is unclear from the publication whether the authors had access to the original data used in the Ripple Effect study or they just compared their model's results with the results in the published paper. This brings to question whether the study can be considered truly validated against empirical data from humans. Without knowledge of the original data, it may be inappropriate to draw conclusions regarding validation. . In order to advance the use of this model for more complex affect contagion situations, it should be more clearly tested against empirical data collected from actual affect contagion research with live subjects instead of computers.

Mutual Absorption of Emotions Model

Bosse et al. developed the mutual absorption of emotions model based on the idea of affect spreading from the “bottom up”, an aggregation of individual affect to create the group affect (34). This method draws from Barsade's theoretical affect research (19, 149). The mutual absorption of emotion model considers the sender's expressivity and the receiver's susceptibility to the affect of others (34). The mathematical equations for the model were verified using computational modeling techniques with multiple iterations of scenarios that represented affect contagion situations. The authors believed the model to be accurate and robust and recommend further empirical verification of the model (34). The multi-agent model for mutual absorption of emotions has been validated in crowd situations and small group affect contagion (263). The theoretical model of Kelly and Barsade can be fully operationalized in the Bosse computational model (34, 149). The Bosse model has been validated by multiple studies of different scenarios, but has not been used to understand affect contagion among healthcare professionals, nor have stimuli been introduced in a natural setting to modify affect within the model. When the mutual absorption of emotions model was compared to the Durupinar infectious disease model regarding

ability to predict accurately affect contagion, both models performed well to changing parameters in the simulation program, but the thermodynamics style (mutual absorption of emotions) model was superior to the epidemiologic model of affect contagion in its ability to reproduce the behaviors demonstrated in actual crowd panic circumstances (263).

VIRTUAL MODELS & SIMULATED MODELS

There are many virtual affect contagion models developed for use with computer programs in which humans interact with characters that respond in a way that imitates human response. Most of the affect contagion computational models are non-specific and attempt to generalize so the models can be applied to varying circumstances (16, 29, 54, 129, 148, 209). One group even developed an affect contagion model that makes recommendations for interventions to modify the affect (78, 79). Some of the models were developed to simulate crowd reactions and understand fear under emergent circumstances. These models were developed with the idea that crowd control and evacuation planning could be done using the simulated affect contagion responses (28, 128, 129, 286). Other models of affect are not intended for understanding affect contagion in the real world, only to mimic it virtually as a means to make human-computer interfaces more appealing (14, 73, 260). The virtual models are tested against themselves for consistent results, but not against real world data to use for understanding affect contagion in a naturalistic setting. For some of the models, surveys regarding “likability” of the interface interaction have been conducted with the end users, but these surveys do not determine whether the user has experienced affect contagion. These computational models can be used to guide the variables included or excluded when developing a computational model applied to naturalistic studies of affect contagion.

AFFECT CONTAGION THROUGH SOCIAL MEDIA

New affect contagion research is developing around social media. Although the reviewed social media studies do not use computational modeling or SNA for analyzing the data collected regarding affect contagion, social media outlets like Twitter and Facebook use social network principles to identify and track relationships. Furthermore, the researchers utilized computational models of word analysis to identify interactions that were related to user affect. The interactions tracked and analyzed in the described studies required advanced social network structures and computational linguistic models for data collection and analysis.

Twitter Study

A study of Twitter account users demonstrated that sparser social networks have higher tendencies to share emotions. Also, Tweepers with more influence and brokerage opportunities tend to share negative emotions more freely (214). Furthermore, emotional states tend to cluster among the network members (214).

Facebook Study I

Emotional contagion was established in Facebook users through manipulation of the user's News Feed, the amount of positive or negative updates from the user's friends were decreased from their viewing in the News Feed feature (156). Decreasing positive updates from friends increased the user's likelihood to post negative updates and decreased positive update posts. Decreasing negative updates from friends had an opposite effect on the user. Kramer, Guillroy, and Hancock suggest that because status updates are not directed at individuals the contagion can occur without specific interaction (156). Reactions to the News Feed demonstrated that exposure to emotional content elicited an emotional response from users, both positive and negative without a negativity bias. Finally, this study of Facebook users found that

users exposed to fewer emotional posts from friends decreased their emotional expression for the next few days (156).

Facebook Study II

In a second study of Facebook users, Kramer reviewed the posts of Facebook users over three days and the posts of the Facebook user's friends (157). Positive Facebook posts increased the likelihood that friends would also have positive posts, and negative posts increased the likelihood that positive posts from friends were suppressed (157). This study, although not SNA, uses a virtual social network platform to identify relationship among users of the platform and demonstrates that affect contagion occurs with virtual relationships and does not necessarily hinge upon proximity of physical location.

Rainfall and Affect Contagion

In a third study utilizing the posts of Facebook users, the affect of users was monitored in relation to rainfall. Rainy days decrease the number of positive posts and increase the number of negative posts by people in the areas receiving the rain (62). The change in emotion related to rainfall can be transferred to other users in areas without rain through the posts. Coviello et al. determined that for each rain influenced post the affect posted by one or two friends was changed (62). Confirmation that events in the daily lives of others with whom a person interacts can cause changes in affect has been previously discussed (11); the findings of Coviello et al. confirm that through social media affect can be changed by an everyday event and transferred to others with whom a person comes in contact (62).

The Fowler and Christakis study of happiness occurred prior to the integration of social media outlets into the everyday routine of so many (94). These studies of affect contagion through social media demonstrate that physical location may no longer be a significant factor for

the spread of affect. Since the Fowler and Christakis happiness study, access to communication has increased, and methods of maintaining long distant relationships have changed to include email, cell phones, and social media. The fluidity of modern communication has allowed for the methods of sharing affect also to modernize. Affect contagion no longer requires physical proximity.

CONCLUSIONS

Upon review of the available scientific literature, Bosse's mutual absorption of emotions model provides a solid foundation to develop and apply to a natural setting (34). This study uses the mutual absorption of emotions model to identify the variables measured and employs a mathematical equation for developing a computational model. The mutual model of absorption has already been validated mathematically and when compared to actual human reactions in evacuation scenarios.

The current study applies the mutual model of absorption to the occurrence of affect contagion in an academic, non-panic, but somewhat stressful environment. This model seems to be the most validated, but it appears that the variables included in the mutual model of absorption have not been previously parsed and quantified individually. For the current research, the investigator collected prospective data from participants using validated self-report instruments providing individual scores for each of the variables identified in the model. Also, this study introduced an affect influencing event to attempt to modify the affect and have a contagion effect. Previous intervention studies were conducted in an open network for a short time period (one week) while this study uses a closed network setting that tracked longitudinally during a 15 week academic semester. This study may better capture the occurrence of affect contagion. This study also used instruments to measure affect expressivity and contagion

susceptibility which were not included in the previous intervention study. Lastly, this study used SNA to analyze the information collected from study participants.

Chapter 1 outlined the theoretical framework and specific aims for the study; chapter 2 provided a synopsis of the literature pertaining to the use of SNA and computational modeling for the understanding of affect contagion. Chapter 3 provides the methodology undertaken to develop an understanding of affect contagion in light of the existing literature, the chosen theoretical framework, and specific aims and research question of this study.

Chapter 3: Methods

INTRODUCTION

In this chapter, the methodology for selection of participants, selected instruments, data collection, and analytical plan are addressed. The chapter concludes with an explanation of the supplementary measures used to reduce variability in the study.

RESEARCH DESIGN

The present study was a descriptive explanatory within and between subjects design that used correlational statistics to understand affect contagion. The study consisted of two phases, real-time data collection, and data analysis. Phase one occurred at the Daniel K. Inouye Graduate School of Nursing (GSN), Uniformed Services University of Health Sciences (USU). During phase two the investigator traveled to Sandia National Laboratories (Sandia) in Albuquerque, New Mexico. This study used social network analysis, traditional linear statistics, and computational modeling to understand the evolution of affect contagion in a group of advanced practice nursing (APN) students. The specific aims of the study were to customize an agent-based model of affect contagion and determine the effect size (primary and secondary) of exposure to an affect influencing stimuli.

POPULATION

Social network analysis (SNA) is the statistical method of mapping and measuring relationships and flows of mood among people, groups, organizations, and other influences. The class of first year GSN students enrolled at USU participated in the study. The class consisted of 60 U.S. military officers who are nurses and current students in the master's or doctorate of nursing practice programs at the GSN. This subject population was chosen because of their prior experiences and military work history in clinical practice as nurses.

INCLUSION / EXCLUSION CRITERIA

In this study, the investigator customizes an existing computational model of affect contagion to a network of APN students. The students in the cohort enrolled in the spring of 2014 and were in classes together during the summer and fall semesters prior to the start of the study. The study occurred during the cohort's second (Fall 2014) and third (Spring 2015) semesters. Other university students who were not the first year APN students were not invited to participate in the study because the other students do not regularly interact or attend class with the APN students.

RESEARCH LOCATION / SETTING

Graduate School of Nursing (GSN)

The study took place in the GSN during the fall and spring semester in 2014 and 2015. The GSN student population was chosen for its ease of access and similarity with the military nursing population clinically practicing in military treatment facilities. The GSN Dean provided a letter of support that can be found in Appendix A. Request for Institutional Review Board (IRB) approval from the USUHS IRB is in Appendix H.

Sandia National Laboratories (Sandia)

Sandia National Laboratories is a research and development corporation that is part of the U.S. Department of Energy. Members of the Complex Adaptive Systems of Systems Engineering department facilitated the present study. Their work focuses non-linear statistical analysis and includes modeling for disaster relief preparedness and public health initiatives to facilitate decision making and inform policy. Sandia supported this study with computational resources and support staff to assist with statistical analysis and computational modeling. Sandia staff regularly engage in computational modeling and have generated an agent-based model of

affect contagion. Sandia also provides competence in uncertainty quantification and sensitivity analysis of both computational and statistical models used in this study. Incomplete cohort participation and imputation of missing social network members increases uncertainty in the study data and interpretations. Uncertainty quantification estimates the potential effect of uncertainties within the model might have on conclusions drawn from the sample participants. Jackknife confidence intervals (CI) were used to quantify the level of uncertainty. Sensitivity analysis refers to the response of the ABM to different input values.

Sandia has a long standing history of applying a complexity paradigm to difficult problems, combining computational modeling software, high performance computing capabilities, and a team of scientists specializing in modeling and analysis to explain behavioral phenomena. A letter of support from Sandia can be found in Appendix B.

DESCRIPTION OF INSTRUMENTS

Data collection involved the use of nine instruments. Self-report instruments provide values to develop social network topology for the ABM, operationalize construct from the theoretical model of Moods and Emotions in Small Groups and Work Teams through measuring corresponding variables, and provide input values for the variables used in the ABM simulation. Specifically, social network roster survey, and friendship nominations identified network relationships among participants and informed the affective compositional effects (266). The International Positive Affect Negative Affect Schedule Short Form (I-PANAS-SF) instrument measured individual state affect (255). The trait affect instrument, Iowa Personality Questionnaire (IPQ), established individual trait affect (77). The perceived stress scale (PSS) facilitated generalizable explanation of the relationships among daily affect and the intergroup context of non-affective influences when cross-referenced with the life history calendar and I-

PANAS-SF (13, 55). Stress levels and affect may change in association with events that occur in the student cohort's normal academic schedules. The contagion susceptibility instrument measured the propensity for an individual to "catch" affect from interactions and operationalizes the shared affective experience (74). The Berkeley Expressivity Questionnaire (BEQ) measured the ability for participants to express their emotions to others operationalizing the shared affective experience (110). Demographic characteristics stratified the network to assess for various patterns related to individual demographic characteristics. Each of instrument is included in Appendix F. A description of the instruments and their psychometric properties follows.

Participants were assigned a unique identifier (UID) number for use during the study. The procedures section of this chapter details the consent process and UID assignment. Study participants completed an initial packet consisting of six instruments:

1. Demographics Sheet

The Demographics Questionnaire includes questions relevant to this study including age, gender, race, relationship status, military service, rank, military branch, academic program, non-military nursing experience, and exercise routine. Demographic characteristics may influence how participants interact. Previous studies have linked gender, relationships, and exercise as influencers on affect (5, 14, 27, 46, 48, 52). The demographic variables were used for cluster analysis and as covariates in statistical analyses. The demographics sheet demonstrates content validity because it is only collecting personal information that is relevant to understanding affect contagion within the APN student network (102).

2. Friendship Nominations (Census Data method)

Friendship nominations weight the influence of a small number of acquaintances on each participant. Participants listed in rank order the three people whom they feel closest to in the cohort. Participants generate nominations from memory without cues from a class list to encourage nominations for which a strong relationship between the participant and the nominated friend exist. The friendship nominations questionnaire demonstrates content validity because the questionnaire focuses on personal relationships that are relevant to understanding affect contagion within the APN student network (102).

3. Social Network Survey Roster (Census Data method)

Participants reported associations with other network members using the census data method (23, 25, 56). The survey is a roster consisting of student names. Participants rate the interaction frequency with classmates on the roster using a scale of one (never) to five (frequently) (69). The scientific literature indicates that academic communities are commonly surveyed using this method (32, 68). This method of mapping the social network identifies both weak and strong ties among the network members and strictly defines network members (69). The social network survey informed social network component of the ABM and determined group member assignment for exposure to the affect influencing stimuli based on centrality and betweenness calculations (see procedures section). The social network survey roster demonstrates content validity because the questionnaire focuses on personal relationships that are relevant to understanding affect contagion within the APN student network (102).

4. Contagion Susceptibility

The emotional contagion scale measures likelihood participants to be influenced by the affect of others (28). The original sample used to develop the instrument included three

populations: practicing physicians, undergraduate students and U.S. Marines (28). The instrument had a Cronbach's α of 0.90, demonstrating contagion susceptibility 90% of the time. The instrument has been used in various work environments to understand affect contagion's impact on burnout, customer service, and manager – worker relationships (1, 3, 22, 42, 63). The instrument consists of 15 questions related to how the participant reacts under various emotional conditions and uses a five-point Likert scale one (never) to five (always). The score from the contagion susceptibility instrument quantifies the susceptibility of the “receiver” variable. The “receiver” is the person in an interaction who is the recipient of another network member's projected affect.

Construct validity was tested between emotional contagion, related constructs, and the emotional contagion scale through comparison to seven other instruments. The relationships between the emotional contagion scale and related constructs were as the researchers hypothesized. Susceptibility to emotional contagion was positively related to reactivity, emotionality, sensitivity to others, social functioning, and empathy. Also, susceptibility was negatively associated with emotional stability, alienation, and masculinity and unrelated to approval motivation (74). Validation of the emotional contagion scale was demonstrated through appropriate convergent and discriminant relationships to the comparison constructs (102).

5. Berkeley Expressivity Questionnaire (BEQ)

The BEQ measures emotional expression through the manifestation of observable behavioral reactions to emotional impulses (111). This definition of expressivity posits that emotions represent points on a scale of positive and negative affect (280). Expressivity is correlated with mood and personality (111). The instrument was developed and tested on

undergraduate students (110). The test-retest reliability of the three student sample groups was 0.86. With an overall Cronbach's α of 0.85, the BEQ reliably measures expressivity with 85% accuracy. The instrument consists of a 16 item seven point Likert scale questionnaire in which the participant ranks their agreement from 1 (strongly disagree) to 7 (strongly agree) with statements related to emotional expression. It has also been used for measurement of the workplace affect among supervisors and subordinates and in studies of empathetic accuracy (232, 288, 289). Responses to the BEQ quantified the expressiveness of the "sender" variable. The "sender" is the person in an interaction who is projecting his or her affect out to other network members.

Factor analysis for the expressivity factor measured by the questionnaire was conducted to test validity based on the internal structure of the questionnaire (102, 110). The first sample contained 22 factors and had a χ -reliability of 0.85 meaning the sample represented affect expressivity 85% of the time. When the 22 factors were reduced to 16, the χ -reliability of 0.85 was maintained (110).

6. Iowa Personality Questionnaire (IPQ)

A trait affect instrument measures generalized affect (65, 77). Defining a participant's general affective trait correlates with their state affect through time (30, 65, 77). The Iowa Personality Questionnaire measures participant trait affect. The IPQ consists of 42 questions comparing personality traits of participants to others their age and gender. The participant used a Likert scale of one to five to quantify their responses (77). The instrument has a Cronbach's α of 0.80 and 0.74 for identifying positive and negative trait affect respectively (77). This instrument has been used in adult populations.

Cconstruct validity was tested between the IPQ, a second personality questionnaire, and related constructs. The IPQ has shown a longitudinal correlation with other personality trait instruments (Multidimensional Personality Questionnaire – MPQ) (77). The relationships between each measured construct and the IPQ or MPQ validated the hypotheses of the researcher about the construct relationships. Furthermore, the convergent and discriminant relationships for the IPQ and MPQ were similar. The response matching ranged from 91%-95% for the two instruments (77). The IPQ was selected instead of the MPQ because it has 234 questions less than the short version of the MPQ and seems to be as valid (77).

The following four instruments were completed on data collection days (see Tables 1 and 2 for timeline):

1. International Positive Affect Negative Affect Schedule Short Form (I-PANAS-SF)

The I-PANAS-SF uses a 10 item survey with a 5-point scale to measure mood (42, 255, 278). The instrument measures state affect. The participants documented their affect in the morning and afternoon to capture changes in affect during the specific period (63). The instrument has been used in adult populations with a reliability of 0.78 for measuring positive affect and 0.76 for negative affect (255). It has been previously applied to the measurement of affect in the work setting (51, 207). The I-PANAS-SF quantifies the affect values for participants. A change in affect related to stimuli exposure was calculated from the I-PANAS-SF responses.

Factor analysis, convergent evidence, and criterion-related validity for the affect items measured by the instrument were conducted to test validity based on the internal structure of the questionnaire (102, 255). Validation through these methods preserved the content validity from the original 20 question PANAS and the I-PANAS-SF relationships to the constructs of positive

and negative affect (255, 278). The goodness of fit of the factor analysis confirmed that the I-PANAS-SF reflect the PA and NA constructs measured by the original PANAS (255, 278). Convergent validity further confirmed the measurement of PA and NA through comparison of the I-PANAS-SF to two affect measuring instruments. The criterion-related validity was measured through correlation of the I-PANAS-SF with age and gender. Gender did not support the criterion-related validity while age did support criterion-related validity (255). The combination of multiple methods for validating the I-PANAS-SF increase confidence that the instruments can accurately measure PA and NA.

2. Perceived Stress Scale (PSS)

The PSS identifies self-reported stress levels. The PSS is a 10-item measure that assesses an individual's appraisal of non-specific life stressors (55). The Perceived Stress Scale demonstrates reliability (0.84 to 0.86); it is predictive of biological indicators of stress in humans with correlation coefficients ranging from 0.52 to 0.76 for stress symptom measure (55). The PSS has been used in general adult populations, academic populations, and adult working populations (5, 10, 166, 190, 218, 275). The PSS was a comparison to the participant's responses to the I-PANAS-SF. Correlated PA and low stress and NA and high stress support the validity of the I-PANAS-SF.

Validation of the PSS has both convergent and discriminant evidence through correlation with ten different instruments that measure emotional variables including depression and anxiety (55, 163). Criterion-related validity has correlated PSS scores with multiple general characteristics including age, race, marital status, employment, income, and number of children (163). The PSS has been used around the world for the last 30 years and has been validated multiple times over as an appropriate instrument for the measurement of perceived stress.

3. Attendance rosters (Jointness Data)

Jointness data establishes associations based on event attendance associating network members who are present (69). Class attendance identifies which students are present to be exposed to the affect contagion (12, 69). The participation roster at each event identifies which members of the network experience direct exposure to the event. The attendance roster demonstrates content validity because the instrument focuses on the relationships that are relevant to understanding affect contagion within the APN student network (102).

4. Life history Calendar

The life history calendar records events that occur in an environment. A calendar chronicles major events that could influence the affect of the environment. Events of interest include the exams, major project due dates, and new policy implementation. The life history calendar provides a way to document accurately events that influence the variable of interest and are not accounted for through the other instruments (13). The life history calendar method has content validity because the instrument has the flexibility for documenting events that may be relevant to the understanding of affect contagion within the APN student network (102).

ENVIRONMENTAL INFLUENCE ON AFFECT

Stressors and events experienced by participants as a part of their everyday living have the ability to influence their affect. Life events, the media, and academic experience can have an impact on individual affect (11, 213). The life history calendar provided a means for documenting the known affect influencing events to include scheduled exams, major assignment due dates, clinical days, mandatory training, and major events in the media that could impact the student directly. However, individual experiences were not identified or described. Changes in affect have been observed related to current events, personal or academic experiences (11, 213).

Intentional changes to the order in which current events were presented had the ability to change the affect of readers (156). Additional exposure to affective stimuli provided a specific identifiable affect influencing event. If the stimuli cannot overcome the noise from the naturally occurring stimuli, then naturally occurring affect contagion was observed. The introduction of the stimuli is intended to be an identifiable event that changes the affect of participants and can be traced back to the specific event, amplifying the existing affect contagion conditions.

DESCRIPTION OF AFFECT INFLUENCING STIMULI

Various forms of affect influencing stimuli were considered for inclusion in this study. Many citations regarding affect and well-being are found in the music literature but are limited in workplace and healthcare worker contexts. Music is known to improve mood, reduce stress, and improve decision making, and productivity (32, 167, 168, 217, 236, 239, 243). However, music selection reflects personal choice and, therefore, music stimuli was not considered for this study. In a study of physicians, candy was given to the stimuli group and improved their affect and decision-making skills (86). Other studies of food also demonstrate increases in positive affect and decreases in negative affect (127, 284), but the participant's perception of food determines how it influences affect (127). For example, a person who enjoys pasta may have improved affect from a free lunch of spaghetti and meatballs, whereas the affect of a person who does not eat pasta may deteriorate from the offering of spaghetti and meatballs. Because of the sensitivities surrounding food it was not selected for inclusion in this study. Spending time with service dogs has demonstrated decreases in stress and improved health (285). Also, dogs facilitate social behaviors like participation in activities and encourage interactions with others (281, 285). Logistically, the use of service dogs for the study was not possible. Massage therapy has been used previously to improve affect and reduce stress in nursing populations (59, 219).

Taking a stretch or exercise break while the work day has demonstrated an improvement in affect as well (262). Financial and time constraints prevented the use of massage therapy and guided stretching for use as the stimuli in this study. Listening to music, offering food, spending time with service dogs, receiving a message and participating in stretch break were all investigated and determined to be unrealistic for execution in the present study.

Humorous video clips were chosen as the stimuli for the study because viewing these clips did not entail the drawbacks identified in the preceding paragraphs. The following is the description of the video-clip-based positive affect influencing stimuli that the study participants were exposed to three times during the spring semester 2015. Exposure to the affect influencing event was meant to manipulate intentionally the affect of the participants. The network was divided into four groups for stimuli exposure. Only one group was exposed during each data collection day. Exposing only part of the network at a time allowed for correlating the changes in affect with the exposure to the stimuli.

Humor in groups increases cohesion and the formation of teams (71, 268). Furthermore, individuals exposed to humor demonstrate an increase in positive affect and a decrease in negative affect (155, 268, 269). Film is one of the most effective methods for mood induction (101, 283). Therefore, it was postulated that exposing some of the network of students to humorous videos would elicit not only a primary change in affect of the exposed group but also demonstrate contagion as evidenced by secondary changes in affect to students in the not exposed group (94). Humorous video clips from the internet are commonplace, the effectiveness of the video clips may be inhibited by a lack of novelty. The participants were selected from a rigorous academic program that require a significant portion of their time for academics. Therefore, participants had limited free time. Documentation of activities done during free time

is not included in this study, but based upon the requirements of the academic programs the student participants are enrolled in, it is unlikely that they are watching humorous internet videos with any frequency. A pool of public domain humorous videos selected through a focus group was shown to the participants. Each video was 6-10 minutes long and intended to evoke a humorous response. A description of the methods used for video selection and links to the video clips is in Appendix C. The procedures for exposure to the affect influencing event are in steps 5 and 8b of the procedures, and Table 2.

PHASE ONE: DATA COLLECTION PROCEDURE – ESTABLISHING AFFECT CONTAGION

During phase one, baseline environmental affect and affect changes due to the affect influencing stimuli were measured. Affect data collected during school days without stimuli exposure established baseline affect conditions. Data from days with stimuli exposure determined primary and secondary affective effects. Table 1 and 2 provide timelines for the study, and Table 3 summarizes the data collection phase of the study.

Weeks 1-4	Weeks 5-8	Weeks 9-14	Weeks 15-20	Weeks 21-52
Recruit	social network analysis	collect affect data	collect affect data	data analysis
Consent	assign stimuli groups	week 9 baseline data	week 15 baseline	
Initial instrument packet		stimuli* exposure	stimuli exposure	
			week 20 closing Social Network Surveys	

Table 1. Study timeline

*Procedure steps 4, 5, and 8b explain stimuli exposure (pp. 67, 69).

Week	Date	Monday	Wednesday	Thursday
9	5-Jan	Baseline		
10	12-Jan		Stimuli Group 1*	
11	19-Jan		Stimuli Group 2*	
12	26-Jan		Stimuli Group 3*	
13	2-Feb		Stimuli Group 4*	
14	9-Feb		Stimuli Group 1*	
15	16-Feb		Stimuli Group 2*	
16	23-Feb		Stimuli Group 3*	
17	2-Mar		Stimuli Group 4*	
18	9-Mar		Stimuli Group 1*	Baseline (postponed because of weather)
19	16-Mar		Stimuli Group 2*	Repeat Social Network
20	30-Mar		Stimuli Group 3*	Baseline

Table 2. Data collection timeline.

Data collection was originally scheduled to occur the week of 6 April as well, but because of a change in the class schedule, the students only had one final exam that week. *Procedure steps 4, 5, and 8b (pp. 67, 69) explain stimuli exposure.

Task	Data Collected	Number of times collected	Estimated completion time
<u>Initial Survey Completion</u>	Social Network Survey	1	60 minutes
	Expressivity Survey		
	Susceptibility Survey		
	Trait Affect Personality		
	Demographics		
<u>Affect Assessment</u>	State Affect Survey (x2 /day)	14	140 minutes
	Stress Scale (x1 /day)		
	Stimuli exposure (x1 6-8 min) 6 of the 14 days		
<u>Closing Social Network Survey</u>	Social Network Surveys	1	15 minutes

Table 3. Data collection summary

1. Recruited student participants during the lunch hour. The investigator was available to meet with students and review the study content and consent. The students also received email invitations to participate.
 - a. Students were recruited to participate through solicitation and word of mouth. Flyers and invitation emails were sent to the students (see Appendix D). The student pool was pre-selected through exclusively inviting students in the first year APN cohort. A table was set up outside the lecture hall in the basement of the GSN where students can sign up to participate. Recruiting ended after four weeks.
2. Faculty members who interact with the APN student cohort were invited to participate. Study content was presented to faculty at a monthly meeting. Faculty members who agree to participate completed the same instruments as the students but did not participate in the social network analysis and stimuli exposure. Although peripheral and transient members of the social network, they have the potential to influence the affect of the network members because of their influential status in the academic hierarchy (39, 43, 50, 137).
3. Consent Process: To prevent undue influence related to military rank, the investigator did not wear her uniform nor disclose her military rank, honoring the autonomy of participants and allowing voluntary participation or withdrawal. Recruitment and follow-up occurred during the lunch break. The investigator reviewed the informed consent with the participants and answered questions. A copy of the consent form was given to participants, and a signed copy was kept for study records. Recruiting and consent occurred in the lounge area outside the lecture hall on the ground floor of the GSN.

Throughout the duration of the study, the investigator reinforced the informed consent by continuing to answer questions from participants and reiterate their choice to continue to participate in the study. Appendix E contains a copy of the consent form.

4. Participants were assigned a unique identifying number (UID), given a card with the UID number on it and completed the one-time initial instruments.
5. Participants were divided into four groups based on network centrality and betweenness. Centrality refers to the number of social network connections a given participant has while betweenness is the number of network shortest paths that pass through a particular participant (212). Network members were exposed to three different affect influencing events. The whole network was divided into four groups, two high centrality and betweenness groups and two low centrality, and betweenness groups. The investigator used PageRank centrality calculations for group assignment. PageRank centrality determines a participants' placement in the network based on popularity and influence through the number of friend nominations from other network members and nomination weight based on the Likert scale scores from the social network surveys and ranking from friendship nominations (253). Members with higher betweenness were in group one and higher centrality group two, and members with lower betweenness were in group three and lower centrality group four. Group size was equal based on the number of participants. Matching of similar centrality and betweenness scores for members of group one with group two and group three with group four assist in answering research questions 1.1 and 2.3: What is the relationship between network members with similar affect and their social interactions and How does network member centrality influence stimuli effect size? The group assignments were for affect influencing event exposure

during collection of affect data. Network members were exposed to three different affect influencing events through the course of the study.

6. For 11 academic weeks, affect data were collected, and the affect influencing stimuli occurred. Baseline affect data were collected three times while stimuli exposure data were collected 11 times, three times with group one, two and three and two times with group four. Weeks nine and 11 had two days each week one day without stimuli to establish baseline affect, and one day with stimuli exposure (Table 1).
7. At the beginning of class on the morning of data collection, students in the stimuli group for that week were informed of the designation (Appendix D).
8. To increase participation rates, paper copy of the I-PANAS-SF were administered twice daily by the investigator, at the beginning of the class time and at the end of the class time (approximately 11:30 a.m. or 3:00 p.m.) to control for crossover affect. Change in responses between the beginning and end of the day was attributed to events during the day.
 - a. On each data collection day without stimuli, the investigator distributed the I-PANAS-SF to the students before the start of class and collected completed instruments at the first break.
 - i. On days when the cohort was together part of the day, the second I-PANAS-SF, and the PSS instruments were distributed at the start of the break and collected before separating into specialty groups.
 - ii. If non-exposure data were collected when the cohort was together for the entire day, then the procedure mirrored data collection on days with stimuli exposure but did not include a stimulus during the lunch hour.

- b. On each data collection day with stimuli, the investigator distributed the I-PANAS-SF to the students, prior to the start of class, and collected the instruments from participants at the first break. The investigator used a roster to verify completion of the instruments.
 - i. During the lunch hour, the identified group participated in the shared affective experience (Appendix C). There was a “sign in” roster at the stimulus event where participants confirmed their participation (Appendix G).
 - ii. At the end of morning class time, the investigator reminded the participants which stimulus group would be participating and listed the participants. Event participants went to a different classroom near the lecture hall and viewed the video. The investigator played the video using the projector and screen in the classroom. Following the video viewing, participants continued with their day as normal.
 - c. At the afternoon break, the second I-PANAS-SF and PSS were distributed to be completed. The investigator collected the instruments from participants at the end of the day. The investigator verified instrument completion with the roster.
9. The repeat Social Network Surveys was administered during the final week of data collection.

Token of appreciation

Following each data collection, cookies available for all network members (N=60). The cookies were on a table separate from the basket where participants returned their surveys and were not available until after the afternoon surveys were distributed.

PHASE TWO: DATA ANALYSIS AND ABM REFINEMENT

The data collected were compiled to answer the specific aims and research questions. The results of the data analysis are to be used to inform the mathematical model and parameterize the ABM for the student APN network (see Chapter 5, Limitations: Computational Model Methods). Social network data collected at the beginning and end of the study verified a dynamic network (see supplementary measures). Although a difference was expected between the two social network surveys, the significance of that difference was not determined. Therefore, the responses to the initial social network surveys were used for the statistical analysis.

Statistical Analysis

The investigators used linear statistics, SNA and a mathematical and computational modeling to explore affect contagion in a network (34, 150, 259). To track the spread of affect, stimuli were introduced to modify affect of specific participants. Specific aim one is to characterize the network. It relied primarily on SNA, computational model, and linear statistics. The p-value is the largest level of acceptable risk for rejecting a true null hypothesis (Type I error), expressed as a probability between 0 and 1. A smaller significance level reduces the likelihood of a Type I error and increases the likelihood of Type II error. Therefore, p-value that balanced the opposing risks of error was chosen. A p-value of 0.05 was used for statistical significance. There was a risk of a Type II error when conducting analyses related to demographics. Increasing the sample size reduces the risk of type II error, but with the closed network the pool of potential participants is restricted. Supplementary measures have been considered to reduce type II error (67). The supplementary measures were compared to the academic evidence available and included as a way to confirm that the population used for this study has similarities with previously studied populations. Demographic variables chosen for

inclusion in the analysis have academic evidence to support further analysis (75, 109, 209). It was hypothesized that the stimuli would boost affect at a specific time point, allowing a change in affect to be attributed to a specific event. Exposing selected network members to the stimuli allows for the observation of affect transfer among network members who did not receive the original stimuli. It was also hypothesized that a change in affect due to the stimuli would be observed in both exposed and non-exposed individuals. Therefore, identifying a change in affect for the not exposed individuals when their affect was unchanged constitutes a Type I error (67). Not identifying a change in affect when one had occurred constitutes a Type II error, (67). For this model, Type I and II errors are difficult to control for and rely heavily on unpredictable circumstances. The noise level of the environment includes naturally occurring circumstances that influence affect. Noise level cannot be controlled for by the investigator and could be a major factor influencing these errors. Another unknown factor is the impact of the stimuli. The video stimuli influenced each person differently; it cannot be predicted the efficacy of the stimuli in advance. If the stimulus is not sufficient to overcome the noise level of the environment, then no change in affect occurs. Therefore, the stimuli for this study were carefully chosen to demonstrate a large enough effect while still being feasible for implementation (94, 101, 283).

Multiple software programs were used to analyze the data for this study. First, optical mark recognition software was used to convert responses to paper surveys into electronic databases. Next various statistical analysis software was used to analyze and visualize the data. A summary of the software programs and procedures for cleaning and analyzing the data follows.

Optical Mark Recognition Software

Optical Mark Recognition (OMR) is a technology for reading data from “fill in the bubble” types of forms. The software includes barcode recognition, image clipping, speech recognition for transcribing handwritten responses, and the ability to recognize printed text (OCR) (254). Remark Office OMR is a software package designed to collect data from plain-paper OMR forms. The software works with an image scanner or multi-function printer to collect the data. Forms are created with any word processor, desktop publishing package, or form design software and can be printed on any laser printer or photocopier. The completed forms are scanned into the software where data can be exported to a various applications as spreadsheets for further analysis.

Social Network Analysis Software

UCINET

UCINET is a statistical analysis software for analyzing and visualizing social networks (33). The analysis capabilities include centrality measures, subgroup identification, role analysis, elementary graph theory, and permutation-based statistical analysis. All social network statistical analysis for this study was performed in UCINET.

R Statistics

R is a program language and software used for conducting statistical analysis (215). Some features of R include linear and nonlinear modeling, standard linear statistics. Assortative mixing correlations were conducted using the statistical analysis program.

SPSS

SPSS is a statistical analysis program that includes descriptive statistics, bivariate statistics, nonparametric tests, linear regression, and prediction for identifying groups (60). For

this study it was used for descriptive statistics, bivariate statistics and nonparametric testing features.

Data entering and cleaning procedure

1. Paper surveys from participants are scanned and saved as pdf files in batches
 - a. Initial survey packet
 - b. Repeat SNS packet
 - c. Weekly PANAS
 - d. Weekly PANAS/PSS
2. Original surveys are stored in a locked fire box
3. Using the Remark Gravic program, a proof of each survey instrument was programmed to be read by the program.
4. Import pdf files into Gravic
 - a. Generated spreadsheet of participant responses
 - b. Review spreadsheet for any missing entries or multiple responses
 - i. Refer to pdf copy or original hard copy of survey instruments to complete the spreadsheet
 - c. Conduct accuracy check for misread data
5. Export files to Excel
 - a. Calculate scores for survey instruments
 - i. IPQ
 - ii. BEQ
 - iii. ECS
 - iv. PANAS

v. PSS

6. Import files to SPSS, R, or UCiNet for data analysis
 - a. Create code book
 - b. Create network structure
 - c. Conduct analysis

Representative Sample and Effect Size Estimation

The study population is a preexisting network with 60 members, a sample of 35 network members participated in the study. The degree is the number of relationships a network member reports, also known as the degree centrality (140). Degree distribution was calculated to determine the representativeness of the sample population in relation to the full network. Network degree distribution seem to follow a preferential attachment, meaning the relationships are not formed randomly or by chance, and, therefore, occur in a “fat-tail” instead of even distribution (140). For the sample population to be considered representative the network of APN students, a non-normal “fat-tailed” degree distribution is necessary (140). The investigator calculates the frequency distribution for the number of links a network member plotted on a frequency graph (140). A skewed, “fat-tailed”, degree distribution has more network members with small or large degrees than moderate degrees. It was unknown what the participation rates would be for the population. However, a response rate for students in this nursing program is approximately 35% based on historical participation in online class evaluation response rates (196). Confidence intervals were calculated to quantify uncertainty. While a minimum of 20% of the network was needed to make general inferences, 80% participation or better provides the most accurate results (61, 133, 134, 152, 274). A sample size of 13 students was calculated

based on minimum participation needed to conduct social network analysis with 20% of the closed network participating.

Faculty members interacting with the students participants were also included. Two faculty members participated consistently in the study for the entire semester, one who taught the main morning lecture and one who taught the main afternoon lecture. Faculty participation is not included in the sample size necessary for data analysis.

Specific Aim 1: Characterize affect contagion in a social network to represent military APN students.

Characterizing affect contagion within the network used a combination of statistical methods. The following sections describe the methods used for answering the research questions related to aim one. Agent based modeling, SNA, and linear statistics were utilized in data analysis.

Agent Based Model Testing and Refinement

To inform an agent based model, the first step was to identify the population of interest (APN students) and a theoretical model that explains behavior (theory of mood and emotions in small groups and work teams (150, 174)). Then relationships were identified through SNA, and a theoretical model was applied to agent interaction (174). Once the population was identified, and the theory that governs behavior and interactions established, data to support the model was collected to quantify each variable (174). The computational model is to be validated through behaviors and interactions observed in the model output that mimic the behaviors and interactions outlined in the theory (174).

The ABM is based upon the mutual absorption of emotions model that uses the Kelly and Barsade's (2001) theoretical model to support the operational variables (34). The analytical model developed by Bosse et al. (2004) uses the four variables measured by the self-report instruments

(Table 4) to determine “sender” and “receiver” characteristics. The Bosse et al. (2004) model consists of a series of equations that measure the group affective mean and predict the change in the affect of the individual through dyadic interactions (34). Dyadic interactions, comparing the affect of pairs of friends, differs from the aggregation (group mean) of affect the theoretical model suggests. However, the Bosse et al. (2004) is the most comprehensive model of affect contagion available, and can be built upon to represent the theorized occurrence of affect contagion. The dyadic relationships are a limiting parameter related to a computational model’s capabilities because the computational model can only consider the affective relationships for each pair and not aggregate the affect for the whole group. However, the model offers flexibility for the addition of the shared affective experience stimuli to understand further and visualize the theoretical basis proposed by Kelly and Barsade (2001).

Parameter	Meaning
q_s	Affect value of sender
ϵ_s	Expressiveness of sender
q_R	Affect value of receiver
δ_R	Susceptibility of receiver
α_{SR}	Strength of connection between sender and receiver

Table 4. Model parameters

The following equations use a weighted averages algorithm to calculate an affective score where the importance of the affect of some network members is more than others based on the strength of relationships, expressivity, and contagion susceptibility. For the group of all participants G in a network where S is the “sender” node, and R is the “receiver” (34).

$$\frac{dq_R}{dt} = \gamma_R(q_R^* - q_R)$$

where

$$\gamma_R = \sum_{S \in G \setminus \{R\}} \gamma_{SR}$$

and

$$q_R^* = \sum_{S \in G \setminus \{R\}} w_{SR} q_S$$

and

$$w_{SR} = \sum_{C \in G \setminus \{R\}} \frac{\epsilon_S \alpha_{SR}}{\sum_{C \in G \setminus \{R\}} \epsilon_C \alpha_{CR}}$$

and

$$\gamma_{SR} = \epsilon_S \alpha_{AS} \delta_R$$

It was expected that data collected without stimuli would follow the mutual absorption of emotions model without a significant difference (34). Data collected with stimuli should demonstrate a difference from the mutual absorption of emotions model.

Research Question 1.1: What is the relationship between network members with similar affect and their social interactions?

Interactions identified from the Social Network Surveys and attendance sheets were arranged in matrices (36). To establish network interactions participants were split into groups through calculating network density, the total number of existing relationships divided by the total number of possible relationships (38, 259). Using demographic data, density can be parsed by specific characteristics. It was expected that affect similarity is related to network density. Totterdell et al. (2004) found a relationship between affect and density; higher density networks had a higher propensity for share affect.

Comparing social network structures and participant characteristics using cluster analysis

identified the overlap of the member and reported affect. Students with strong relationships should demonstrate a propensity for affect contagion greater than students with weaker or no relationships.

Structural equivalence, two nodes having identical relationships with the nodes around them (140), has also demonstrated a relationship with affect. Affect similarity was found among network members who were structurally equivalent (259). The census data were used to calculate structural equivalence. Structural equivalence was evaluated using Pearson correlations and Jaccard matching. Comparisons of affect score from stimulus exposure groups one, two, three, and four for exposure to the same affect influencing events were used to understand the role of structural equivalence in affect contagion (40).

Research Question 1.2: Do Individual's with strong ties have greater affect similarity?

Census data and the I-PANAS-SF are used to calculate the affective group tone (reactions that occur when network members interact), identify network relationships and aggregate affect scores based on the social network relationships (58). To ensure that the aggregated group tone was appropriate, Intraclass correlation coefficients were calculated. Intraclass correlation coefficients 1 (ICC(1)), which estimate the proportion of variance in individual-level outcomes and intraclass correlation coefficients 2 (ICC(2)) that estimate the group mean justify aggregation of individual scores (31). Aggregation is appropriate if an F-test is significant (153), and the ICC (2) is greater than or equal to .70 (24, 153) and group similarity of individual affect r values should equal or exceed .70 (96, 141). Under these conditions, it is appropriate to aggregate the individual data to the group level (56, 58, 181). Assortative mixing, the correlation of affect based on identified network relationships, by afternoon affect scores, was conducted for each data collection day to measure the likelihood that pairs of nodes would have similar affect scores. Assortativity is scored on a scale of -1 to 1, -1 is negatively correlated, 1 is positively correlated. Jackknife confidence

intervals were calculated to quantify the uncertainty associated with assortativity scores.

Research Question 1.3: What are the system mechanisms influencing affect within the network?

System mechanisms are characteristics unique to the social network that may influence how affect contagion occurred. Clustering coefficients and cliques are two methods for analyzing how network members group together. The clustering coefficient measures the tendency for nodes to group together, or cluster (212). In social networks, this clustering occurs on average more often than the probability of establishing a random tie. The clustering coefficient measures the concentration of relationships in a network (212). The roster data were used to identify clusters of network members who shared relationships, called cliques. A clique can have as few as three network members who share ties among them (212). These measurements provide insight to the friendships between participants. Assortative mixing correlations and Jackknife CIs were calculated for the three main cliques identified to determine affect similarity.

Research Question 1.4: What is the relationship between network topology and ECS scores?

Spearman's rank order correlations were conducted to determine the relationship between ECS scores and network topology. It was hypothesized that central members of the network would have higher ECS scores than peripheral members and ECS scores would be similar based on the academic program.

Research Question 1.5: What is the relationship between network topology and BEQ scores?

Spearman's rank order correlations were conducted to determine the relationship between BEQ scores and network topology. It was hypothesized that central members of the network would have higher BEQ scores than peripheral members, and BEQ scores would be similar based on the academic program.

Research Question 1.6: *What is the relationship between ECS and BEQ scores?*

Spearman's rank order correlation determined whether there is a relationship between BEQ and ECS scores. It was expected that scores would be positively correlated suggesting participants who are more expressive are also more susceptible to affective contagion.

Research Question 1.7: *What is the relationship between IPQ and ECS scores? What is the relationship between IPQ and BEQ scores?*

Spearman's rank order was used to compare IPQ scores with ECS and BEQ scores.

Research Question 1.8: *What is the relationship between gender and ECS scores? What is the relationship between gender and BEQ scores?*

To measure the relationships among gender, and ECS or BEQ scores, independent sample t-test were conducted. The test was conducted twice, once with the ECS scores and once with the BEQ scores. It was expected that males would have lower ECS and BEQ scores than females.

Research Question 1.9: *What is the relationship between age and ECS scores? What is the relationship between age and BEQ scores?*

Multiple regression compared age and the scores from the ECS and the BEQ. A negative relationship between age and ECS scores and a positive relationship between age and BEQ scores were expected.

Specific Aim 2: Determine the effect size (primary and secondary) of exposure to affect influencing stimuli.

Research Question 2.1: *What is the primary effect size of the affect influencing exposure to graduate nursing students?*

A between-within subjects analysis of variance by time point was used to determine whether the affect scores of participants in the stimuli group differed from the non-exposed network

members. A change in affect would be present for participants exposed to the shared affective experience stimulus.

Research Question 2.2: What is the secondary effect size of the affect influencing exposure to graduate nursing students?

Secondary effects were determined through assortativity correlations of affect between the stimuli group members and their identified friends. A change in affect was expected for participants not exposed to the stimuli. The secondary change in affect should be smaller than a primary change in affect (94).

Research Question 2.3: How does network location of the primary exposure group influence the secondary effect size of the stimuli?

Centrality and betweenness measures were used to determine individual connectedness and assign groups. Group one was the high centrality, group two was the high betweenness group, group three was low betweenness and group four was low centrality. All groups were exposed to the same stimuli on different days (Table 2). To determine the effect size of the stimuli, multiple steps were taken to determine whether an affect contagion effect occurred and could be associated with the stimuli. First, the time points in which a change in affect occurred in the intervention group were identified. Next, assortativity correlation of affect was conducted for the networks of the stimuli group for the identified time points. Finally, assortativity correlation of affect were conducted on the whole network. If the assortativity correlations of the stimuli group and the whole network were both significant for a specific time point, then the correlation of affect maybe associated with stimuli exposure.

Research Question 2.4: *Are there cumulative affective effects that occur during the study?*

Group emotion scores were calculated for each data collection day. Comparison of group emotion scores overtime using between within subjects analysis of variance determines the existence of cumulative affective effects.

Table 5 provides an overview of the research questions, the instruments used to quantify the variables being measured, and the statistical analysis used to answer the research questions. P-values for significance are less than 0.05.

Research Question	Instrument	Validity	Analysis
1.1 What is the relationship between network members with similar affect and their social interactions?	I-PANAS-SF, Demographics, Jointness and Census Data	I-PANAS-SF: Cronbach's α = .89 Minimum participation 80%	Nonsymmetric binary matrix, structural equivalence, density, assortative mixing, mixed model
1.2 Do individuals with strong ties have greater affect similarity?	I-PANAS-SF, Demographics, Jointness and Census Data	I-PANAS-SF: Cronbach's α = .89 Minimum participation 80%	Assortative mixing, ICC(1), ICC(2)
1.3 What are the system mechanisms influencing affect within the network?	I-PANAS-SF, IPQ (Trait Affect), Contagion susceptibility, BEQ, Jointness and Census Data	IPQ Cronbach's α .80, positive and .74 negative BEQ Cronbach's α 0.85 Contagion Susceptibility Cronbach's α .90	Cliques, cluster coefficient, density, assortative mixing

Table 5. Instruments and data analysis.

Research Question	Instrument	Independent Variable	Dependent Variable	Analysis
1.4 What is the relationship between network topology and ECS scores?	Jointness and Census Data, ECS	Network Proximity	ECS	Pearson/ Spearman Correlation
1.5 What is the relationship between network topology and BEQ scores?	Jointness and Census Data, BEQ	Network Proximity	BEQ	Pearson/ Spearman Correlation
1.6 What is the relationship between ECS and BEQ scores?	ECS and BEQ	ECS	BEQ	Pearson / Spearman Correlation
1.7 What is the relationship between IPQ and ECS scores? What is the relationship between IPQ and BEQ scores?	IPQ, ECS, BEQ	IPQ	ECS, BEQ	Pearson / Spearman Correlation
1.8 What is the relationship between gender ECS scores? What is the relationship between gender and BEQ scores?	Demographics, ECS, BEQ	Gender	ECS, BEQ	Independent Sample t-test
1.9 What is the relationship between age and ECS scores? What is the relationship between age and BEQ scores?	Demographics, ECS, BEQ	Age	ECS, BEQ	Pearson/ Spearman Correlation

Table 5. Instruments and Data Analysis.

Research Question	Instrument	Analysis
2.1 What is the primary effect size of the affect influencing exposure to graduate nursing students?	I-PANAS-SF	Between-within subjects analysis of variance by time point, paired t-test
2.2 What is the secondary effect size of the affect influencing exposure to graduate nursing students?	I-PANAS-SF, Contagion susceptibility, BEQ	Assortative mixing
2.3 How does network location of the primary exposure group influence the secondary effect size of the stimuli?	I-PANAS-SF, Contagion susceptibility, BEQ, Jointness and Census Data	Identify time points where intervention worked and affect contagion occurred, determine exposure group and conduct assortativity analysis
2.4 Are there cumulative affective effects that occur during the study?	I-PANAS-SF	Between-within subjects analysis of variance

Table 5. Instruments and Data Analysis.

Supplementary Measures

The following factors were relevant to data analysis and interpretation. They could not be controlled for, but instead observed and documented over the course of the study (Table 6).

Trait affect and Stress Conditions

Personality type and stress level influence general state affect (135, 199). Therefore, the student participants also completed the IPQ and weekly PSS. The PSS and IPQ instruments were compared to the state affect (I-PANAS_SF) of participants using correlational statistics. It was expected that these scores are correlated with the state affect.

Affect influencing Events

Affective events that occur in a field environment were accounted for so that if there was a significant change in affect that cannot be explained by the model, then qualitative explanation from field notes could be compared to the model for explanation. Events like major project due dates, exam dates, and spontaneous social events were included in a diary/calendar to account for possible uncontrolled affect influences (13).

Faculty inclusion

Faculty affect has the potential to influence student affect (39, 43, 50, 137). Faculty who interact with the students on the data collection days were asked to participate to account for affect changes related to interactions. Although peripheral and transient members of the social network, they have the potential to influence the affect of the network members because of their influential status in the academic hierarchy (39, 43, 50, 137).

Repeat Measure Social Network Surveys

Data were collected from the students regarding their affect and network relationships at the end of their second semester and beginning of their third semesters. This time frame within

the academic calendar provided the students within the network to become acquainted and establish a more mature and stable network structure than if the study occurred during their 1st semester. The maturity of the network assisted in the interpretation of the social network surveys. Because each survey provided a single time point static representation and cannot fully capture daily participant interactions, the social network survey administered at the close of the study should differ slightly from the initial social network surveys. The social network surveys were completed a second time to account for network dynamics. Quadratic assignment procedures were conducted to regress the initial and repeat social network surveys. Although differences are expected and confirm a dynamic network, they should not be statistically significant. Therefore, data analysis was conducted using the result from the social network surveys completed in the initial packet.

Supplementary Measures	Dependent Variable	Independent Variable	Analysis
Trait/State Affect	IPQ-BF	I-PANAS-SF	Pearson/ Spearman Correlation
Stress/State	PSS	I-PANAS-SF	Pearson/ Spearman Correlation relation
Events	Life History Calendar	I-PANAS-SF	Qualitative Association
Faculty	Faculty I-PANAS-SF	Student I-PANAS-SF	Pearson/ Spearman Correlation
Social Network	Initial Social Network Responses	Closing Social Network Responses	Quadratic Assignment Procedure Regression

Table 6. Supplementary measures.

Maintaining Confidentiality

The participants in the study were part of a small class at an easily identifiable university. Respecting their rights as participants and ensuring they were not identifiable as individuals when publishing results was of the utmost importance to the investigator. To guard the identities of participants, the researcher will not publish data that could identify individual participants. Use of information from the demographics sheet was screened when conducting and describing the population. If particular demographics could easily identify a small portion of participants, then it will not be reported in that way. An example of characteristics that when combined could identify an individual participant are age, rank, gender, and specific program of study. The UID helped maintain participant confidentiality with the investigator; it was the investigator's responsibility to report the findings in a manner that continued to maintain confidentiality.

CONCLUSIONS/SUMMARY

The results of the study were to be used to refine an ABM of affect contagion. Social network analysis provided an understanding of the topology of participant relationships (34, 263). Linear statistical methods identified relationships among the self – report measures to provide insight to the occurrence of affect contagion.

In this chapter the study population, setting, and instrumentation for the study were described. Then the procedures for data collection and data analysis processes were addressed. The chapter concluded with explanations of supplementary measures that account for noise within the network.

Chapter 4: Results

INTRODUCTION

This study was conducted to understand affect contagion in a network of military nurses in an academic environment and determined whether an affect influencing stimulus could change affect within the network. The data were collected for the study through an initial packet of self-report instruments which included a demographics survey, the Emotional Contagion Scale (ECS), the Berkeley Expressivity Questionnaire (BEQ), the social network roster and nomination surveys, and the Iowa Personality Questionnaire (IPQ). The International Positive Affect Negative Affect Schedule Short Form (I-PANAS-SF) and Perceived Stress Scale (PSS) were administered on 14 days during a semester. Participants were divided into four different stimulus exposure groups based on self-reported placement in the network derived from the social network roster survey. Exposure to one of three stimuli occurred on 11 of the data collection days while three of the data collection days did not have stimuli to compare the affect of the population between exposed and non-exposed days. State affect was measured twice daily on data collection days, at the beginning of morning class time (around 7:30 in the morning) and near the end of afternoon classes (about 2:30). Stimulus exposure occurred during the lunch hour for approximately 10 minutes. The information from the initial survey packet and 14 days throughout the semester generated data that answered the specific aims and research questions:

Specific Aim 1: Characterize affect contagion in a social network to represent military APN students

Research Question 1.1: What is the relationship between network members with similar affect and their social interactions?

Research Question 1.2: Do Individual's with strong ties have greater affect similarity?

Research Question 1.3: What are the system mechanisms influencing affect within the network?

Research Question 1.4: What is the relationship between network topology and ECS scores?

Research Question 1.5: What is the relationship between network topology and BEQ scores?

Research Question 1.6: What is the relationship between ECS and BEQ scores?

Research Question 1.7: What is the relationship between IPQ and ECS scores? BEQ scores?

Research Question 1.8: What is the relationship between gender and ECS scores? BEQ scores?

Research Question 1.9: What is the relationship between age and ECS scores? BEQ scores?

Specific Aim 2: Determine the effect size (primary and secondary) of exposure to affect influencing stimulus.

Research Question 2.1: What is the primary effect size of the affect influencing exposure to graduate nursing students?

Research Question 2.2: What is the secondary effect size of the affect influencing exposure to graduate nursing students?

Research Question 2.3: How does network location of the primary exposure group influence the secondary effect size of the stimulus?

Research Question 2.4: Are there cumulative affective effects that occur during the study?

Various methods of analysis were used to answer the research questions associated with the specific aims. Analysis methods including social network statistics, parametric and nonparametric linear statistics were applied to understand relationships between network members, their affect, the relationship between network membership and affect, the ability of a stimulus to influence affect. Findings from the statistical analysis are addressed in this chapter.

SETTING AND STUDY SAMPLE

This study was conducted on a closed network of graduate nursing students ($N = 60$). A closed network is a defined population with a set number of members. For this study it was a class of graduate nursing students, a closed network was chosen to more easily identify relationships and interactions within this specific population. Study participants were those students from the network of 60 students who participated in weekly affect surveys ($n = 35$), most students also completed the initial packet and repeat social network analysis surveys ($n = 33$). Previous studies of affect contagion in a college undergraduate population used an open network member in which the network members were identified by participants through keeping a journal of whom participants interacted with (270, 271). The open-network method builds a unique network for each participant and the network members reported by the participant may not be participating in the study. Workplace and military affect contagion studies used the closed network method in which participants in the study were identified through membership in a specific group, for example a department at work, specific factory, or military training program (147, 257–259). Two faculty members also participated in the study but were not considered part of the 60 member closed network of students. Analysis of student affect related to the affect of the participating faculty is found in the supplementary measures at the end of this chapter. Table 7 describes the demographics of the total network and the network of participants.

	Whole Network (N=60)	Participating Network (n=35)
<u>Gender</u>		
Male	25 (42%)	14 (40%)
Female	35 (58%)	21 (60%)
<u>Academic Program</u>		
WHNPP	2	2 (100%)
CNS	2	0 (0%)
FNP	29	13 (45%)
RNA	19	10 (53%)
PMHNP	13	10 (77%)
<u>Branch of Service</u>		
Army	27	17 (63%)
Navy	21	10 (48%)
Air Force	15	8 (53%)
<u>Rank</u>		
Officer Pay Grade 2	2	1(50%)
Officer Pay Grade 3	47	26 (55%)
Officer Pay Grade 4	14	8 (57%)
<u>Experience</u>		
Age		36 years (min = 27, max = 57)
Nursing Experience		11 years (min = 4, max = 29 S.D = 5.5)
Military Experience		10 years (min = 3, max = 23, S.D. = 5)

Table 7. Demographics for the entire cohort and study participants.

Data were collected from faculty and students through the initial survey packet at the end of the fall semester, with 14 more data collection days occurring during the spring semester. Participants took the initial survey packets home to complete and returned them to the Principal Investigator. Data from the surveys were entered into spreadsheets using optical mark recognition software (OMR) (254). The data from the social network roster survey were

analyzed to determine participant placement within the network and assignment to stimulus exposure groups: high betweenness, high centrality, low betweenness, and low centrality. Centrality is the number of relationships a given participant has as nominated by other participants, and betweenness is the number of network shortest paths that pass through a particular participant (212). Participant centrality scores ranged between 35 and 31 while betweenness scores ranged from 55.632 to 0. Most betweenness scores were ranged between 1 and 0. Participants were divided evenly among the four stimulus exposure group.

Schedule conflicts reduced the number of days during which stimulus exposure data could be collected to 11 times during the semester. Because of a last minute change in the cohort's academic schedule the twelfth data collection day did not occur, and the low centrality group was only exposed to two of the three stimuli. The stimulus exposure days occurred once weekly when the cohort of students had classes together for the entire day. Two-morning sessions and one-afternoon session were attended by all 60 students. One non-exposure to the stimulus day occurred at the beginning of the semester when the students were together for a special workshop for an entire day. Additionally, collection of stimulus exposure data could not occur when the whole cohort was together for only half of the day; students were divided by academic specialty for the remainder of the day (table 10). Data were collected during the whole cohort class time on these non-exposure days. Beginning of the day and end of the data surveys were collected from each participant and entered into spreadsheets using the OMR software.

Sandia National Laboratories provided computational resources, and consultation on study design and statistical analysis Sandia assisted in uncertainty quantification and sensitivity analysis for the statistical models used in this study. Uncertainty quantification estimates the potential effect of uncertainties within the model on results drawn from the sample participants.

Jackknife confidence intervals (CI) were used to quantify the level of uncertainty due to incomplete cohort participation and imputation of missing social network members.

Sample and Effect Size Estimation

Analysis of the data began with determining the representativeness of the sample and effect size estimation. For the purpose of generalizability, the intent of this analysis is to understand the workings of the social network from which the participants belong. It is the intent of the research to be able to generalize the findings to other military nurses in academic programs similar to the environment the sample was taken from. In order to do this, the researcher first calculated the degree distribution. Degree distribution, the number of participants who nominated a given individual, was calculated to determine whether the participating sample is representative of the whole network. The median normalized degree distribution was 1.25 (S.D. = 0 – 2.5). A q-q plot of the distribution visualizes the general linearity of the data (Figure 2). The q-q plot demonstrates that the data is normally distributed. Literature sources recommend a minimum of 20% of the network to make general inferences (61, 133, 134, 152, 274); 58% of network members chose to participate in this study. The confidence interval and standard error were then calculated for the population. At a 95% confidence level, the standard error was 0.055. Once sample representativeness and effect size estimation were established, it was possible to move forward with data analysis. In the following section, data analysis is organized under each individual research question for this study.

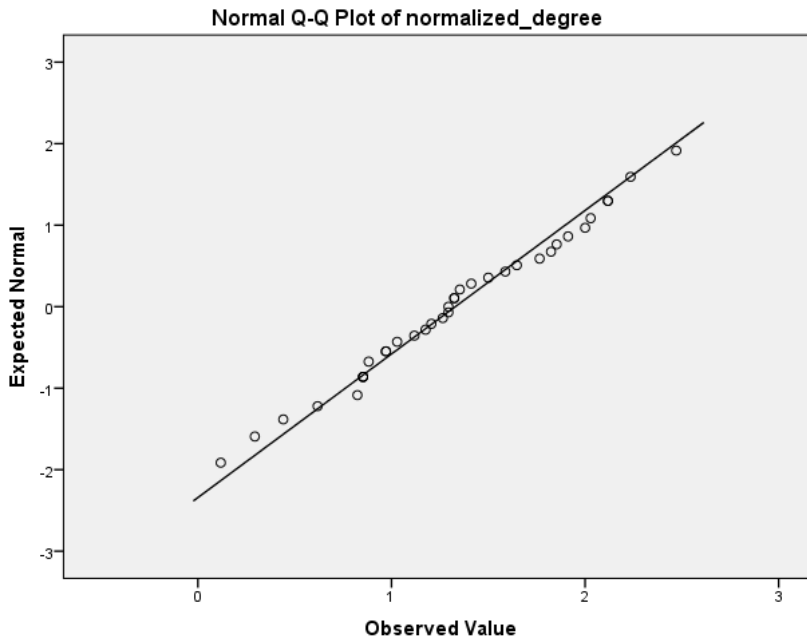


Figure 2. Q-Q plot of the degree distribution.

Research Question 1.1 What is the relationship between network members with similar affect and their social interactions?

To understand affect similarity and social interactions of network members, network interaction groups identified in with the social network roster survey were compared to participant state affect (I-PANAS-SF). Assortativity mixing analysis procedures identify the correlation of member relationships with affect scores. Students with strong relationships within the network would presumably demonstrate a propensity for a shared affect that is greater than students with weaker or no relationships.

A diagram of the complete social network for this analysis is shown in Figure 3. This schematic represents the network of Advance Practice Nursing students who were students in the cohort ($N = 60$). Each student is represented by a square (node), the lines between them (edges) represent identified relationships among members of the network. These relationships were ranked as: never interacting (1), only interacting in the classroom (2), interacting occasionally

outside of class (3), interacting a couple times a month outside class (4), and interacting most weeks outside class (5). The edges in Figure 3 represent the existence of relationships; line thickness is commonly used to quantify relationship strength, but for the purpose of legibility was omitted from Figure 3. Non-participating class members are most peripheral in the Figure (outside the circle) because the information provided about their relationships was from participating classmates. Non-participating members are included in Figure 3 to demonstrate the connectedness of participating and non-participating students. Although some students chose not to participate, their relationships with participants were likely to impact affect of participants.

The roster network (Figure 3) was generated having nodes of both participants and non-participants. Social network data analysis focused on only on the participant friendship nomination network (Figure 4) and a subset of the roster network with edge weights of 3, 4, or 5. Study participants ($n = 35$) were analyzed using the subset network derived from the social network roster survey (roster network) with edge weights 3, 4, and 5 (Figure 5). Edge weight corresponds with the score given to the relationship using the 5-point scale. These higher edge weights were chosen to produce a tractable network topology which shows clearly the stronger categories of the relationship while eliminating the weak relationship.

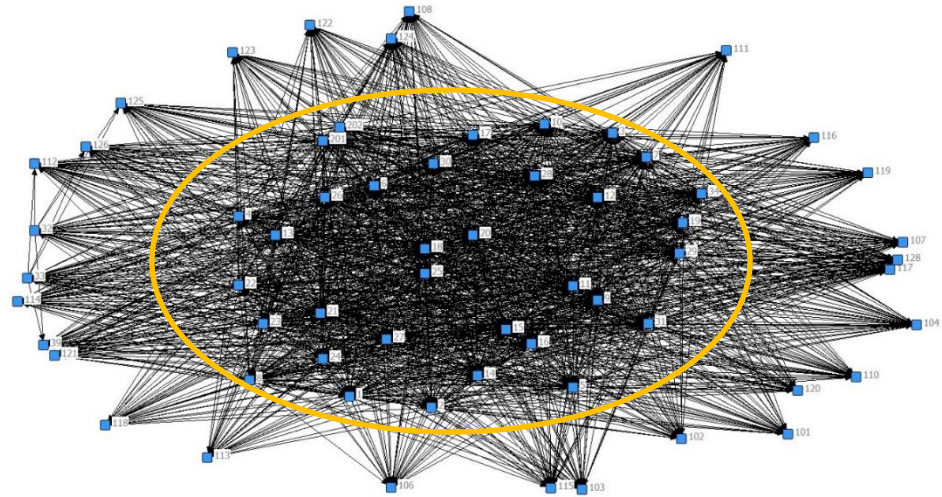


Figure 3. A diagram of the complete social network.
Nodes inside the circle participated in the study. Peripheral nodes, outside the circle, were non-participant members of the student cohort.

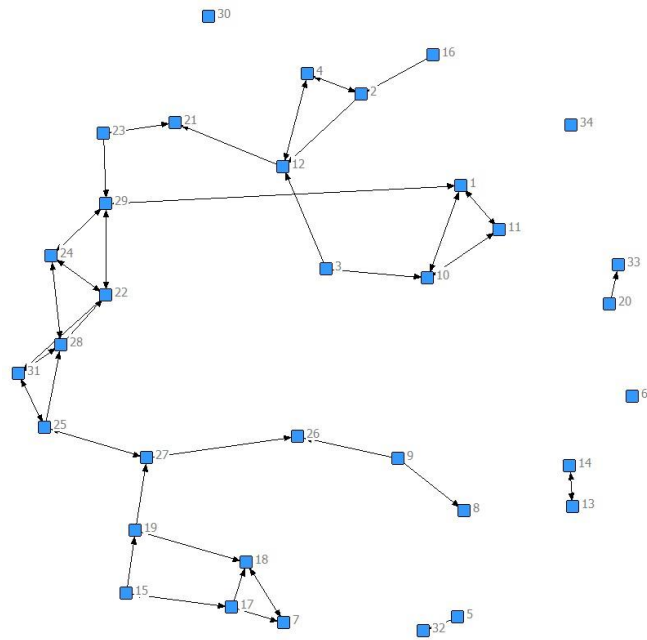


Figure 4. Nomination network with only participant nodes and edges.
Some participants only identified non-participant friends and, therefore, do not have any edges.

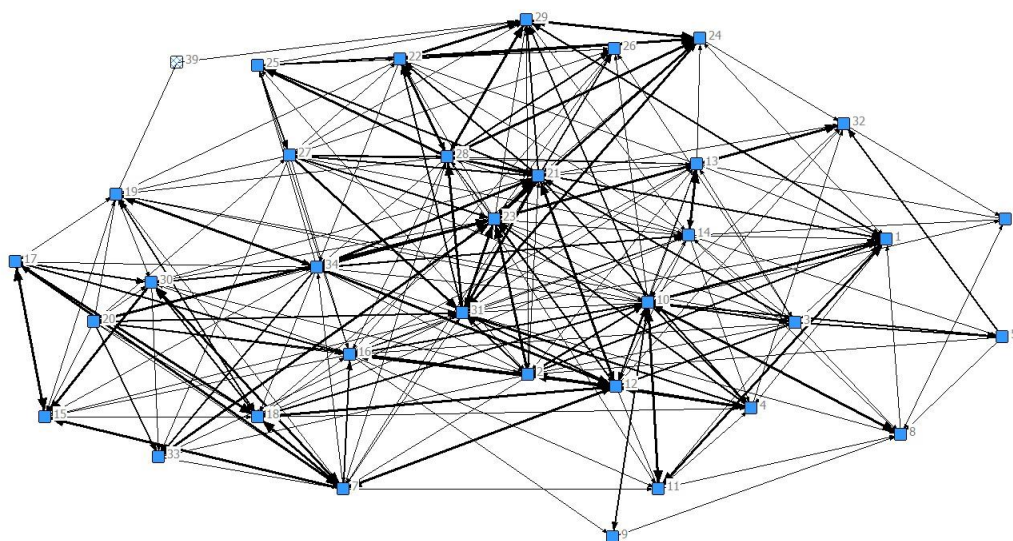


Figure 5. The roster network of participants with edge weights 3, 4, and 5 denoted by line thickness

When considering the general characteristics of the students in relation to their location within the network, the affect profiles of peripheral network members and central network members did not differ with regards to state or trait or state affect scores, BEQ scores, or ECS scores (research questions 1.4-, 1.5). Network placement did not indicate a person was more or less expressive, susceptible to the affect of others, or relate to their positive affect (PA) or negative affect (NA) scores, neither trait nor state. Student network placement does not relate to the affect variables of this study.

To determine the correlation of stimulus groups to affect, Pearson coefficient values were measured on structural equivalence, two participants sharing identical relationships with the nodes around them. Pearson correlations scores range from -1.0, where two participants have opposite patterns of relationships, 0.0 when the relationships between the two participants cannot predict their relationship to a third participant, to 1.0, when participants have an identical set of relationships (Table 8). Structurally equivalent participants would be expected to have similar

affect profiles and affect scores, meaning that I-PANAS-SF scores would be similar for specific centrality and betweenness groupings. When comparing the stimulus groupings to the structural equivalence heat map, most participants demonstrated similar relationship structure. No participants had opposite patterns of relationships. Participants 32, 33, and 39 chose not to complete the social network roster.

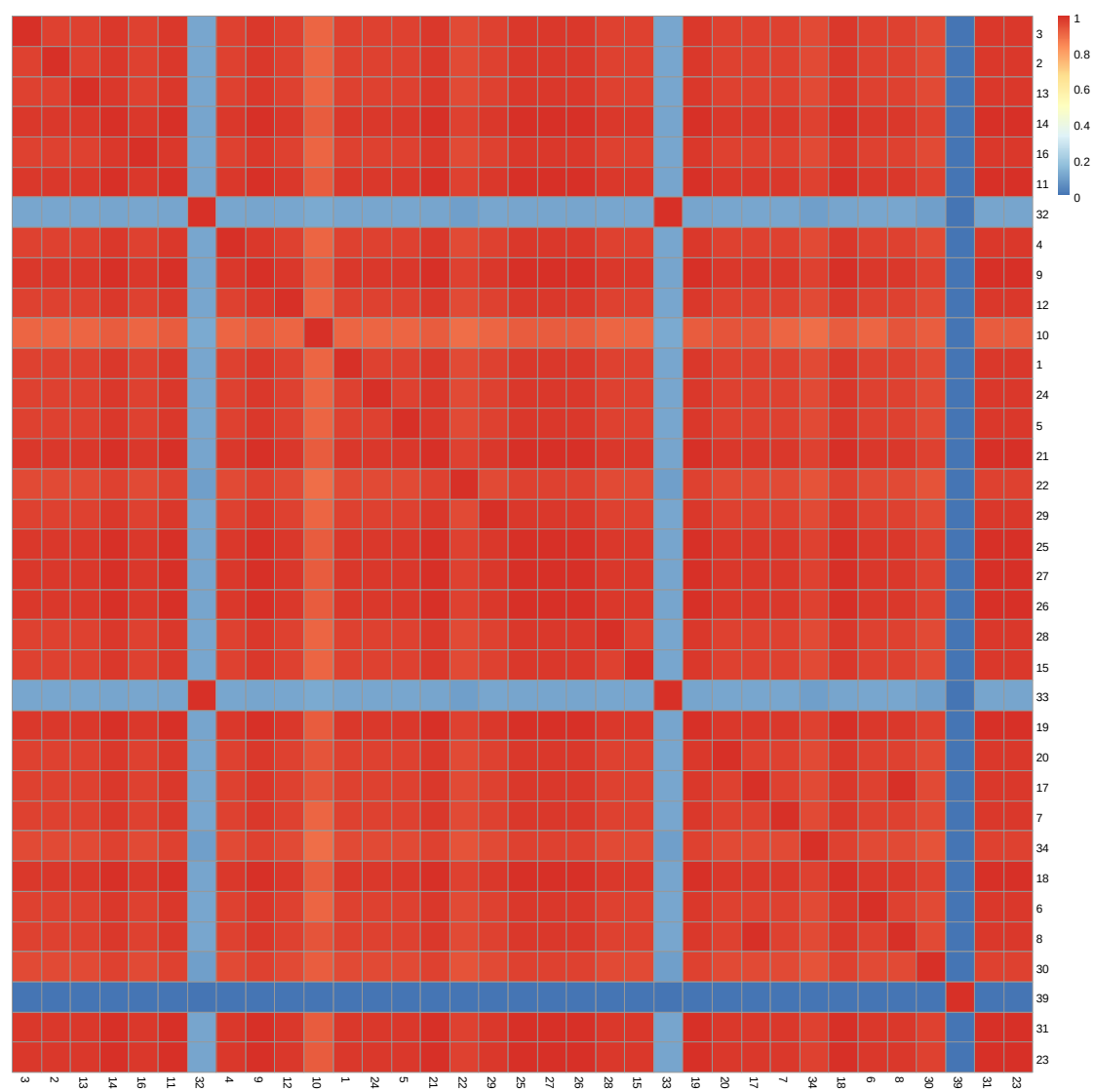


Table 8. Heat map of participants’ structural equivalence. Participant UIDs are listed along the X and Y axis. Each box represents the relationship between the participants as determined by Pearson correlation coefficient of 1.0 (red) indicating that two participants share identical relationships with the other network members, score of 0 indicates no relationship.

To determine the relationship between social interaction and affect similarity over time, a mixed model with stimulus group as a between-subjects factor, time and group by time interaction as within subjects factors, and afternoon affect scores as the dependent variables with a first order autoregression covariance structure. The distribution of the afternoon NA (ANA) scale was found to be skewed with unequal variance over time. Data were log transformed and reanalyzed using the mixed model method. No statistical difference in the findings was observed. Therefore, results are presented on the original scale for clarity. There were statistical differences for afternoon PA (APA) between the stimulus groups (table 9). Visually the low betweenness group had lower PA scores than the rest of the network and the low centrality group had scores that are more unpredictable than the other stimulus groups for both PA and NA (Figure 6).

		Stimulus Group x Time	Academic Program x Time
APA	F (n, d)	1.54 (39, 290.57)	2.153 (38, 294.55)
	p-value	0.025*	<0.001*
ANA	F (n, d)	0.792 (39, 250.38)	0.895 (38, 265.52)
	p-value	0.807	0.649

Table 9. Mean afternoon affect over time by stimulus group and academic program

* Designates statistically significant values.

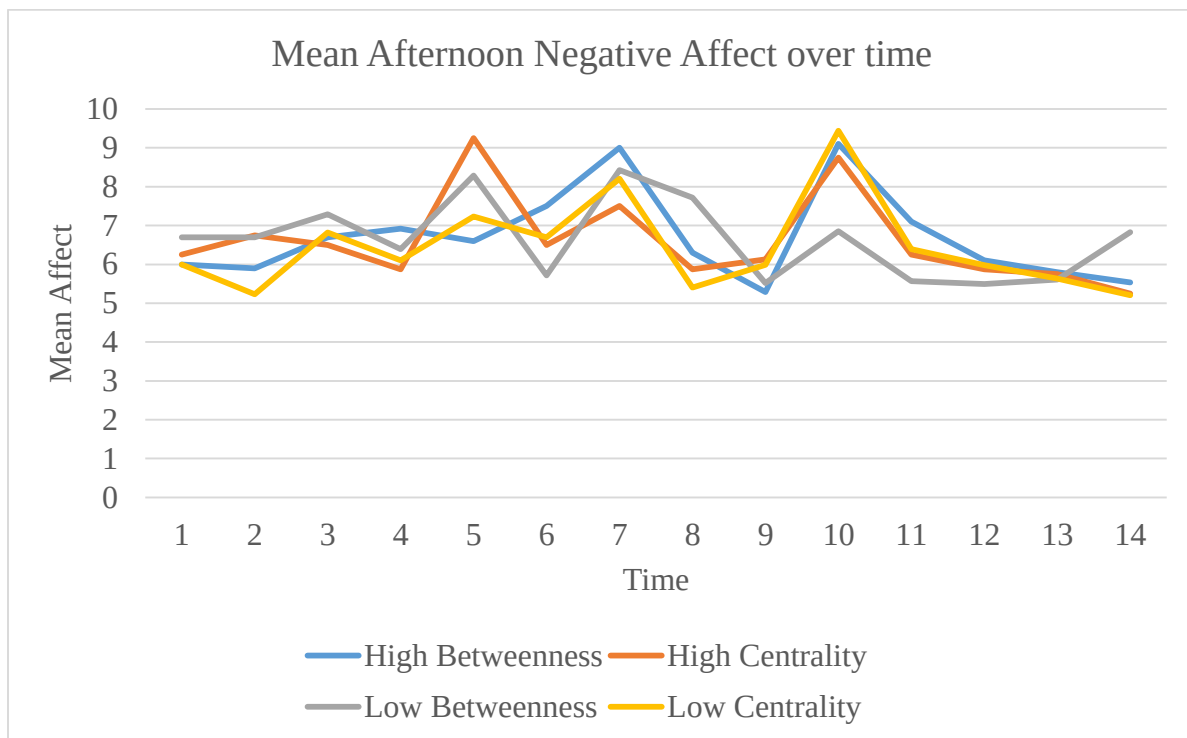
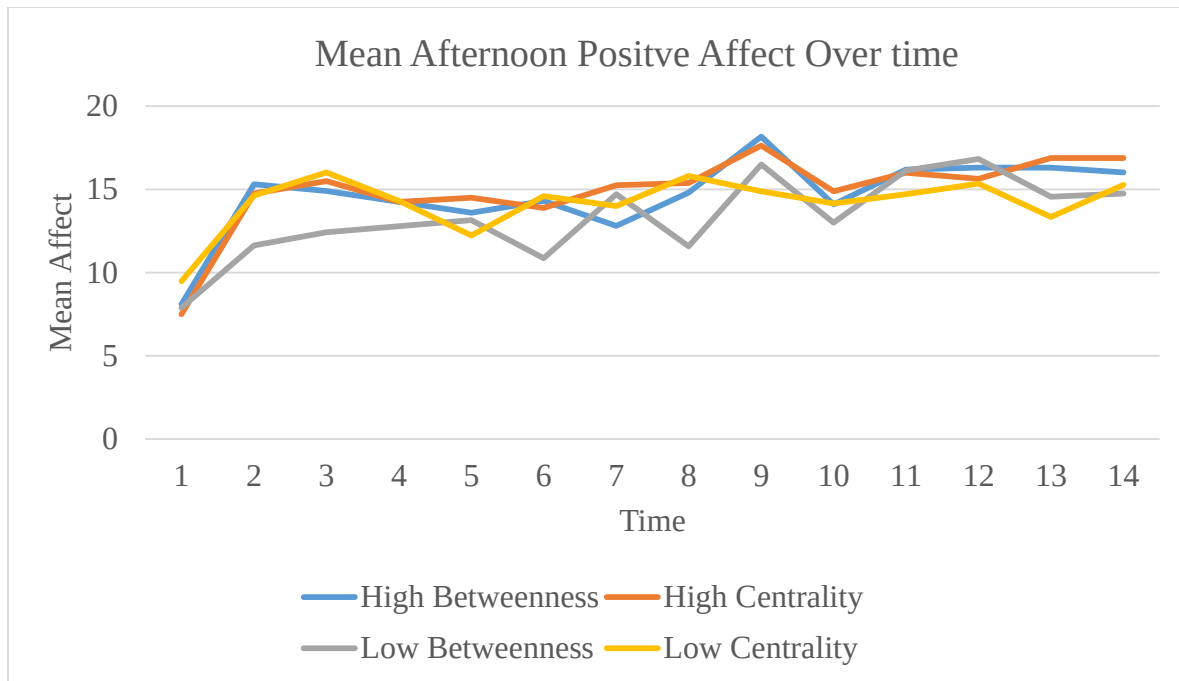


Figure 6. Mean Affect (NA) over 14 data collection days by stimulus group

Interactions identified from the Social Network Surveys were used to calculate network density (11) to determine social interactions between affect-similar network members. Network density describes the number of actual ties in a network as a percentage of all possible

relationship ties. The denser a network, the higher the likelihood of affect contagion because there are more relationships available to potentially share affect. The density of the survey roster network was 0.270; the nomination network was 0.047. These scores mean that 27% of all possible relationships were present in the roster network, and 4.7% of all possible relationships were present in the nomination network. This difference is to be expected because the nomination network was limited to only three identified relationships with other network members, whether or not they were also participating in the study per participant. This network was then reduced to only include other study participants so that there was affect data to compare. While the roster network included the entire cohort of APN students ($N = 60$), that was reduced to include study participants ($n = 35$). The density of the sub-network based on the academic program is higher than the total network (Family Nurse Practitioners = 0.923, Registered Nurse Anesthetists = 0.80, and Psychiatric Mental Health Nurse Practitioners = 0.985. Participant affect scores compared based on the academic program could be more correlated within the groups because a student in the same academic program spend more time together during the academic day than they do with students in other academic programs.

A mixed model with academic program as a between-subjects factor, time and group by time interaction as within subjects factors, and afternoon affect scores as the dependent variables with a first order autoregression covariance structure was used to determine the relationship between social interaction and affect similarity over time. The distribution of the NA scale was found to be skewed with unequal variance over time. Data was log transformed and reanalyzed using the mixed model method. No statistical difference in the findings was observed. Therefore, results are presented on the original scale for clarity. There were statistical differences for afternoon PA between the academic programs (table 9). Sub-networks with

higher density, like the academic program, exhibited statistically significant affect similarity across time (Figure 7).

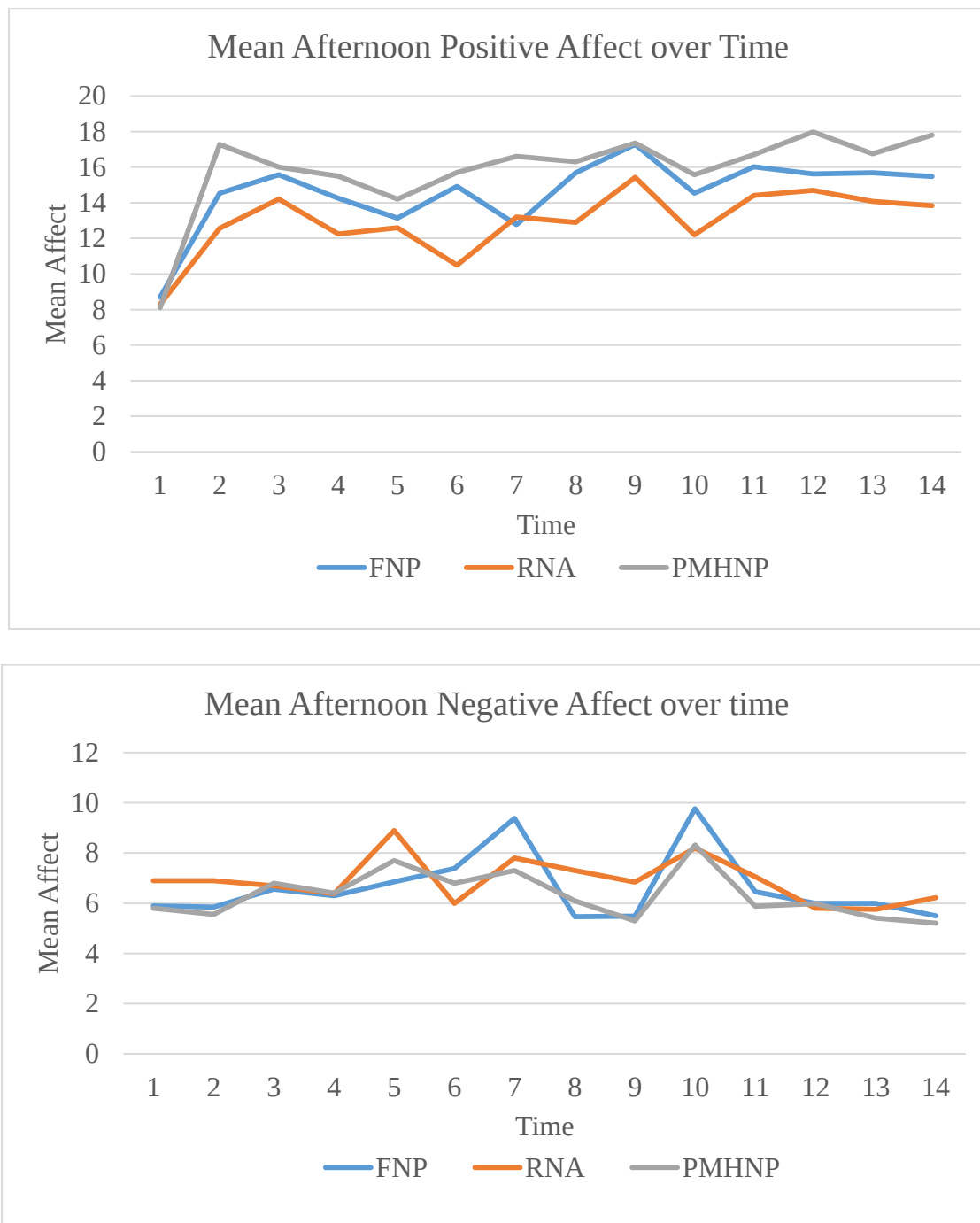


Figure 7. Mean affect over 14 data collection days by academic program

Social interactions were determined based on identifying two types of sub-networks, the stimulus groups in which members shared structural equivalence. The four stimulus exposure groups were high centrality, high betweenness, low centrality, and low betweenness, within the network. Academic program subnetworks included FNP, RNA, and PMHNP, participants shared the most relationships and spent the most time together during the academic week (Table 10). Affect scores were compared using mixed model over the 14 data collection time points. Statistical differences were found for positive affect in the sub-networks.

Monday	Tuesday			Wednesday	Thursday				Friday
HCHC Small Groups				ADV. PATHO.	HEALTH POLICY AND ETHICS				STUDY DAY
STUDY DAY	PEDS.	PRINCIPLES II	ADV. CON.	ADV. PHARM.					
	PEDS.	DIAG.		ADV. CON.	EBP II	FAMILY THEORY 1200-1550	HEALTH RESOURCE MGMT 1200-1550	ADV. CON.	

Legend:

RNA	FNP/WHNP
CNS	All Students
PMHNP	Cross-Program

HCHC Small Groups: Human Context in Healthcare
 Peds.: Pediatrics
 Diag.: Diagnosis
 Adv. Con: Advanced Concepts
 Adv. Patho.: Advanced Pathophysiology
 Adv. Pharm.: Advanced Pharmacology
 EBP II: Evidenced Based Practice II
 Health Resource MGMT: Health Resource Management

Table 10. Sample student schedule for the semester.
Students worked independently on study days.

Research Question 1.2. Do individuals with strong ties have greater affect similarity?

Analysis of participant affect with participant identified relationships was undertaken to answer the research question: Do individuals with strong ties have greater affect similarity?

Assortative mixing correlations were used to determine whether participants shared a more similar affect with other participants whom they identified as their friends. Before conducting assortativity analysis, it must be determined whether affect scores can be aggregated.

Data Aggregation

Calculation of intraclass correlation coefficients on positive affect and negative affect scores from the I-PANAS-SF using the participants in the roster network (n=35) to determine the appropriateness of aggregating affect scores of participants. Intraclass correlation coefficients were calculated to justify aggregation of data. Intraclass correlation coefficients 1 (ICC(1)) estimate the proportion of variance in individual-level outcomes. Scores for the ICC(1) were 0.627 for PA and 0.458 for NA. Intraclass correlation coefficients 2 (ICC(2)) estimates the group mean to justify the aggregation of individual scores. ICC(2) scores were 0.723 for PA and 0.629 for NA. F-tests indicated that aggregation was appropriate with ($p < 0.001$) for all four correlation coefficients. This indicates that the individual variability of affect scores over time can be explained by aggregated affect scores of the network. Under these conditions, it is appropriate to aggregate the individual data to the group level.

An analysis of the observed assortative mixing of affect scores explored the strength of similarities between connected individuals in each friendship network. Assortative mixing is the bias in favor of connections between network members with similar characteristics. Assortative mixing can be attributed to three main ideas: tendency of individuals to associate and bond with similar others (homophily), social influence, and transitive effects in the network (friends of a friend) (200).

An assortative mixing coefficient values range from +1 to -1, where a value of 0 indicates there is no association between friend pairs in the network and their reported affect scores. Additionally, nonparametric Spearman's rank correlation coefficient was chosen to quantify assortative mixing of affect scores to accurately capture the ordinal structure of the survey data. Looking at Table 2, week 1, 6, 8, and 10 had a correlated change in afternoon affect. This means students who identified themselves as having a relationship in the network reported similar affect scores during weeks 1, 6, 8, and 10. Uncertainty measures the likelihood of a correlation to occur by chance instead of intentionally within a network. To quantify the uncertainty in the assortative mixing correlations, a jackknife resampling approach was employed to build 95% confidence intervals (CI). Smaller CIs indicate a higher confidence in the derived correlation assortative mixing scores. Timepoint 12 and 13 do not have scores for afternoon negative affect (ANA) because all of the scores were the same (Table 11). Assortative mixing correlations of ≥ 0.25 was used to distinguish noteworthy correlations. At the 0.25 correlation network members had a 1:4 chance of sharing affect with their friends.

Time	Affect Type	Assortativity	Jackknife lower CI	Jackknife upper CI
T0	ANA	0.141	-0.010	0.389
T1*	ANA	0.561*	0.321	0.872
T2	ANA	-0.011	-0.196	0.175
T3	ANA	-0.223	-0.294	-0.160
T4	ANA	0.093	-0.128	0.321
T5	ANA	-0.160	-0.220	-0.110
T6*	ANA	0.292*	0.116	0.470
T7	ANA	-0.071	-0.120	-0.035
T8*	ANA	0.390*	0.060	0.757
T9	ANA	-0.230	-0.404	-0.062
T10	ANA	0.108	-0.144	0.364
T11	ANA	-0.014	-0.237	0.212
T12	ANA	NA	NA	NA
T13	ANA	NA	NA	NA
T0	APA	-0.168	-0.363	0.025
T1	APA	0.009	-0.188	0.207
T2	APA	-0.072	-0.245	0.099
T3	APA	-0.217	-0.404	-0.035
T4	APA	-0.189	-0.366	-0.0178
T5	APA	0.105	-0.094	0.307
T6	APA	-0.141	-0.321	0.0341
T7	APA	-0.022	-0.218	0.173
T8	APA	-0.169	-0.403	0.062
T9	APA	0.003	-0.191	0.200
T10*	APA	-0.258*	-0.494	-0.030
T11	APA	0.0749	-0.131	0.282
T12	APA	0.057	-0.141	0.257
T13	APA	-0.170	-0.382	0.037

Table 11. Assortative mixing affect correlations, 95% Jackknife confidence intervals. Assortativity scores represent the degree of affect similarity among socially connected individuals, CIs the range over which the true assortativity value could occur with a 95% confidence. Smaller CI range indicates a higher confidence correlation. * are noteworthy values.

Research Question 1.3. What are the system mechanisms influencing affect within the network?

System mechanisms are characteristics of the social network that may influence how affect contagion occurs. Friendships within the network could be related to personal characteristics of the participants. Participants may form groups based on shared characteristics like gender, academic program, or military branch of service (212). Clustering coefficients, and cliques are two methods for analyzing how network members group together (212). These measurements provide insight into the effect of friendships among participants on their affect scores. Assortative mixing correlations and Jackknife CIs were calculated for the three main cliques identified to determine affect similarity. No statistically significant correlations in affect were present for the three cliques.

The clustering coefficient measures the tendency for nodes to group together, or cluster. In social networks, this clustering occurs on average more often than the probability of establishing a random tie. The clustering coefficient measures the concentration of relationships in a network and is represented by a number between 0 and 1. A value of zero means that relationships have no pattern to their formation and are just as likely to occur by chance as they are intentional. A value of 1 demonstrates intentionally formed relationships into cliques that were unlikely to be random. The averaged local clustering coefficient of the network built by the survey roster was 0.413 with an average in-degree centrality score of 9.171. This means that the likelihood of network members to have relationships is greater than expected by chance alone and have an average of 9 relationships per node. The nomination network has an averaged local clustering coefficient of 0.257 and an average in-degree centrality score of 1.56. The roster network is more connected because participants were not limited to the number of friendships

they could identify. The roster data were used to identify clusters of network members who shared relationships, called cliques. A minimum of three network members are required for a relationship to be considered a clique (33). There were 121 separate cliques identified from the roster network of participants using edge weights of 3, 4, and 5 to identify the strongest relationships. A clique can have as few as three network members who share ties among them. Figure 8 is an overlap matrix of the three largest cliques in the network. The level represents the amount of overlap, common relationships, shared by the network members (87). The Figure represents three main cliques within the network, the three most central members of the network are participants 10, 11, and 12. Clique membership did not correlate with a program of study, gender or branch of service, common characteristics in the formation of cliques. The group of participants formed relationships within the network based on criteria that were not identified in this study. The prominent cliques among the participants were heterogeneous with regards to the selected characteristics. Assortativity correlations were conducted for the three major cliques to identify affect similarity among participants within the cliques. No affect correlations were found among the clique members for the 14 data collection days.

Level	UID	15	16	20	7	18	30	25	26	24	32	29	3	1	4	27	22	28	21	34	31	14	10	12	13	23
	UID	22	5	25	27	29	32	18	20	13	7	17	1	12	8	19	16	21	15	28	34	4	11	10	3	35
24																							X	X		
22																							X	X	X	X
19.111																							X	X	X	X
15.556																							X	X	X	X
15																	X	X					X	X	X	X
14.574																	X	X			X		X	X	X	X
13																	X	X	X	X	X		X	X	X	X
10.651																	X	X	X	X	X		X	X	X	X
9.917																	X	X	X	X	X		X	X	X	X
9.333																X	X	X	X	X	X		X	X	X	X
9					X	X										X	X	X	X	X	X		X	X	X	X
6.715					X	X										X	X	X	X	X	X		X	X	X	X
6.667					X	X	X									X	X	X	X	X	X		X	X	X	X
5			X	X	X	X	X									X	X	X	X	X	X		X	X	X	X
4.882			X	X	X	X	X								X	X	X	X	X	X	X		X	X	X	X
4.4		X	X	X	X	X	X								X	X	X	X	X	X	X		X	X	X	X

Figure 8. Clique overlap matrix.

The three main cliques in the network are presented in the Figure; each X denotes an existing relationship between two participants. Participants are identified using the unique identifier (UID) assigned to them for the study. The line between participant 34 and 4 delineates the two cliques that form into one at level 10.651. The level is a measure of overlap (33). As the level decreases, the amount of overlap decreases, indicating a fewer number of cliques in common.

Research Question 1.4. What is the relationship between network topology and ECS scores?

The relationship between network topology using centrality or betweenness scores and emotional contagion susceptibility measured by ECS scores was investigated using Pearson's Product moment correlation. Exploratory analyses were performed, and data were analyzed to ensure no violations of the assumptions of normality, linearity, and homoscedasticity were present. The relationship between in-degree (nominations from others) centrality and ECS scores was not statistically significant, Table 12. No relationship was found between contagion susceptibility and betweenness, Table 12. One way analysis of variance was conducted to determine whether ECS scores differed by academic program. No relationship was found between academic program and ECS score. Emotional contagion susceptibility is not related to network topology.

Research Question 1.5. What is the relationship between network topology (centrality or betweenness score) and BEQ scores?

The relationship between network topology measured by centrality or betweenness and expressivity measured by BEQ scores was investigated using Pearson's Product moment correlation. Exploratory analyses were performed, and data were analyzed to ensure no violations of the assumptions of normality, linearity, and homoscedasticity were present. The relationship between in-degree (nominations from others) centrality and BEQ scores was not statistically significant, Table 12. No relationship was found between expressivity and betweenness, Table 12. One way analysis of variance was conducted to determine whether BEQ

scores differed by academic program. No relationship was found between academic program and BEQ score. Expressivity is not related to network topology.

		Centrality	Betweenness
BEQ	Pearson	-0.0261	0.07
	p-value	0.136	0.58
	N	34	34
ECS	Pearson	-0.183	0.052
	p-value	0.301	0.772
	N	34	34

Table 12. Pearson correlation topology with expressivity and contagion susceptibility

Research Question 1.6. What is the relationship between ECS and BEQ scores?

The relationship between emotional contagions susceptibility through ECS scores and expressivity through BEQ scores was investigated using Pearson's Product moment correlation. A ranked ordinal correlation coefficient was used to help capture the structure in the survey data. Exploratory analyses were performed, and data were analyzed to ensure no violations of the assumptions of normality, linearity, and homoscedasticity were present. No relationship between ECS and BEQ scores was found, Table 13. Emotional contagion susceptibility was found to not be correlated with emotional expressivity.

		ECS
BEQ	Pearson	-0.083
	p-value	0.651
	N	32

Table 13. Pearson correlation expressivity and emotional contagion susceptibility.

Research Question 1.7. What is the relationship between IPQ and ECS scores? What is the relationship between IPQ and BEQ scores?

The relationship between trait affect measured by the IPQ scores and emotional contagion susceptibility measured by ECS scores was investigated using Pearson's Product moment correlation. A ranked ordinal correlation coefficient was used to help capture the structure in the survey data. Exploratory analyses were performed, and data were analyzed to ensure no violations of the assumptions of normality, linearity, and homoscedasticity were present. No relationship between IPQ and ECS scores was found, for NA, table 14. Emotional contagion susceptibility is not correlated with trait affect.

The relationship between trait affect measured by IPQ scores and expressivity measured by BEQ scores was investigated using Spearman's Rank correlation. Initial exploratory analyses were performed, and IPQ- positive affect were not normally distributed. No relationship between IPQ- negative affect and BEQ scores were found, for NA, table 14. Emotional expressivity is not correlated with negative trait affect. However, IPQ-PA and BEQ scores had a moderate negative correlation, $r = -.433$, $n = 32$, $p = .013$. Emotional expressivity is negatively correlated with positive trait affect. Participants with higher expressivity scores were more likely to have lower trait PA.

		BEQ	ECS
IPQ-NA	Pearson	-0.277	-0.007
	p-value	0.124	0.969
	N	32	34
IPQ-PA	Pearson	-0.433	0.139
	p-value	0.013*	0.433
	N	32	34

Table 14. Correlation of trait affect with expressivity and emotional contagion susceptibility.

*indicates statistically significant value

To further investigate the relationship between affect and expressivity, BEQ scores were compared to state affect scores reported by the I-PANAS-SF. The I-PANAS-SF provide two scores, one for positive affect, and one for negative affect. Pearson's product-moment correlation coefficient was used to assess the relationship between expressivity and state affect. Data were analyzed to ensure no violations of the assumptions of normality, linearity, and homoscedasticity were present. There was a positive correlation between both morning and afternoon PA scores and BEQ scores, morning $r = .214$, $n = 427$, $p < 0.001$, afternoon $r = .096$, $n = 420$, $p = .049$. No correlation was found between both morning and afternoon NA scores and BEQ scores, Table 15. Both trait and state positive affect are correlated with expressivity. Expressivity scores were negatively correlated with trait PA while expressivity was positively correlated with state PA.

		BEQ
I-PANAS-SF Morning PA	Pearson	0.214
	p-value	< 0.001*
	N	427
I-PANAS-SF Afternoon PA	Pearson	0.096
	p-value	0.049*
	N	420
I-PANAS-SF Morning NA	Pearson	-0.019
	p-value	0.695
	N	427
I-PANAS-SF Afternoon NA	Pearson	0.066
	p-value	0.175
	N	420

Table 15. Pearson correlation scores among state affect and expressivity.

* indicates significant values.

Research Question 1.8. What is the relationship between gender and ECS scores? What is the relationship between gender and BEQ scores?

The relationship between emotional contagion susceptibility measured by ECS scores and gender was investigated using Independent samples t-test. No relationship between gender and ECS scores was found for males ($M=49.077$, $SD = 10.193$,) and females ($M = 49.19$, $SD = 8.69$, $t(32) = -.035$, $p = .97$, two-tailed). Gender does not have a relationship with emotional contagion susceptibility.

The relationship between expressivity measured by BEQ scores and gender was investigated using Independent samples t-test. No relationship between gender and BEQ scores was found for males ($M=58.308$, $SD = 14.6423$,) and females ($M = 49.43$, $SD = 14.8175$, $t(32) = 1.706$, $p = .098$, two-tailed). Gender does not have a relationship with emotional expressivity.

Research Question 1.9. What is the relationship between age and ECS scores? What is the relationship between age and BEQ scores?

The relationship between age and emotional contagion susceptibility measured by ECS scores was investigated using Spearman's Rank correlation. Initial exploratory analyses were performed, and ECS responses were not normally distributed. No relationship between age and ECS scores was found, $r = .188$, $n = 32$, $p = .303$. Emotional contagion susceptibility is not correlated with age.

The relationship between age and expressivity measured by BEQ scores was investigated using Spearman's Rank correlation. Initial exploratory analyses were performed, and ECS responses were not normally distributed. No relationship between ECS and BEQ scores was found, $r = -.179$, $n = 34$, $p = .316$. Age is not correlated with emotional expressivity.

Research Question 2.1. What is the primary effect size of the affect influencing exposure to graduate nursing students?

The primary effect size of the affect influencing stimulus was determined through comparison of the difference in mean afternoon affect for the stimulus group from the mean affect of non-exposed participants. A between-within subjects analysis of variance was conducted to determine whether stimulus exposure influenced the afternoon affect of the exposed group. It was expected that a change in affect from the morning affect to afternoon affect would differ for participants exposed to the shared affective experience stimulus from the participants not exposed to the stimulus. The affect influencing stimulus was administered to the group during the lunch hour on 11 of the data collection days. There were three different affect influencing stimuli, three of the four exposure groups observed all three stimuli. The fourth group was only exposed twice because there was a change in the schedule for the semester and the final affect exposure day was canceled. On five of the 11 exposure days, exposure groups had affect scores different from the non-exposed participants. The exposure groups that exhibited statistical changes in affect during weeks 3, 5, 7, 9 and 10 (Table 11). During week 3, the low betweenness group had statistically significant changes in the attribute attentive, item on the I-PANAS-SF, indicating a slight increase in positive affect compared to non-exposed participants). In reviewing the life event calendar; the participants gave presentations in the morning on week 3. During week 5 the high betweenness group had statistically significant changes in the attributes of attentive and alert, indicating a slight change in positive affect. During the pharmacology class time, the students worked in small groups and presented to the whole class as a group. The low betweenness group had a statistically significant score for the attribute hostile on week 7. No events were documented for week 7. The high betweenness group reported statistically significant changes in the attribute attentive and active during week 9. No

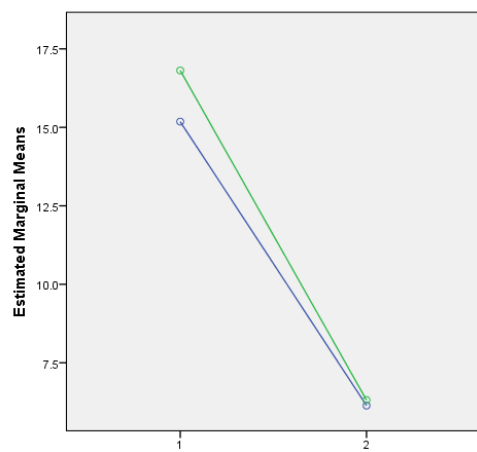
events were documented for week 9 in the life event calendar. The high centrality group had statistically significant changes to the attribute hostile during week 10. Five events were documented in the calendar on week 10: the class did not have an exam the day before (this was the only Tuesday without an exam), the class was scheduled to start an hour later (at 8:30 instead of 7:30), the morning faculty member brought cookies for the students, an investigator from a different study came to recruit students to participate and held a hoola hooping competition, and a classmate brought a homemade treat for the class. This difference in the change in affect from morning to afternoon affect scores between the participants exposed to the affect influencing stimuli and the non-exposed participants supports a primary effect size of the intervention (Table 16).

Week		Attribute			
		Attentive	Active	Hostile	Alert
3	Wilks' Lambda	0.994	0.968	0.992	0.822
	p-value	0.687	0.334	0.633	0.050*
5	Wilks' Lambda	0.882	.957	.964	0.822
	p-value	0.050*	.248	.289	0.050*
7	Wilks' Lambda	.949	.835	.750	.949
	p-value	.216	.021	.004*	.216
9	Wilks' Lambda	0.878	0.834	0.996	.924
	p-value	0.047*	0.019*	0.713	.122
10	Wilks' Lambda	.996	.991	.821	.996
	p-value	.742	.626	0.020*	.742

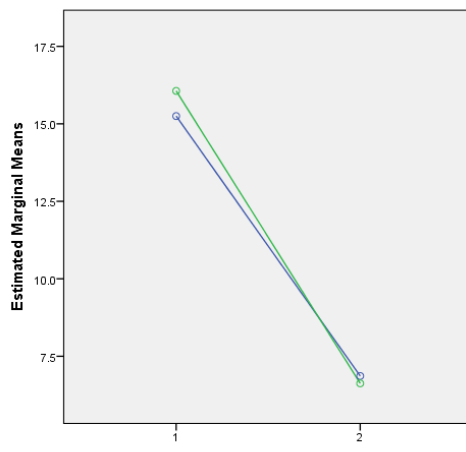
Table 16. Stimuli groups that differed from the non-exposed participants.

Although changes in affect were statistically significant only during five of the stimulus exposure times, differences in affect scores were present in all the weeks. A paired T-test over time for PA and NA, degrees of freedom (df): $n-1$ taking into account NA values was $30-1=29$ df demonstrated statistically significant changes in Positive affect between morning and afternoon

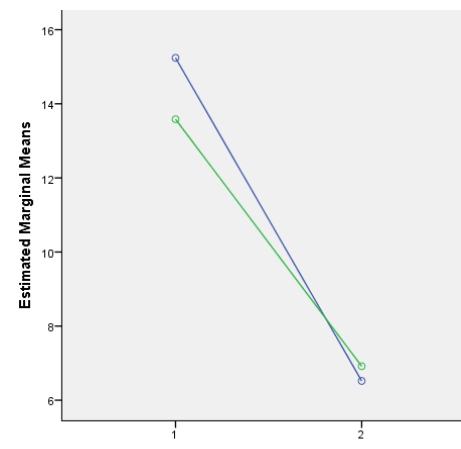
scores ($t = 3.88$, $df = 29$, $p\text{-value} < 0.001$). Negative affect did not have statistically significant differences between morning and afternoon scores ($t = -0.725$, $df = 29$, $p\text{-value} = 0.763$). Figures 9 and 10 are graphs of the mean affect scores for both the groups exposed to stimuli and the non-exposed group. In general, both positive and negative affect scores decreased between morning and afternoon.



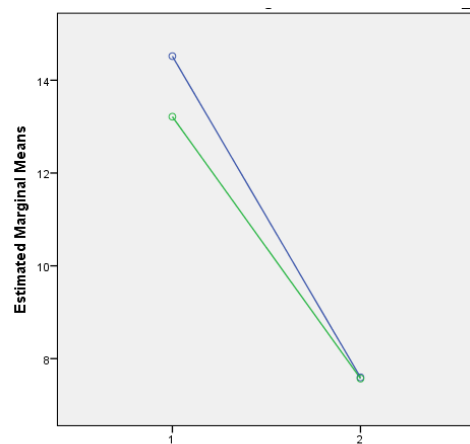
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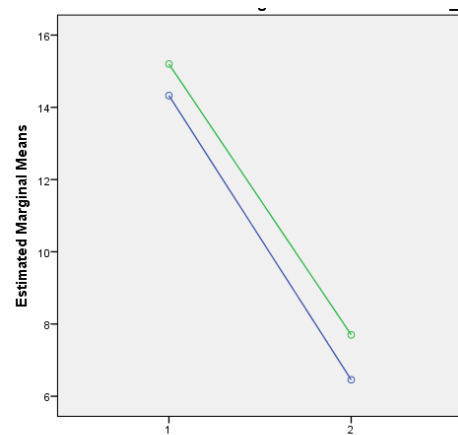
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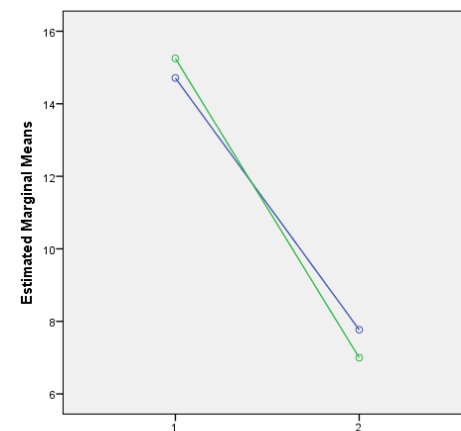
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5



6

Week

Week

PA

PA

PA

PA

PA

PA

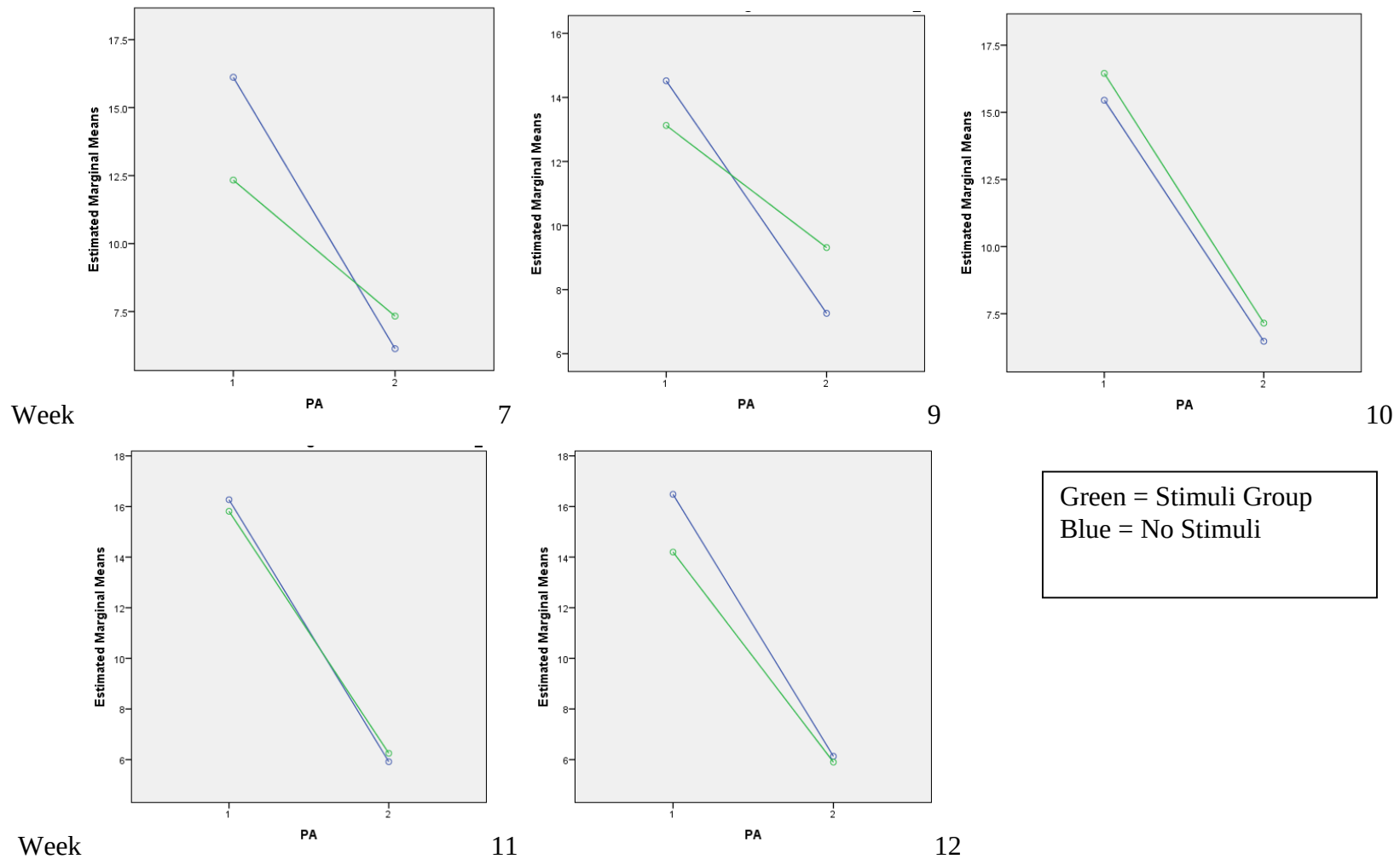
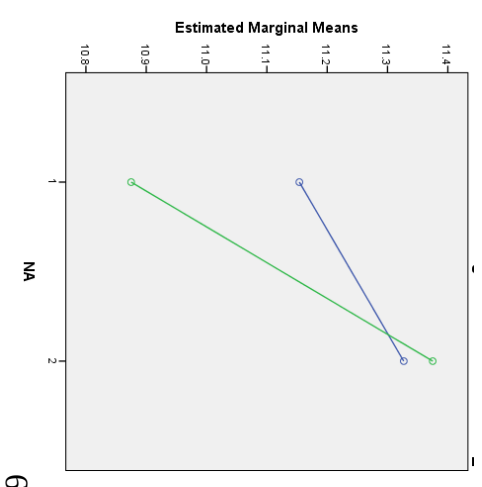
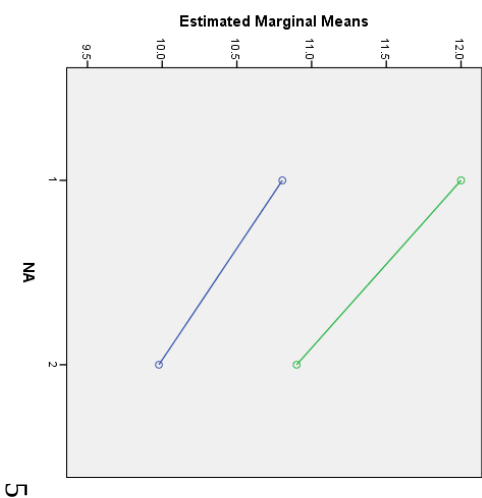
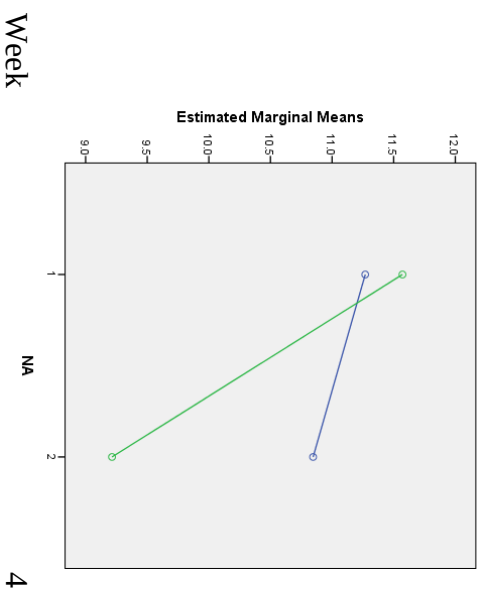
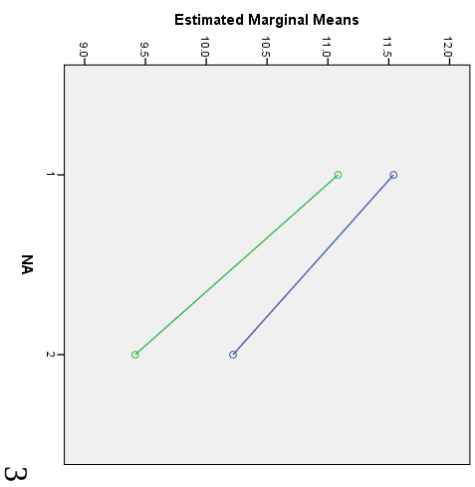
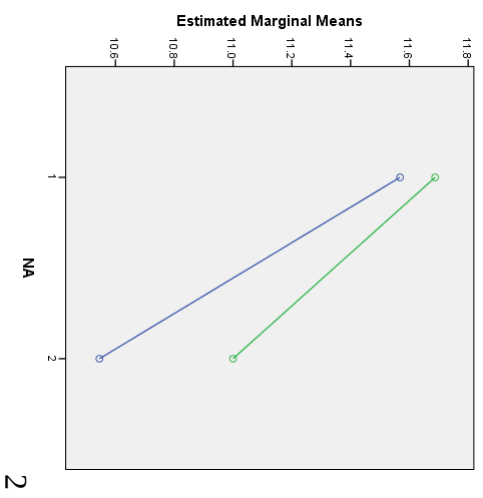
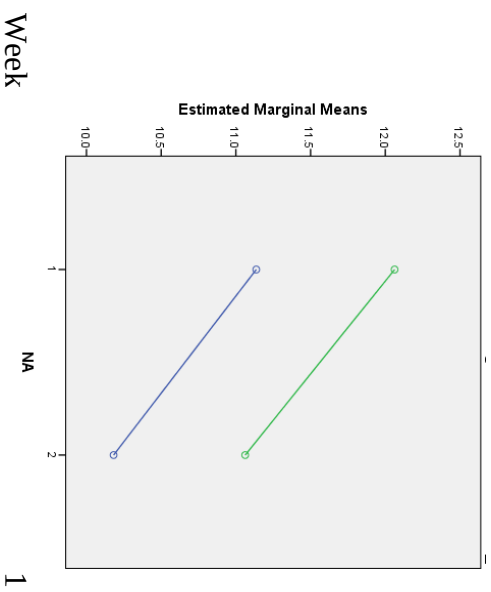


Figure 9. Weekly Mean PA by Stimulus Group. Measured in the morning (1) and afternoon (2). Weeks 0, 8, and 13 did not have a stimulus group exposure.



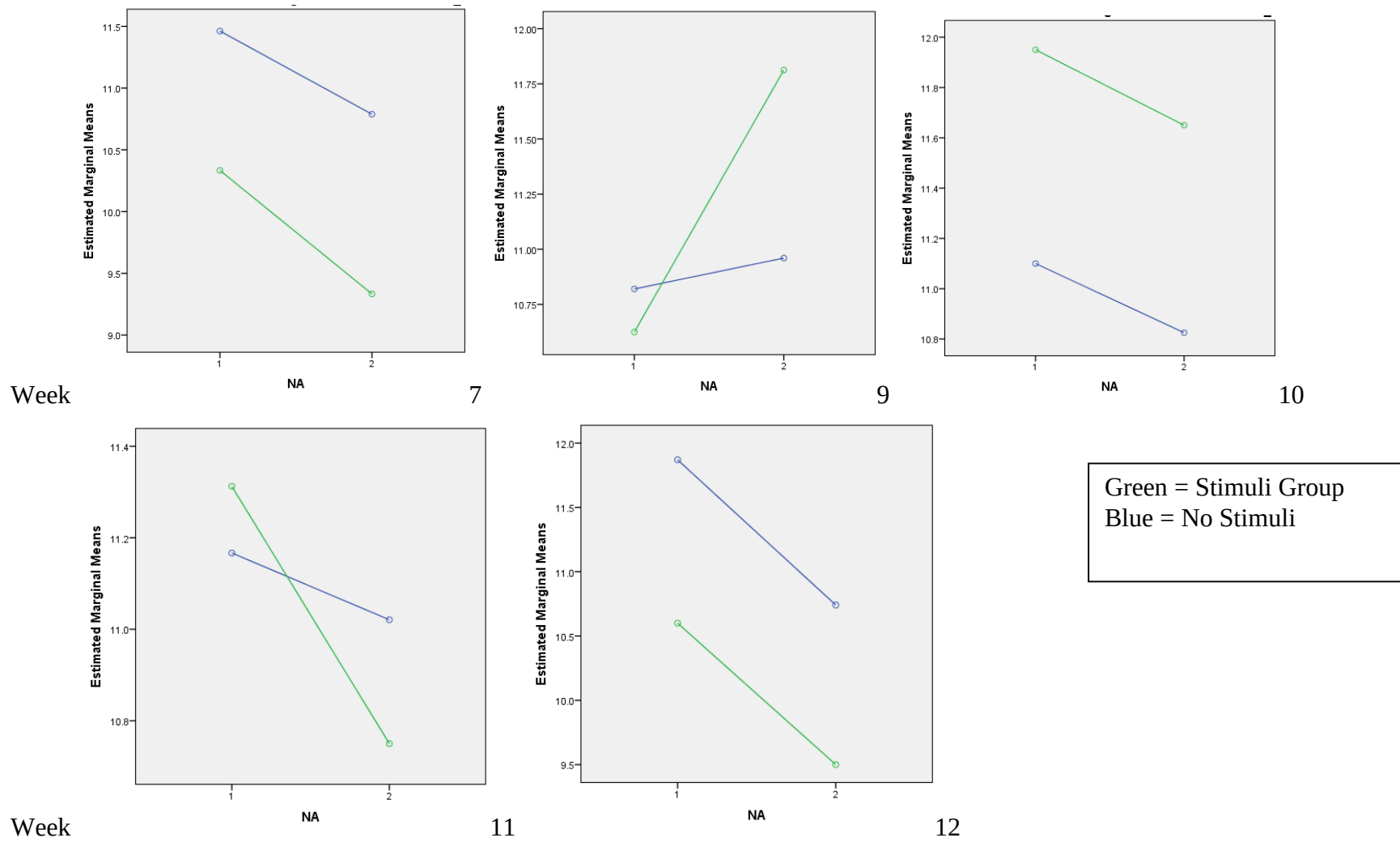


Figure 10. Weekly Mean NA by Stimuli Group. Measured in the morning (1) and afternoon (2). Weeks 0, 8, and 13 did not have a stimuli exposure groups.

Research Question 2.2. What is the secondary effect size of the affect influencing exposure for graduate nursing students?

To determine whether there was a secondary effect of the affect influencing exposure, assortativity analysis of affect was repeated on days when shared affect (week 1, 6, 8, and 10) was identified, and a primary effect size (week 3, 5, 7, 9, 10) occurred. Repeated assortative mixing was done only for the stimuli group and their identified friends on week 10. Assortativity analysis was not repeated for the stimulus group on weeks 3, 5, 7, and 9 because no affect contagion occurred in the full network that week. Assortativity analysis for week 10 used the social network roster and nomination data to identify relationships among the affect influencing exposure group and their friends. Affect scores between the friends were compared for correlation using the assortative mixing. Jackknife CIs were calculated to quantify the certainty of the correlation. If affect of the non-exposed friends correlated with the affect of the stimulus group, then a secondary effect of the stimulus was present. On week 10 the assortativity score was -.37, with a Jackknife CI of -0.14 to -0.31. The high centrality group experience an increase in the attribute hostile during week 10, their identified friends in the network had negatively correlated affect with the group. This indicates that the friends of the intervention group had an opposite change in affect. There were multiple events that could elicit positive affect that occurred that day (no exam, late start, cookies, homemade treats, and hoola hooping). A secondary effect was detected during week 10.

Research Question 2.3. How does network location of the primary exposure group influence the secondary effect size of the stimulus?

Although the students exposed to the stimulus demonstrated a change in affect in week 3, 5, 7, 9, and 10, and an assortativity correlation demonstrated similar affect during weeks 1, 6, 8, and 10, the assortativity correlation cutoff value only supported affect similarity with the friends of stimulus group members during week 10. Therefore, even though the low centrality, high betweenness, and high centrality groups all were influenced by stimulus exposure, network location did not have an impact on secondary exposure for the centrality groups. Regarding the high centrality group (week 10), negatively correlated assortativity allowed for the rest of the network to be protected from their increase in negative affect (Table 4).

Research Question 2.4. Are there cumulative affective effects that occur during the study?

Group emotion scores were calculated for each data collection day. Comparison of group emotion (mean) scores over time was conducted using a mixed model with time as a within subjects factor to determine whether cumulative affective effects occurred (Figure 11). Affect had statistically significant changes during the semester (table 17). The changes in affect over time is unlikely to be a cumulative affective effect because changes in affect for intervention groups was minimal and only occurred on three of the exposure time-points. Furthermore, the changes in affect were not strong enough to have a secondary effect on the day of the intervention it is unlikely that the cumulative affective effects are related to intervention exposure. Week 9 has the highest positive affect and lowest negative affect; this data collection day was the final class before spring break. Week 10 has opposing scores to week 9 as students start in the final three weeks of classes for the semester. The semester finished with time-point 14, concluding the didactic portion of the APN student's coursework.

MPA	F (n,d)	2.193 (13, 339.46)
	p-value	0.01
MNA	F (n,d)	2.81 (13, 281.62)
	p-value	0.001
APA	F (n,d)	11.652 (13, 312.64)
	p-value	<0.001
ANA	F (n,d)	6.504 (13, 265.03)
	p-value	<0.001

Table 17. Mean morning and afternoon affect scores changed over time.

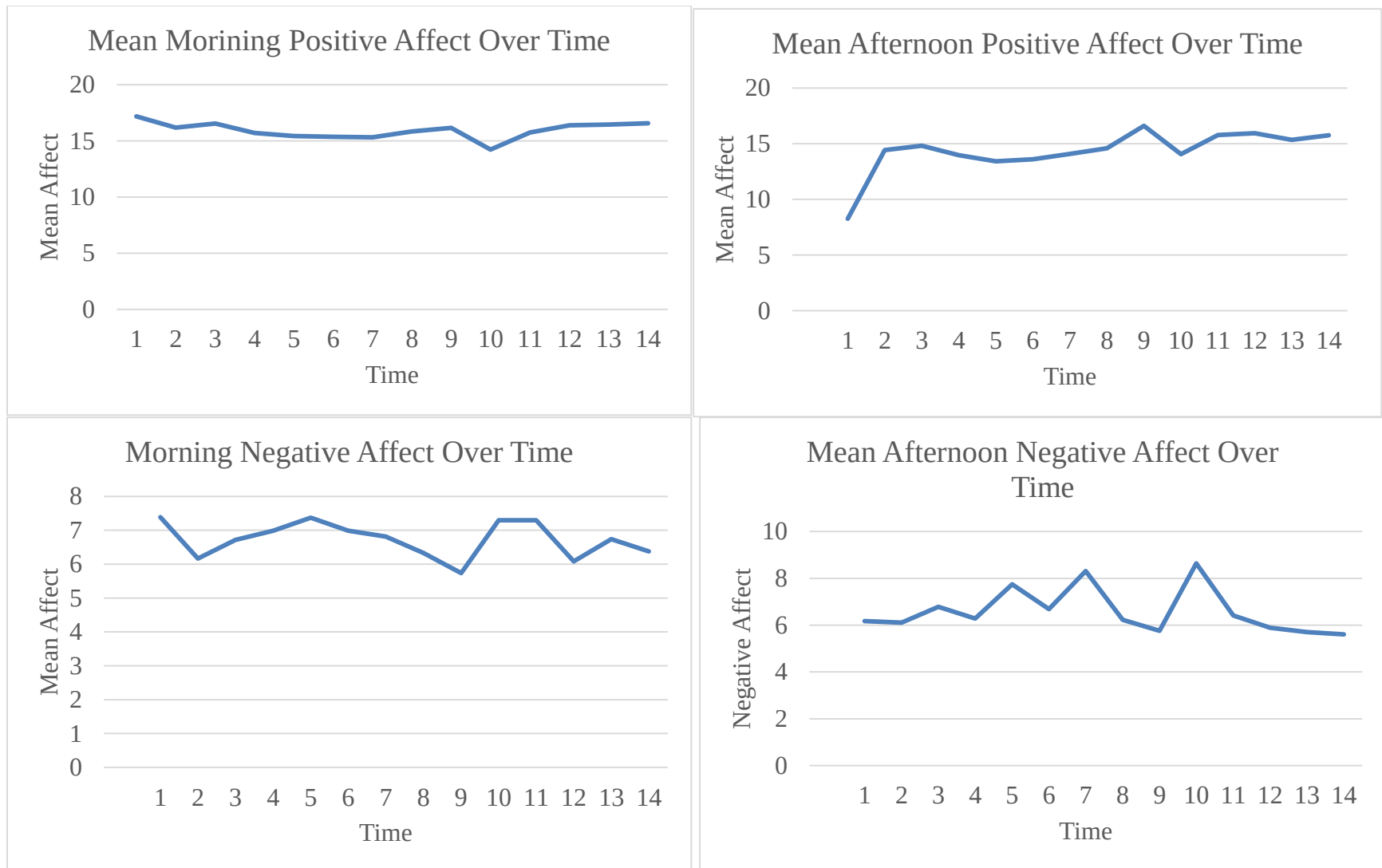


Figure 11. Mean affect scores for morning and afternoon affect over time

SUPPLEMENTARY MEASURES

Trait Affect and State Affect

The relationship between trait and state affect was confirmed through correlation of scores from the IPQ and PANAS. Both the IPQ and PANAS provide two scores, one for positive affect, and one for negative affect. Pearson's product-moment correlation coefficient was used to assess the relationship between trait and state affect. Data were analyzed to ensure no violations of the assumptions of normality, linearity, and homoscedasticity were present. There was a strong positive correlation between both morning and afternoon PA scores and PA IPQ scores, morning $r = .206$, $n = 427$, $p < 0.001$, afternoon $r = .237$, $n = 420$, $p < 0.001$. There was a strong positive correlation between both morning and afternoon NA scores and NA IPQ scores, morning $r = .479$, $n = 427$, $p < 0.001$, afternoon $r = .337$, $n = 420$, $p < 0.001$.

State Affect and Stress Conditions

To establish a relationship between stress conditions and state affect, participants self-reported stress levels and state affect. Scores from the PSS were used to measure reported stress, and the I-PANAS-SF was used to report state affect. The I-PANAS-SF provides two scores, one for positive affect, and one for negative affect. Pearson's product-moment correlation coefficient was used to assess the relationship between stress levels and state affect. Data were analyzed to ensure no violations of the assumptions of normality, linearity, and homoscedasticity were present. There was a strong negative correlation between both morning and afternoon PA scores and PSS scores, morning $r = -.47$, $n = 440$, $p < 0.001$, afternoon $r = -.391$, $n = 460$, $p < 0.001$. There was a strong positive correlation between both morning and afternoon NA scores and PSS scores,

morning $r = .534$, $n = 440$, $p < 0.001$, afternoon $r = .491$, $n = 460$, $p < 0.001$. Higher reported positive affect was correlated with lower reported stress, and higher reported negative affect is correlated with higher reported stress.

Event Calendar

A calendar diary was maintained during the data collection period. The students had exams weekly on Tuesdays, additional presentations, quizzes, and exams were noted on their respective days. Other events like special guest lecturers, therapy dog visits, and surprise food treats were also recorded in the record. Comparison of these events through observational assessment to student affect scores revealed that PA scores were lower, and NA scores were higher during weeks with stressful events like presentations and tests. This was especially evident during weeks of heavy workload, for example, multiple major projects, presentations and exams due at the same time in the middle of the semester (Figure 11).

Faculty Inclusion

The two faculty members who were the primary instructors on data collection days participated in the study. On days where the students gave class presentations or had visiting faculty, the participating faculty did not provide data. Correlations were conducted between the morning affect scores and the afternoon affect scores of the faculty members and the students. No correlations were found between the affect of students and their faculty (See Table 18).

Faculty Participant		Affect Time			
		MPA	MNA	APA	ANA
Morning Faculty	Spearman	0.204	-0.103	0.0051	0.408
	p-value	0.572	0.776	0.935	0.495
Afternoon Faculty	Spearman	-0.19	-0.11	< 0.001	-0.295
	p-value	0.625	0.779	1.00	0.521

Table 18. Faculty affect score correlations with student affect scores

Repeat Measure Social Network Survey

A Quadratic Assignment Procedure (QAP) regression of the initial social network survey and the repeat social network survey demonstrated an 84.5% correlation between the identified friendships in the network. The non-participants were removed from the network for analysis because the statistical program automatically fills the blank spaces with zeros. For the QAP analysis, multiple iterations are run and with almost half of the relationship values as zero when the non-participants were included, the results did not accurately reflect the relationships in the two networks. This correlation between the identified relationships from the initial social network survey and the repeated survey indicate that the participants maintained similar relationships throughout the semester ($r = 0.189$, $p = 0.003$, Jaccard = 0.845). It also confirms that the network is dynamic because although the relationships identified in the initial and repeat social network roster surveys were correlated, changes to the relationships were present in the network.

SUMMARY

A cohort of military APN students participated in this study to determine whether affect contagion occurred within the cohort over one academic semester. Participants completed self-report instruments that measured trait affect, their ability to express affect, susceptibility to the affect of others, and strength of relationships with other students in

the cohort. On each data collection day (14 days throughout the semester), state affect was measured in the morning and afternoon, and stress levels were measured in the afternoon. A stimulus was introduced to participants in the study in small groups during the lunch hour of 11 of the data collection days to determine whether the stimulus influenced the affect of both the exposed participant and non-exposed friends of the participant. Data collected from participants were cleaned and entered into spreadsheets for data analysis.

The results from data analysis included statistically significant findings regarding a correlation of affect among study participants. Network placement, or sub-group membership like cliques, stimulus exposure group, or academic program did not have correlations in affect. Scores from self-report instruments used for data collection were compared to identify relationships with participant placement in the network, and with the other instruments. A statistically significant relationship between positive trait affect scores measured by the IPQ and expressivity scores measured by the BEQ was identified. Furthermore, positive state affect scores (morning and afternoon) measured by the I-PANAS-SF were correlated with expressivity. Exposure to the affect influencing stimulus significantly changed the affect of the exposed group on three of the 11 exposure days. But a change in affect did not spread to the friends of the exposed group. Data collection days occurred 14 times during a 16 week semester, because of the length of time between collections days (usually seven days), cumulative affective effects could not be associated with the stimuli introduced in the study. In-depth discussion of the findings, insights regarding the findings and recommendations for future research proceed in chapter 5.

Chapter 5: Discussion

SUMMARY OF THE STUDY

The purpose of this study was to understand affect contagion in a network of military nurses in an academic environment and determine whether an affect influencing stimulus could change affect within the network. The study was designed using Kelly and Barsade's middle range theory of Moods and emotions in small groups and work teams (2001) and a computational model of affect contagion developed by Tsai et al. (2011). Similar studies of affect contagion that used social network analysis were conducted by Totterdell and his research teams (1998, 2000, 2004) and Greetham and her colleagues (2011, 2014). The Totterdell group conducted observational studies of affect in various work environments (257–259), while Greetham et al. observed affect contagion in undergraduate students, then introduced stimuli to the network to determine whether a specific stimulus could influence affect contagion in the network (270, 271). The aims of this study were to characterize affect contagion in a social network to represent military Advanced Practice Nursing students, and determine the effect size (primary and secondary) of exposure to an affect influencing stimulus. There were 13 research questions related to these aim that were answered in the study.

Participants were recruited from a closed network of 60 military advanced practice nursing students. A total of 35 participants were included in the study and completed usable questionnaires. They completed an initial packet of surveys which included questions regarding their demographics, a social network roster survey and nomination survey identified participant relationships with other network members, the Berkeley Expressivity Questionnaire (BEQ) to quantify the participant's ability to

express their affect to others, the Emotional Contagion Scale (ECS) to determine participant's susceptibility to the emotions shared by other network members, and the Iowa Personality Questionnaire to correlate trait affect with state affect. The social network roster was repeated at the end of the study to confirm the dynamics of the network and network stability.

The main study period took place during the winter semester. Data were collected on a weekly basis 14 times, 11 times with exposure to a stimulus and 3 times without stimulus exposure. The participants completed the 10 question International Positive Affect Negative Affect Schedule Short Form (I-PANAS-SF) on each of the data collection days in the morning and afternoon to measure state affect. They also completed the Perceived Stress Scale (PSS) in the afternoon to correlate stress levels with affect scores. Prior to the first day of the winter semester, participants were divided evenly into 4 stimuli exposure groups based on placement in the network. Each group was exposed to an affect influencing stimuli during the lunch hour on 3 data collection days. The stimulus administered during lunch hours was intended to modify the affect of the exposed individual and have a secondary affective effect on the network members with whom exposed individuals interacted. Stimulus exposure occurred during weeks 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, and 12. Weeks 0, 8, and 13 had data collection without stimulus exposure. At the end of the study the social network survey was repeated to capture the dynamic nature of relationship within the network.

This study had 2 specific aims and answered 13 research question and 5 supplementary measures. Discussion of significant findings related to the hypotheses for

the research questions and supplementary measures follows. The chapter concludes with limitations to the study and recommendations for future research.

SPECIFIC AIM 1

CHARACTERIZE AFFECT CONTAGION IN A SOCIAL NETWORK TO REPRESENT MILITARY APN STUDENTS.

There were three major findings for specific aim 1. Affect contagion occurred on four data collection days; stimulus exposure on three data collection days changed the affect of exposed participants; and expressivity was correlated with trait and state affect. A discussion of these findings and the findings from the other research questions associated with specific aim 1 follows.

Research Question 1.1: What is the relationship among network members with similar affect and what are their social interactions?

Hypothesis: Convergence of affect will occur in the student group based upon the community structures within the network.

This hypothesis was confirmed. Structural equivalence of network members and academic program groups shared similar affect over the semester. The sharing of affect in a social network was previously established for the general public of Framingham, Massachusetts, in factory settings, the clinical nursing environment, sports teams, and undergraduate students (94, 257–259, 270, 271). Affect was shared among the participants in the study demonstrating correlations for afternoon positive affect. When the mean scores of subnetworks were plotted overtime, distinct differences were

observed. The affect of participants in the FNP and RNA academic programs demonstrated a more labile affect than participants in the PMHNP program. Furthermore, the PMHNP students reported consistently lower NA and higher PA than the other groups. This difference among the participants invites questions about differences in the academic programs, and the personality types who choose various nursing specialties. It may also have implications for how to target interventions for differing nursing specialties. Also, the low centrality group had more labile affect scores than the other stimulus exposure groups. Previous studies were not longitudinal (257–259, 270, 271). The data collection times were shorter and the variations in affect over days may be more subtle than the changes observed over the 14 weeks of this study. Continued investigations of affect contagion should include longitudinal research to observe affect for consistency or correlate changes in affect with affective experiences that could influence the affect of network members.

Research Question 1.2: Do Individual's with strong ties with other network members have greater affect similarity?

Hypothesis: Individuals who interact both in and out of the classroom will have a higher propensity for convergence of affect than individuals who interact minimally.

This hypothesis was confirmed through assortative mixing that correlated the affect of the dyadic friendships. Affect similarity occurred during 4 weeks of the data collection (1, 6, 8, and 10). Like question 1.1, identifying the weeks when convergence occurred and the importance of the friendship networks involved in this process aligns with previous social network affect contagion studies (94, 257–259, 270, 271). Fowler and Christakis (2008) determined that spouses who lived together and family members

who lived in close proximity (within 1 mile) experienced the most affect contagion. Studies from the Totterdell group among networks with higher density, and the most interactions like departments within a factory or business (257–259). The most recent affect contagion studies Greetham et al determined that affect contagion among friends of participants with initially high positive affect was positive and negative with participants with initially high negative affect (271). Identifying the weeks when affect convergence occurred was necessary to then determine whether stimulus exposure during the identified weeks had any effects on the network. Because stronger friendship ties have a higher propensity for sharing affect (1), it may be possible for secondary affective effects to occur among network members who have friendship ties with the stimulus exposure group.

Research Question 1.3. What are the system mechanisms influencing affect within the network?

Hypothesis: Individual and small group interactions impact the affect of the entire network.

This hypothesis was confirmed through cluster coefficient quantification, clique identification, and density calculations network members in this study shared many relationship with each other. The highly connected network members shared affect multiple time during the study but clustering, cliques, and increased density did not seem to impact the sharing of affect. The clique identification indicates that participants do not choose friendships based upon gender, program of study, or branch of service.

Mechanisms that led to the formation of specific cliques in the network may include shared previous duty assignments or deployments together, or shared interests. These

variables were not considered or obtained for this study but could explain the formation of cliques in the network.

Research Question 1.4: What is the relationship between network topology and ECS scores?

Hypothesis: Central members of the network will have higher ECS scores than peripheral members (social power). ECS scores will be similar based on an academic program (group membership, situational similarity).

This hypothesis was not confirmed. ECS scores did not correlate with network topology. The previous investigators utilized information from multiple studies to develop a computational which was validated mathematically (209). Therefore, multiple populations were used to associate ECS scores and topology, but did not do so directly. Social power can be associated with centrality but in this case is not the same. Furthermore, participants did not have correlations of ECS scores based on academic group. These findings could in part be due to the small sample size, when dividing the participating cohort of 35 into smaller groups, there may not be enough participants in each group to draw conclusions.

Research Question 1.5: What is the relationship between network topology and BEQ scores?

Hypothesis: Central members of the network will have higher BEQ scores than peripheral members (social power). BEQ scores will be similar based on an academic program (group membership, situation similarity).

This hypothesis was not confirmed. BEQ scores did not correlate with network topology and participants did not have correlations of BEQ scores based on academic group. These findings could in part be due to the small sample size, when dividing the participating cohort of 35 into smaller groups, there may not be enough participants in each group to draw conclusions.

Research Question 1.6: What is the relationship between ECS and BEQ scores?

Hypothesis: Participant ECS scores correlate with their BEQ scores.

This hypothesis was not confirmed. ECS and BEQ scores were not correlated. These self-report instruments had not been previously used together, and although expressivity scores were not related to emotional contagion susceptibility scores, their usefulness and tools that are independent was important for understanding their relationship with individual affect (research question 1.7).

**Research Question 1.7: What is the relationship between IPQ and ECS scores?
BEQ scores?**

Hypothesis: No relationship exists between the IPQ and ECS scores.

This hypothesis was confirmed. No relationship existed between trait affect scores measured by the Iowa personality Questionnaire (IPQ) and emotional contagion susceptibility measure by ECS scores. However, trait positive affect had a moderate negative correlation with expressivity, which could indicate that participants with lower positive affect are more expressive than participants with higher positive affect. This correlation finding from the current study is new, previous studies explored contagion susceptibility and state affect emotional contagion susceptibility was positively correlated

with state affect (74, 75). Trait affect and expressivity were not explored in prior research. The correlation between expressivity and positive affect in the current study could be used to plan stimuli that could modify the spread of affect in the network through targeting participants with high expressivity scores and low positive affect scores. Similarly, a previous affect contagion study that included an intervention found participants with low initial negative affect were better at expressing affect (271). Exposing a group with low initial negative affect or participants with high expressivity and low positive affect scores to a stimulus that promotes positive affect may support a larger signal and contagion of positive affect within the network than exposing individuals based on network placement. Furthermore, the positive correlation of high morning state PA from the morning I-PANAS-SF scores with expressivity and the decrease in positive affect that occurred each data collection day, support the need for future studies that focus on a stimuli to boost positive affect particularly with participants who have high expressivity scores.

Research Question 1.8. What is the relationship between gender and ECS scores? BEQ scores?

Hypothesis: There may not be a difference among participants based on gender for their susceptibility to contagion, or expressivity of affect because of their chosen profession, nursing.

As hypothesized, no difference was found among participants based on gender. Previously, military physicians completed the ECS as part of the validation of the instrument (75). All the students in this study were nurses which is similar to Doherty et al.'s (1995) study of physicians from Tripler Army Medical Center who also did not

display gender differences in contagion susceptibility. A literature review of affect expression related to gender concluded that expressivity differences in gender may be related to conformity with gender roles, not individual expression of affect (160). Because the self-report measures were anonymous and male nurses do not necessarily conform to gender roles through their choice of profession as nurses, expressivity scores did not differ for the genders.

Research Question 1.9. What is the relationship between age and ECS scores? BEQ scores?

Hypothesis: Participants will show less susceptibility to emotional contagion as they age, there will be a negative relationship between age and ECS score. While expressivity will not have a relationship with age; there will be no significance in the relationship between BEQ and age.

This hypothesis was not confirmed. No correlations were present for age and self-report contagion susceptibility or expressivity in the study sample. This finding differs from the susceptibility findings of previous research but could be related to the age of the participants in this study were younger than the Gross et al. (1997) study which included participants as old as 96 years old and focused on comparing participants over 70 years of age to participants younger than 70 years of age. The oldest participant in this study was 57, which would be considered in the young category regarding age and susceptibility in the study (109). Previously Gross et al. (1997) found that expressivity of emotions decreased with age. Again, the Gross et al. research considered old adults to be over the age of 70 years while the oldest participant in the current study was only 57 years old which could account for the difference in the findings.

SPECIFIC AIM 2

DETERMINE THE PRIMARY AND SECONDARY AFFECTIVE EFFECT SIZE OF AN AFFECT INFLUENCING STIMULI FOR USU GRADUATE NURSING STUDENTS.

There were three findings for specific aim 2. Affect scores differed for stimulus exposure groups at 5 timepoints; there was a negative secondary affective effect for one timepoint; and affect evolved over time. A discussion of these findings and the findings from the other research questions associated with specific aim 2 follows.

Research Question 2.1. What is the primary effect size of a shared affective experience for USU graduate nursing students?

Hypothesis: Exposure to the shared affective experience will change the affect of the exposed individual when compared to affect of non-exposed participants.

This hypothesis was confirmed, the stimulus exposure groups' self-reported affect differed significantly from the non-exposed group during weeks for 3, 5, 7, 9, and 10 for I-PANAS-SF attributes attentive, active, hostile, or alert. There was an overall statistically significant difference between morning and afternoon PA over the semester. Negative affect scores differed for each of the stimuli exposure weeks but did not reach a level of significance. Because there was a difference in affect scores between the exposed and non-exposed participants, the potential for the participants exposed to stimuli to influence the affect of the non-exposed participants existed. In previous research, when all participants from a social network were exposed to a positive stimulus, group level positive affect increased and negative affect decreased, but affect contagion

could not be identified (271). Both studies demonstrated changes in affect attributed to the introduction of stimuli.

Research Question 2.2. What is the secondary effect size of a shared affective experience for USU graduate nursing students who do not participate in the experience?

Hypothesis: Interaction with individuals exposed to the shared affective experience will change the affect of non-exposed network members when compared to the non-exposed member's affect on a day without any exposure to stimuli.

This hypothesis was supported, but in an unexpected manner. One week (week 10) had correlated assortativity scores, and the score was negatively correlated. The multiple positive stimuli (no exam, late start, hoola hooping, cookies and treats) on week 10 were likely to be the cause of the negative correlation, not the exposure to the stimulus. A previous study of affect contagion in a network of undergraduate students identified stimulus exposure groups based on initial negative affect scores (271). A positive affect contagion occurred in the network when the stimulus group had a low initial negative affect and a negative affect contagion occurred when the stimulus group had a high initial negative affect (271). Since higher self-report expressivity was correlated with lower self-report positive affect for the study sample, future work may consider targeting this group for stimulus exposure to increase the likelihood of a contagion occurring.

Research Question 2.3. How does network location of the primary exposure group influence the secondary effect size of the stimulus?

Hypothesis: Affect, like communication, trust, and cooperation, will be promoted by this network of students. Furthermore, confirmation of the negative association between the interpersonal environment and stress may be present if the affect contagion is less present during high-stress data collection days.

This hypothesis was not confirmed. Although affect was shared among participants and the stimulus changed the exposed group's affect, it only correlated with friendships ties within the network for week 10. But the correlation was negative and therefore an opposite secondary effect was present. Comparison of affective changes in the network to environmental stimuli may better explain this negative correlation. Multiple events were documented during week 10 (no exam the previous day, a late start, cookies from faculty, treat from classmate, and hoola hooping) that could have influenced the affect and buffered the influence of the stimulus exposure group. In this instance, the stimulus group had the potential of causing a negative affect contagion. The group's central location in the network offered high potential for the negative contagion to occur, but the rest of the network seemed more influenced by environmental factors than the stimulus group.

Research Question 2.4. Are there cumulative affective effects that occur during the study?

Hypothesis: Cumulative affective effects will occur. The change in group affect will be visualized using the ABM. The linear plot of group affect overtime should demonstrate either an increase or decrease, not a flat horizontal line.

The current study collected information once weekly when the cohort of participants was together. The students worked together in small groups and academic programs during the rest of the week. Because the network was divided during most of the week, affective measurements were not possible more than once weekly. Because of the extended time between data collection days, cumulative affective effects over the course of the semester are unlikely to be related to the stimuli from this study. Instead, observations of the affect over time describe the ebb and flow of state affect for the network during the semester. Most studies of affect contagion in natural settings are conducted for shorter periods of time usually about 7 – 14 days (257, 258, 270, 271), or 3-4 data collection times that are related to an identified change (259). The longitudinal study of affect contagion on a social network collected affective data for nine years (94).

SUPPLEMENTARY MEASURES

Affect and Stress Conditions

Stress levels are correlated with trait affect, and state affect is correlated with trait affect (135, 199). Therefore, a self-report instrument to measure stress was administered on each data collection day. As expected, the stress scores were correlated with both trait

affect measured by the IPQ and state affect measured by the I-PANAS-SF, and the trait and state affect scores were correlated.

Life event calendar

The life event calendar were qualitative observations of the environment for factors that may influence the affect of the network (13). Cross referencing with the event calendar assisted in explanation of the results for multiple research questions.

Repeated Measure Social Network Survey

As a method to confirm the dynamics of the network, a second social network survey was administered at the end of the data collection time. The results of the first and second social network survey were compared using a regression model through a technique called quadratic assignment procedures (259). There were differences between the relationships identified in the surveys, confirming a dynamic network. The changes were not statistically significant, demonstrating stability among the friendships in the network.

Faculty Inclusion

The inclusion of faculty members to supplement the affect of the students was to support the premise that faculty members have the potential to influence the affect of the students. Only two faculty members participated in the study, one who taught a class in the morning on the day of data collection and the other taught class in the afternoon. It was expected that the affect of faculty members would influence the affect of the students with whom they interacted based (39, 43, 50, 137). But for this network, no similarities were found between the participating faculty members and students. This could be

because only two faculty members participated and although primary instructors, were only involved with the network for about 2-3 hours weekly. Also, the courses featured many guest lecturers and student led learning activities, the faculty members who participated in the study were often facilitators instead of interacting directly with the network. This limited the amount of interaction decreased the likelihood of correlated affect among the faculty and students.

Fraternization is a concept within the military that may further delineate the academic hierarchy between the participating faculty and students. A social norm for this cohort of students is to maintain a distant relationship from their faculty members who are seen as “higher ranking” and therefore inappropriate to form relationships that would lead to a sharing of affect (197). Students are reminded at least twice during the year that non-military faculty members are to be respected and treated as if they are senior ranking military officers (197). This social norm is present under other military circumstance between enlisted and officer rank and within the officer ranks between company and field grade. A similar perspective may be taken for the faculty-student relationship, reducing the likelihood of sharing affect.

LIMITATIONS OF THE STUDY

Population

Study results indicate that affect converges in a network of military nursing students in an academic advanced practice nursing program. It was conducted in an academic setting with a staged stimulus, administered 11 times to attempt to modify the affect of the network members during one semester of the academic year. This study was foundational for establishing the existence of a contagion effect in the military nursing

student population, however, future research is needed to explore the clinical work environment for military nurses or the academic environment for non-military nursing populations in order to build upon the findings of this study.

Data collection days

Unfortunately, the academic calendar limited the number of days on which data could be collected. The cohort was only whole once weekly for an entire day, this meant that stimulus exposure could only occur once weekly. Because of a last minute change in schedule one group was not exposed to the third stimulus. The study could not be continued into the summer semester because the students traveled to various clinical sites across the country and were no longer in classes together as a cohort. Ideally, data collection would be conducted longitudinally over multiple weeks, as in this study, but with consecutive data collections days at each time (3-4 days in a row). This clustering of data collection days done longitudinally may offer a more complete affective picture and better define the occurrence of affect contagion and allow for observation of affection contagion's evolution in the study population.

Computational Model Methods

Because of the length of time between data collection days and the short-acting effect from the stimuli, shared affect could be confirmed occasionally within the network but not consistently in a way that modeled affect contagion occurring over time. Therefore, the data could not be tested in the computational model. For the data to be tested in the computational model, shared affect would have to be consistently present and an affect contagion from the stimulus was needed. Affect contagion only occurred

on four of the 14 data collection days, and was not associated with stimulus exposure. On three occasions students exposed to the stimulus experienced a change in affect, but the affect of non-exposed friends of the exposed group did not have affect scores that correlated with the exposed group. Without the computational model, social network analysis and linear statistical methods were able to provide support for continued research with refined methods to provide data that can be analyzed with the computational model. Future work should consider consecutive data collection days with the same network to monitor the affect evolution and deterioration of the signal from the stimuli. Also, use of a stimulus that has an impact that is large enough to distinguish its effect from the affect influencing events that could cause noise in the environment reducing the effectiveness of the stimulus.

Effective Stimuli

The stimulus chosen for this study effected the self-reported affective state of the exposed group but was not strong enough to overcome the affective noise of the environment and influence non-exposed network members. Consideration of the noise level for this network could provide insight for choosing stimuli for future studies. The noise level of the environment included various factors that may have influenced the affect of the participants. This semester was the final and heaviest (18 credits) didactic semester for the cohort of students. With an extreme emphasis on academic success, the students worked tirelessly to meet the requirements of the program.. The curriculum for the cohort was also new, the program is only in its second class of students and continues to evolve. The evolution of the program meant frequent last minute changes to project requirements, study sessions, and schedules. The program is exclusively U.S. military

nurses creating additional requirements and complications to the student's schedules and stress level because they had military mandatory training and other requirements that needed to be factored in and balanced with their academic calendar. Small changes to the environment may have also influenced the affect of participants, for example therapy dogs occasionally came to class to visit the students with a faculty member; the dogs were there to socialize with students at the begin of class or during a break. Also, faculty members and students in the cohort would bring in food for the other students.

Furthermore one time events like hula hooping competitions and high profile guest speakers could all be sources of noise in the network. The many facets mentioned that could contribute to the noise level of the environment are all job related, personal factors including family obligations and personal health may also factor in to the affective noise level. Greetham et al. (2014) used free ice cream and identifying 3 things that participants were grateful for as stimuli to cause contagion in a network. When recipients of the stimuli had low negative affect, a positive affect contagion occurred, but when the stimulus group had high negative affect, a negative affect contagion occurred from the same stimulus. These results relate to the findings from research question 1.7 which found a correlation between both trait and state positive affect and expressivity. Because clinical environment will also have affective noise that could block the affective signal of the stimulus, future research will need to focus on finding an effective stimulus, possibly one that already exists in the environment. For example, if there is a reoccurring event that could influence the affect of the network then using the embedded event for the stimulus in a future study may be more effective than attempting to inject a new stimulus with a large enough signal to influence affect without upsetting the network. Once an effective

stimulus is identified then progressive studies that target part of the network population (like people with high BEQ and trait positive affect scores) with the intent to enhance the contagion can occur.

CONCLUSIONS

In this study affect contagion in a social network of military APN students was characterized and an affect influencing stimulus was introduced to determine the effect of stimulus on affect contagion. Previous affect contagion research has not included a military nursing population. The specific aims for this study were to characterize the affect of the network and to determine the effects of an affective stimulus on the spread of affect in the network. For specific aim 1, the cohort of participants demonstrated an affect contagion and affect similarity was found among students in the same academic program and stimulus group members. Also, there were associations between expressivity of participants and their trait and state affect. For specific aim 2, stimulus exposure demonstrated change in affect for the exposed group on multiple exposure days, but non-exposed friends only had one day in which affect was correlated with the exposed participants. An effective stimulus is necessary for future affect contagion studies because the affect influencers occurring naturally in an environment are difficult to distinguish from and overcome. The right stimulus has the potential to decrease negative affect in an environment and increase positive affect, facilitating an improved affective state for members of a participating network. The evolution of affect occurred during the semester. The changes in affect could be qualitatively associated with various events documented in the life event calendar.

Recommendations for future work

This field of study involving social network analysis and affect contagion is in its infancy and has led to more questions about the dynamics of affect contagion occurring in a social network similar to the military advanced practice nursing student network who participated in this research. Future work should include transitioning to a clinical work environment and associating the affect of healthcare workers to the affect of their patients and health outcomes or complications. Metrics like length of stay, complications, staff absenteeism, and frequency of safety mishaps or errors could be associated with the occurrence of affect contagion in a clinical setting. The importance of healthcare worker affect has rarely been correlated directly to patient outcomes. One study found that in the outpatient setting, healing time decreased, and compliance increased among patients who were seen at a clinic where staff had a higher positive affect compared to a clinical with lower negative affect (195). Future work should be conducted on consecutive days to better identify affect contagion and observe the occurrence of affective stimuli, natural or induced, and the time for the stimulus signal to deteriorate. Consideration of the affective environment could facilitate maintaining healthy employee relationships, employee commitment to an organization and ultimately patient care.

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30 July 2014

MEMORANDUM FOR DIRECTOR HUMAN RESEARCH PROTECTIONS PROGRAM AND
 EXECUTIVE SECRETARY INSTITUTIONAL REVIEW BOARD

Subject: Approval of Graduate School of Nursing Student Participation in Protocol #T0-61-3094,
 "An Agent Based Model of Affect Contagion in Graduate Nursing Students".

Attached is a copy of the USUHS IRB approval memo and an approved protocol involving the participation of graduate school of nursing students.

The investigators observe the affect of nurses who are graduate students in the Doctorate of Nursing Practice (DNP) using social network analysis (SNA) to create an agent based model (ABM) of the affect contagion. An intervention to influence affect will be introduced to determine its secondary influences within the network.

The purpose of this study is to determine the feasibility of using an intervention to change affect in a nursing population and model the affective effects in an agent based computational model.

BACKGROUND ON RESEARCH

This study is of a social network that exists in a class of graduate nursing students. There are 62 students in the cohort. The study consists of 10 data collection time points to understand the patterns of affect contagion within the group. A social network survey will be used to establish the social network. An affect instrument will be administered at each time point to the student participants and the faculty members with whom they interact with on the day of data collection to determine whether the group affect also has correlative influence with the faculty. Affect groups will be compared to the identified social network. Rules for the agent based model of the affect contagion will be derived from social network analysis of the unit. Computational modeling the affect contagion provides the opportunity to not only observe its evolution, but also modify the affect within the model to observe whether it has the potential to greatly change affective outcomes within the network.

The specific aims and research questions for this study are:

1. Develop an agent-based model of affect contagion in a social network representing nursing students and faculty interacting in a graduate school setting.
 - a. What is the relationship between network members with similar affect and their social interactions?
 - b. Do Individual's with strong ties have greater affect similarity?
 - c. What are the system mechanisms influencing affect within the network?
2. Determine the primary and secondary affective effect size of yoga-based stretching and a provided meal for graduate nursing student.

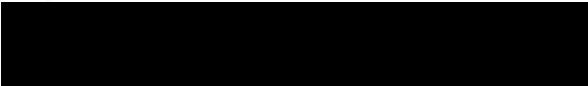
- a. What is the primary effect size of providing food or stretch break to graduate nursing students?
- b. What is the secondary effect size of providing food or stretch break to graduate nursing students who do not participate in the intervention?
- c. How does network member centrality influence intervention effect size?

I respectfully request your permission to allow participation of USUHS graduate school of nursing students in this study. I am available at your convenience to discuss the protocol in more detail.

Patricia M. Schmidt
CPT, AN, USA
Patricia.schmidt@usuhs.edu
(414)416-8566

With your concurrence, the Office of Research (IRB) will approve this project for the use of graduate school of nursing students.

Concur/Nonconcur


LTC Michelle Munroe
Commandant, Graduate School
of Nursing

Concur/Nonconcur


Ada Sue Hinshaw, Ph.D., R.N., FAAN
Dean, Graduate School of Nursing



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Theresa Brown
Distinguished R&D

Pat Finley
Principal R&D

Tom Moore
Senior R&D

August 8, 2014

RE: Patricia Schmidt TSNRP Graduate Award Application Letter of Support

We enthusiastically support the graduate award application of Patricia Schmidt. She is an insightful and diligent researcher, and this opportunity will allow her to further develop an expertise that spans both subject matter expertise and theoretical foundations, as well as expanding on her ability to implement complex systems in models for the purposes of experimental characterization of dynamics and the design of interventions. These complex systems models can then be practically applied to healthcare work environments to improve the quality of care.

The investigation of transmission of affective states in social networks is important to both clinical and institutional operations. The proposed study and modeling effort is a key component in Sandia's work in the field, and strongly leverages Sandia's experience in modeling complex social systems. Sandia is committed to the success of this effort, and will contribute computational time, physical space, and expertise in the theoretical and modeling components.

The research community has a strong need for individuals whose expertise spans multiple areas of expertise and domains of investigation. We see this collaboration as an invaluable opportunity help address this need in assisting with the development of a researcher who has a demonstrated capability for the work.

Theresa Brown, Pat Finley and Tom Moore

CASoS Engineering
<http://www.sandia.gov/CasosEngineering/>

Appendix C: Selecting video clips for affect influencing stimuli

BACKGROUND

Humorous videos can increase positive affect and decrease negative affect. The internet provides open access to an almost infinite amount of humorous video clips.

Problem: Three humorous video clips are needed to act as stimuli in a study to understand affect contagion.

PURPOSE

From a focus group, determine which open access humorous video clips will improve affect (increase positive affect and / or decrease negative affect).

Population: Multiple groups of professionals were solicited by the investigator for participation through listservs. The listservs contain lists of people who are associated with the investigator.

Participant characteristics include medical and non-medical professionals, military members and people with no association with the military, and graduate students. Solicitation was only sent to people who were at least 18 years old. There were 52 responses to the participation solicitation.

METHOD

1. A list of humorous video clips was selected by the investigator using the website YouTube.com.
 - a. From the “Popular on YouTube” section, the “Today’s Funniest Clips” section was selected.
 - b. The following search terms were used:
 - i. stand-up comedy
 - ii. whose line is it anyway

- iii. candid camera
 - iv. I get that a lot
 - v. Funny pets
 - vi. Funny babies
 - vii. Funny falls
 - viii. Animated funny video
 - ix. Funny military videos
 - x. Elders react
- c. Only video clips that were 5-10 minutes in length were selected.
- d. A minimum of 50,000 views
- e. Video clips could not be offensive
- f. 37 video clips were selected using the above criteria
- 2. An online google survey was designed for viewing the video clips.
 - a. Each video was assigned a random 20 digit number so that viewers would not be biased by the title of video clips.
 - b. Video clips were randomly ordered for viewing by participants
 - c. The google survey consisted of 3 parts
 - i. I-PANAS-SF pre-viewing
 - ii. Link to view the video clip
 - iii. I-PANAS-SF post-viewing
 - d. Participants could choose how many video clips they watched, but were asked to wait at least an hour between videos
- 3. Invitations were sent to request participation

4. Results were automatically populated in a google spreadsheet for analysis.

RESULTS

1. Data was reviewed for completeness. All 52 responses were complete and included for analysis.
2. I-PANAS-SF responses were scored
3. The change in affect from pre-test to post-test was calculated
 - a. Responses that indicated a decrease in positive affect and/or an increase in negative affect were identified. Video clips that elicited this response from viewers were removed.
 - b. If there were multiple views of the same video that had polarize responses, the video was removed from the list.
 - c. There were 6 video clips that increased positive affect or decreased negative affect.
4. The three video clips that saw the largest change in affect were:
 - a. “Just for laughs” science fiction video with an increase in PA by 4 points and a decrease in NA by 1 point
 - b. “Snoop Dogg I get that a lot” video clip increased positive affect by 4 points and there was no change in negative affect.
 - c. “Just for laughs” most crazy complex pranks demonstrated an increase in positive affect by 2 points and a decrease in negative affect by one point.
5. These three video clips will be used in the shared affective experience study as the affect influencing stimuli.

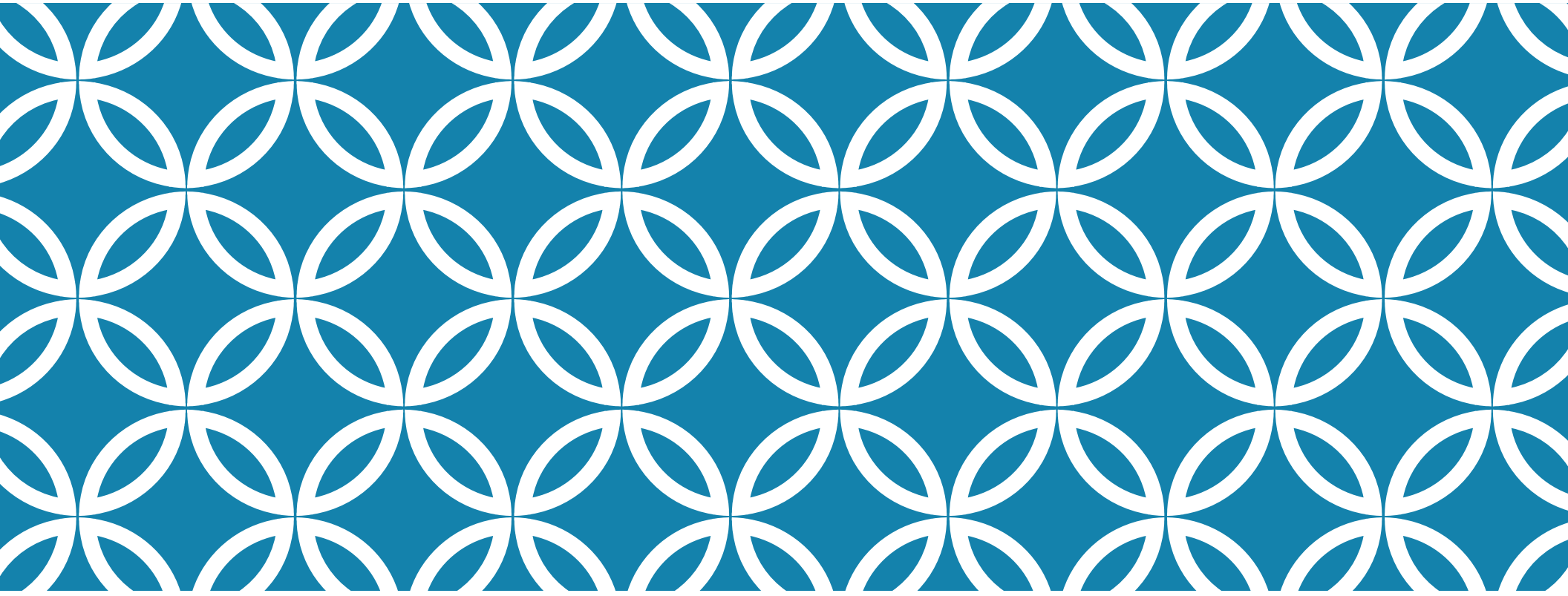
DISCUSSION

Because google surveys randomly ordered and assigned video clips for viewing, some of the videos were watch multiple times while others were only viewed once. In the future it would be ideal to have enough participants to have the same number of views of all of the videos in the pool.

CONCLUSION

The three final videos are between six and 9 minutes in length and had at least 120,000 views on YouTube. URL Links are listed below:

1. “Just for laughs” science fiction <https://www.youtube.com/watch?v=WD94mEYFaCw>
2. “Snoop Dogg I get that a lot” <https://www.youtube.com/watch?v=2vdt5u9e5k0>
3. “Just for laughs” most crazy complex pranks
<https://www.youtube.com/watch?v=662KGcqiT5Q>



AN AGENT BASED MODEL OF AFFECT CONTAGION REPRESENTING THE SPREAD OF EMOTIONS IN A NURSING NETWORK

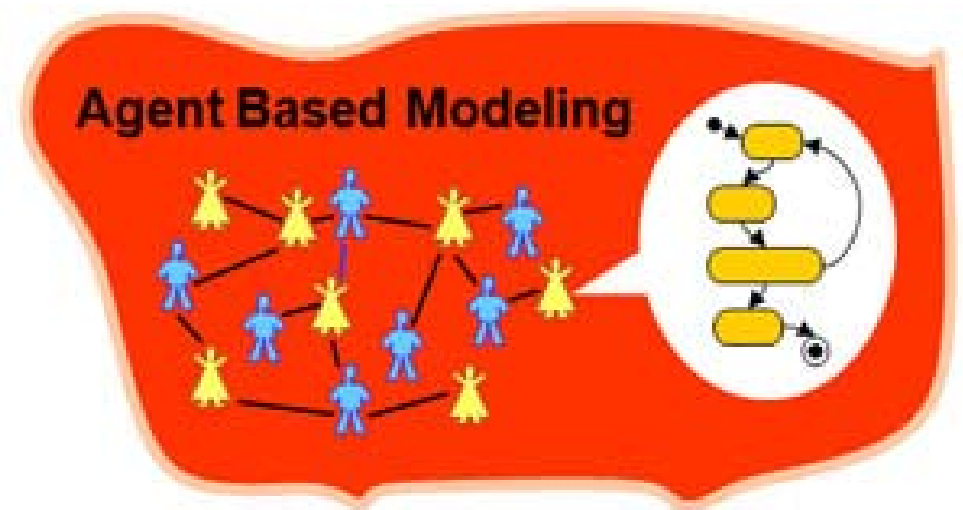
AFFECT CONTAGION IN THE WORKPLACE

- Definition: The transfer of emotion / mood
- Studied on individual, paired levels, and groups (controlled environments)



AN AGENT BASED MODEL

- An agent based model is a computational representation a real world situation
- Develop an agent based model to describe affect contagion in a nursing environment.



RELATIONSHIP WITH HEALTH MISSIONS

Magnet Metric

- Peer Feedback

Strategic Pillars

- Quality of Care
- Service Excellence
- Business of Healthcare
- Research

MHS Quad Aim

- Better Care
- Better Health



NETWORK DESCRIPTION

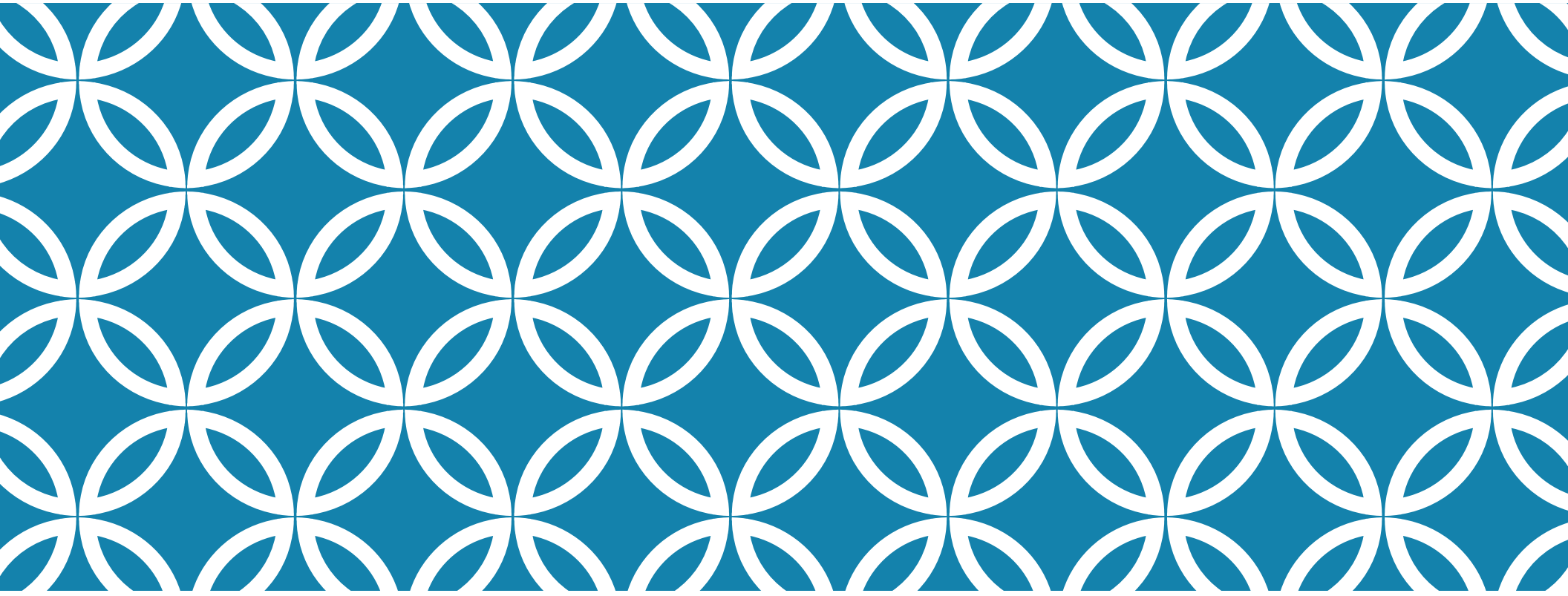
- The Master's and DNP first year cohort.
 - Students
 - Faculty members who interact with students on collection days

PARTICIPANT COMMITMENT

- Positive Affect Negative Affect Schedule twice on data collection days— 10 questions
- Perceived Stress Scale one time on data collection days – 10 questions
- Berkeley Expressivity Questionnaire one time – 14 questions
- Emotional Contagion Scale one time – 10 questions
- Iowa Personality Questionnaire one time – 42 questions
- Social Network Survey one time
- Demographics Questionnaire (Doherty, 1997; Gross & John, 1997; Watson, 1988)

STIMULI (STUDENTS ONLY)

- Participants are divide into 2 intervention groups
- Each participant will be exposed to each stimuli six times
- The stumuli will occur during the lunch hour on Thursdays
 - 10 minutes
- Participants will be notified of which days they will be assigned to participate in the intervention



**THANK YOU FOR YOUR TIME.
ANY QUESTIONS?**

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Is your mood catching?

Participate in a study to understand how moods and emotions spread among nurses.

All Masters and DNP students in the 2017 cohort and the faculty are eligible to participate.

Contact Patricia Schmidt if interest in participating.

Patricia.schmidt@usuhs.edu

Phone: (xxx)xxx.xxxx



A Friendly Reminder

Tomorrow is an intervention day!



Please plan to meet in room XXX in the X Building at 11:30 to participate in the Affect Contagion Study Stimulus.



EMOTIONAL CONTAGION IN THE WORKPLACE

- Affect influences various metrics
 - Performance
 - Decision Making
 - Turnover and Absence
 - Prosocial Behavior
 - Negotiation and Conflict Resolution



**UNIFORMED SERVICES UNIVERSITY
BETHESDA, MARYLAND**

This consent form is valid only if it contains the "USUHS IRB Approved" stamp. Do not sign this form or participate in this research if the IRB stamp is not present or if it has expired.

Consent for Voluntary Participation in a Non-Clinical Research Study

1. INTRODUCTION OF THE STUDY

You are being asked to be in a research study entitled, "An Agent Based Model of Affect Contagion in Graduate Nursing Students", at the Uniformed Services University (USU), Bethesda, Maryland. You have been asked to take part in this study because you are a student or faculty member interacting with the students in the first year master's or Doctorate of Nursing Practice program at USUHS. Your participation is voluntary. Refusal to participate will not result in any punishment or loss of benefits to which you are otherwise permitted. Please read the information below, and ask questions about anything you do not understand, before deciding whether to take part in the study.

2. PURPOSE OF THE STUDY

The purpose of the study is to learn about the transfer of moods and emotions among nurses and the impact of positive stimuli on moods and emotions. It is known that nurses influence the moods of their coworkers, and that patients can influence the mood of nurses. What is not known is the extent of the mood transfer. Whether it requires direct interaction with the stimuli of whether mood transfer occurs on multiple levels. Other studies have shown that moods and emotions do transfer but have not observed the evolution of this transfer over time. This study will be conducted over a 12 week period to better understand the changes of mood and emotions among a group of nurses. From the study, we hope to gain an understanding of the processes that occur within the group that lead to the transfer of mood and emotions among the group members.

3. PROCEDURES TO BE FOLLOWED

If you agree to be in this study, you will be asked to complete an initial questionnaire package that includes:

1. A social network survey identifying relationships with other students.
2. A trait affect survey that identifies your general perspective regarding how you view your environment.
3. A survey that measures how susceptible you are to the emotions of others.
4. A survey that measures how much you project your mood and emotions.
5. A demographic form.

You will then be assigned to one of two groups. Regardless of your group assignment, all participants will be asked to complete additional brief questionnaires on stress and mood before

47 and after your Wednesday and/or Thursday classes. Some participants will also be asked to
 48 watch a brief humorous video clip during the lunch hour.
 49 6. The social network survey will be repeated at the end of the study.
 50

Task	Data Collected	Number of times collected	Estimated completion time
<u>Initial Survey Completion</u>	Social Network Survey	1	60 minutes
	Expressivity Survey		
	Susceptibility Survey		
	Trait Affect Personality		
	Demographics		
<u>Affect Assessment</u>	State Affect Survey (x2 /day)	14	10 minutes
	Stress Scale (x1 /day)		
	Stimuli exposure (x1 6-8 min) 6 of the 14 days		
Repeat Measures	Social Network Survey	1	10 minutes

51

52

53 **4. NUMBER OF PEOPLE THAT WILL TAKE PART IN THIS STUDY**

54 A total of 70 subjects are expected to take part in this study.

55

56 **5. AMOUNT OF TIME FOR YOU TO COMPLETE THE STUDY**

57 You will be part of this study for 5 months. The initial questionnaires will be completed
 58 in October / November and the stimuli exposure will occur for 14 sessions over 12 weeks
 59 January through March.

60

61 **6. ELIGIBILITY FOR BEING IN THIS STUDY**

62

63 You are eligible to participate because you are a student or faculty member who interacts with
 64 the students in the cohort participating in the study.

65

66 **7. COMPENSATION FOR BEING IN THIS STUDY**

67 You will not receive any compensation for participating in this study.

68

69 **8. POSSIBLE RISKS OR DISCOMFORTS FROM BEING IN THIS STUDY**

70

71 There are no expected risks or discomforts from being in this study.

72

73 If something in this research makes you uncomfortable or upset, you may choose to stop taking
 74 part in this research at any time without loss of benefits; you may contact the investigator for
 75 referral. If the investigator notes any distress or anxiety associated with the research, you will be
 76 referred to the behavioral health department.

77

78

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20 OCTOBER 2014

79 **9. POSSIBLE BENEFITS FROM BEING IN THIS STUDY**

80
81 You will not benefit directly from participating in this study. The information we learn may help
82 us learn about how moods and emotions travel among nurses. This information could be used to
83 help nurses understand how their mood and emotions influence others. The information gained
84 could be used as a method for assessing the emotional state of environments where nurses
85 practice, determine whether environmental changes or events can be implemented to improve
86 mood and emotions, and applied as a tool to provide peer feedback in the Patient Caring Touch
87 Model. However, no benefit can be guaranteed.
88

89 **10. CONFIDENTIALITY/PRIVACY AND HOW YOUR IDENTITY AND YOUR**
90 **RESEARCH RECORDS WILL BE MAINTAINED**

91
92 All information you provide as part of this study will be confidential and will be protected to the
93 fullest extent provided by law. Your responses to our interviews and questionnaires, will be
94 maintained in a fire safe locked file box and electronically in an encrypted database. All records
95 related to this study will be accessible to those persons directly involved in conducting this study
96 and members of the USUHS Institutional Review Board (IRB). In addition to the IRB at
97 USUHS, other federal agencies that help protect people who are involved in research studies,
98 may need to see the information you give us. Other than those groups, records from this study
99 will be kept private to the fullest extent of the law. Scientific reports that come out of this study
100 may include your ideas, but they will not use your name or identify you in any way.
101

102 **11. CONDITIONS WHICH YOUR PARTICIPATION IN THIS STUDY MAY BE**
103 **STOPPED WITHOUT YOUR CONSENT**

104
105 There are no anticipated circumstances where your participation would be stopped without your
106 consent.
107

108 **12. IF YOU DECIDE TO STOP TAKING PART IN THIS STUDY AND THE**
109 **INSTRUCTIONS FOR STOPPING EARLY**

110
111 You have the right to withdraw from this study at any time. If you decide to stop taking part in
112 this study, you should notify the principal investigator as soon as possible.
113

114 If you decide to withdraw from the study, the information you provided will not be used for data
115 analysis and will be destroyed upon completion of the study.
116

117 **13. COMPENSATION TO YOU IF YOU ARE INJURED AND LIMITS TO YOUR**
118 **MEDICAL CARE**

119
120 This study should not entail any physical or mental risk beyond those described above. We do
121 not expect complications to occur, but if, for any reason, you feel that continuing this study
122 would constitute a hardship for you, we will end your participation in the study.
123

124 If at any time you believe you have suffered an injury or illness as a result of participating in this

research project, contact the Director of Human Subjects Protection Program at the Uniformed Services University of the Health Sciences, Bethesda, Maryland 20814-4799 at (301) 295-9534. This person can review the matter with you. They can provide information about your rights as a research volunteer. They may also be able to identify resources available to you. If you believe the government or one of the government's employees (such as a military doctor) has injured you, a claim for damages (money) against the federal government (including the military) may be filed under the Federal Torts Claims Act. Information about judicial avenues of compensation is available from the University's General Counsel at (301) 295-3028.

14. CONTACT FOR QUESTIONS OR PROBLEMS

If you have questions about this research, you should contact Patricia Schmidt the person in charge of the study. Her phone number at USUHS is **414-416-8566**. Even in the evening or on weekends, you can leave a message at that number. If you have questions about your rights as a research subject, you should call the Director of Human Research Protections Programs at USUHS at (301) 295-9534. He/she is your representative and has no connection to the researcher conducting this study.

SIGNATURE OF RESEARCH PARTICIPANT OR LEGAL REPRESENTATIVE

You have read (or someone has read to you) the information in this consent form. You have been given a chance to ask questions and all of your questions have been answered to your satisfaction.

BY SIGNING THIS CONSENT FORM, YOU FREELY AGREE TO TAKE PART IN THE RESEARCH IT DESCRIBES.

Participant's Signature

Date

Participant's Printed Name

SIGNATURE OF INVESTIGATOR

You have explained the research to the participant, or his/her legal representative, and answered all of his/her questions. You believe that the volunteer subject understands the information described in this document and freely consents to participate.

Investigator's Signature

Date (must be the same as the participant's)

Investigator's Printed Name

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20 OCTOBER 2014

Expires: 19 OCTOBER 2015

SIGNATURE OF WITNESS

Your signature as witness is intended to attest that the information in the consent document and any other information was explained to and apparently understood by the participant, or the participant's legal representative, that questions and concerns were addressed and that informed consent was freely given.

Witness' Signature

Date (must be the same as the participant's)

Witness' Printed Name

USUHS IRB APPROVED
20 OCTOBER 2014
Expires: 19 OCTOBER 2015

The Positive and Negative Affect Schedule (PANAS; Watson et al. 1988)

PANAS Questionnaire

This scale consists of a number of words that describe different feelings and emotions. Read each item and then list the number from the scale below that is, at the present moment the way you feel.

1	2	3	4	5
Very Slightly or Not at All	A Little	Moderately	Quite a Bit	Extremely

1. Upset
2. Hostile
3. Alert
4. Ashamed
5. Inspired
6. Nervous
7. Determined
8. Attentive
9. Afraid
10. Active

Social Network Survey – Census Data (Valente, 2010)

This survey consists of the names of your fellow students. Please identify how frequently you interact with each person on the roster using the scale provided below.

1	2	3	4	5
Not at all	Only in the Classroom	Occasionally outside of Class	Moderately couple times per month Outside of class	Quite a Bit most weeks outside of class

1. Name
2. Name
3. Name
4.

The Berkeley Expressivity Questionnaire (Gross & John, 1997)

For each statement below, please indicate your agreement or disagreement.

1	2	3	4	5	6	7
Strongly Disagree			Neutral			Strongly Agree
1.	Whenever I feel positive emotions, people can easily see exactly what I am feeling.					
2.	I sometimes cry during sad movies.					
3.	People often do not know what I am feeling.					
4.	I laugh out loud when someone tells me a joke that I think is funny.					
5.	It is difficult for me to hide my fear.					
6.	When I'm happy, my feelings show.					
7.	My body reacts very strongly to emotional situations.					
8.	I've learned it is better to suppress my anger than to show it.					
9.	No matter how nervous or upset I am, I tend to keep a calm exterior.					
10.	I am an emotionally expressive person.					
11.	I have strong emotions.					
12.	I am sometimes unable to hide my feelings, even though I would like to.					
13.	Whenever I feel negative emotions, people can easily see exactly what I am feeling					
14.	There have been times when I have not been able to stop crying even though I tried to stop.					
15.	I experience my emotions very strongly.					
16.	What I'm feeling is written all over my face.					

The Emotional Contagion Scale (Doherty, 1997)

This scale consists of a number of situations that describe different events that can induce feelings and emotions. Read each item and then list the number from the scale below that best describes how you would act in the situation.

1	2	3	4	5
Never	Rarely	Usually	Often	Always

1. If Someone I'm talking with begins to cry, I get teary-eyed
2. Being with a happy person picks me up when I'm feeling down
3. When someone smiles warmly at me, I smile back and feel warm inside
4. I get filled with sorrow when people talk about the death of their loved ones
5. I clench my jaws and my shoulders get tight when I see the angry faces on the news
6. When I look into the eyes of the one I love my mind is filled with thoughts of romance
7. It irritates me to be around angry people
8. Watching the fearful faces of victims on the news makes me try to imagine how they might be feeling
9. I melt when the one I love holds me close
10. I tense when overhearing an angry quarrel
11. Being around happy people fills my mind with happy thoughts
12. I sense my body responding when the one I love touches me
13. I notice myself getting tense when I'm around people who are stressed out
14. I cry at sad movies
15. Listening to the shrill screams of a terrified child in a dentist's waiting room makes me feel nervous.

Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983)

This scale consists of a number of questions related to the stress you have experienced in the last week. Read each item and then list the number from the scale below that best describes you.

0	1	2	3	4
Never	Almost Never	Sometimes	Fairly Often	Very Often

1. In the last week, how often have you been upset because of something that happened unexpectedly?
2. In the last week, how often have you felt that you were unable to control the important things in your life?
3. In the last week, how often have you felt nervous and “stressed”?
4. In the last week, how often have you felt confident about your ability to handle your personal problems?
5. In the last week, how often have you felt that things were going your way?
6. In the last week, how often have you found that you could not cope with all the things that you had to do?
7. In the last week, how often have you been able to control irritations in your life?
8. In the last week, how often have you felt that you were on top of things?
9. In the last week, how often have you been angered because of things that happened that were outside of your control?
10. In the last week, how often have you felt difficulties were piling up to high that you could not overcome them?

Iowa Personality Questionnaire (Donnellan, Conger, & Burzette, 2005)

Please compare *yourself* with other people of *your age and sex* on each of the following traits or characteristics.

1	2	3	4	5
I am not at all happy cheerful		About average		I am extremely happy and cheerful

1. 1= I am not at all happy and cheerful
5= I am extremely happy and cheerful
2. 1= I am not a leader at all
5= I am a natural leader; others defer to me
3. 1= I am not at all tense, nervous, or worried
5= I am extremely tense, nervous, or worried
4. 1= I am careful, I think before I act
5= I am extremely impulsive, I act without thinking
5. 1= I believe that people often make things difficult for me
5= I do not believe that people make things difficult for me
6. 1= I have no imagination at all
5= I have a rich imagination
7. 1= I am not at all enthusiastic. I am not interested in or excited by life
5= I am extremely enthusiastic. I am interested in and excited about life
8. 1= I value having a good reputation in the community
5= I do not particularly care about my reputation in the community
9. 1= I am not at all ambitious
5= I am extremely ambitious, I strive for perfection
10. 1= I am not at all sociable. I like being alone
5= I am extremely sociable. I like being with people
11. 1= I am not at all tough. I do not take advantage of others
5= I am extremely tough. I take advantage of others
12. 1= I am not at all interested in good manners, proper behavior
5= I am extremely interested in good manners, proper behavior
13. 1= I worry at great deal
5= I don't worry very much
14. 1= I do not feel poorly treated by others at all
5= I feel others treat me very poorly and unfairly
15. 1= I am not at all adventurous. I prefer safe activities
5= I am extremely adventurous. I take risks
16. 1= I usually finish one activity before starting another
5= I usually don't finish an activity before I start another one
17. 1= I carry a grudge. I try to get even
5= I am extremely conciliatory. I turn "the other cheek"
18. 1= I am not at all responsive to beautiful sights or sounds
5= I am extremely responsive to beautiful sights or sounds
19. 1= I am not at all suspicious. I do not feel exploited

- 5= I am extremely suspicious. I feel exploited by others
20. 1= I am not at all hardworking
5= I am extremely hardworking
21. 1= I remain calm, even in difficult situations
5= I am easily upset about things
22. 1= I prefer to work out problems alone
5= I always seek support from others when faced with problems
23. 1= I am not at all level-headed, sensible, or orderly
5= I am extremely level-headed, sensible, or orderly
24. 1= I am not at all safety conscious
5= I am extremely safety conscious, I avoid risk
25. 1= I do not feel unlucky at all
5= I feel extremely unlucky, poorly treated
26. 1= I sometimes enjoy teasing or frightening others
5= I could never enjoy teasing or frightening others
27. 1= I avoid thrills and adventures
5= I seek thrills and adventures
28. 1= I am not at all strict. I am flexible about rules
5= I am extremely strict. I believe in rules and discipline
29. 1= I am not at all affectionate
5= I am extremely affectionate. I value close personal relationships
30. 1= I do not respect my parents or their ideas
5= I always respect and admire my parents and their ideas
31. 1= I am not at all aggressive
5= I am extremely aggressive, always ready for a fight
32. 1= I am not at all even-tempered. I tend to be moody and emotionally unstable
5= I am extremely even tempered. I am emotionally stable
33. 1= I am not at all persuasive or convincing to others
5= I am extremely persuasive, convincing to others
34. 1= I believe people are nice to me only when they want something
5= I believe people are nice to me just to be nice
35. 1= I am not at all optimistic
5= I am extremely optimistic. I see the bright side of things
36. 1= I don't plan for the future at all
5= I plan for the future
37. 1= I don't daydream at all
5= I daydream, get lost in my own thoughts
38. 1= I am not at all sensitive. My feelings are not easily hurt
5= I am extremely sensitive. My feelings are easily hurt
39. 1= I am often ready to hit people when I'm angry at them
5= even when I'm angry, I wouldn't hit someone
40. 1= I am not at all socially visible. I would rather not be the center of attention
5= I am extremely socially visible. I enjoy being in the spotlight
41. 1= I am not at all persevering. I do not like a challenge
5= I am extremely persevering. I like a challenge
42. 1= I believe that children owe their parents love and gratitude
5= I do not believe that children owe their parents love and gratitude

Demographics Form

UID: _____

Please complete the information requested to the best of your knowledge.

Age: _____

Gender: _____

Relationship Status: _____

Rank: _____

Branch of service: _____

Program: CNS RNA FNP PMH

Years in military: _____

Years of nursing experience to include nursing related jobs (medic, emt, CNA, LVN, LPN, etc): _____

How frequently do you exercise?

Daily 3-5 days/week 1-2 days/week occasionally

Social Network Survey – Name Generator

Please Identify three students in your cohort that you feel closest to.

1. _____
2. _____
3. _____

UID	Baseline 1			Baseline 2			Baseline 3			Baseline 4			Experience 3 Group 2					
	Date			Date			Date			Date			Date					
	PANAS	PSS	PANAS	PANAS	PSS	PANAS	PANAS	PSS	PANAS	PANAS	PSS	PANAS	PANAS	PSS	PANAS	Stimuli		
xxx																		
xxx																		
xxx																		
xxx																		



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October 21, 2014
(Revised October 23, 2014)

MEMORANDUM FOR CPT PATRICIA SCHMIDT, NC, USA, GRADUATE SCHOOL OF NURSING

SUBJECT: USU IRB #1 (FWA 00001628; DoD Assurance P60001) Approval of Protocol TO-61-3094 for Human Subjects Participation

Congratulations! The Initial Review for your No More Than Minimal Risk human subjects research protocol TO-61-3094 entitled "An Agent Based Model of Affect Contagion in Graduate Nursing Students," was reviewed and approved for execution on October 20, 2014 by Edmund Howe, M.D., J.D., Chair IRB #1 under the provision of 32 CFR 219.110(b)(1) Suppl.F(7). This approval will be reported to the USU IRB #1 scheduled to meet on **November 13, 2014**.

The purpose of this study is to learn about the transfer of moods and emotions among nurses and the impact of positive stimuli on moods and emotions. Recruitment will take place in the class of the Graduate School of Nursing (62 students) at USU by a PhD Nursing student. Faculty who interact with the student cohort on data collection days will also be included because their affect has the potential to influence the affect of the cohort. The study consists of 12 data collection time points with an affect influencing stimuli to understand the patterns of affect contagion within the group. A social network survey will be used to establish the social network. An affect instrument will be administered at each time point to the student participants and the faculty member.

Authorization to conduct protocol TO-61-3094 will automatically terminate on October 19, 2015. If you plan to continue data collection or analysis beyond this date, IRB approval for continuation is required. Please submit a USU Form 3204 A/B, application for continuing approval 60 days prior to your termination date. You will receive a reminder from IRBNet.

You are required to submit amendments to this protocol, changes to the informed consent document (if applicable), adverse event reports, and other information pertinent to human research for this project in IRBNet. No changes to this protocol may be implemented prior to IRB approval. If you have questions regarding this IRB action or questions of a more general nature concerning human participation in research, please contact Micah Stretch at 301-295-9534 or micah.stretch@usuhs.edu.

Edmund G. Howe, M.D., J.D.
Chair, IRB #1

Concur Nonconcur



Arthur L. Kellerman, MD, MPH
Professor and Dean, School of Medicine

OCT 22 2014

Date

This document has been signed electronically.

"Electronic Signature Notice: In accordance with the "Government Paperwork Elimination Act" (GPEA) (Pub.L. 105-277; codified at 44 USC 3504); Federal and DOD applicable instructions, directives and regulations, documents have been electronically signed and authorized by all who have been required to do so. These signatures have the same effect as their paper-based counterparts. Verification is retained within our protected electronic records and audit trails."

Learning to Care for Those in Harm's Way