

1. **Cover Page** (1 page):

Title: The Complex Dimensions of Humans and Society: Biological, Chemical, Energetic, Psychological, and Social.

Participating Departments:

- Department of Chemistry
- Department of Kinesiology
- Department of Mathematics and Statistics
- Department of Mechanical Engineering and Engineering Science
- Department of Physics and Optical Science
- Department of Psychological Science
- Department of Sociology

Leaders:

- David Bellar, Professor and Chair, Dept of Kinesiology
- Stephanie Moller, Professor of Sociology
- Susan Trammell, Professor of Physics and Optical Science

Target Category: Future Opportunity and Investment

Keywords: health, subtle energy, thermal imaging, mind-body practices, stress

2. Executive Summary

Research on health and social outcomes is increasingly interdisciplinary, yet gaps in knowledge persist due to disciplinary silos. Health studies often turn to biological, psychological, and biochemical markers without incorporating energy in the body (a physics-based approach) [1]. Research on individuals' social outcomes consider a limited number of biological indicators, such as genetics, without fully incorporating an array of biological, biochemical, and most notably energetic markers. We propose an Area of Excellence designed to remove boundaries within and between the physical, applied, computer, and social sciences. We will integrate expertise across disciplines to generate ground-breaking, interdisciplinary research.

The theoretical perspective that ties these disciplines together is found in eastern medicine and philosophy. The eastern influence on our culture and research is found in the expansion of: individualized practices, including yoga, meditation, breathwork, and tai chi; and energy healing professions, including reiki, healing touch therapy, acupuncture, and other forms of Energy Medicine [1], [2]. NIH has a center devoted to understanding these practices and fields, entitled The National Center for Complementary and Integrative Health.

Eastern practices assume that subtle energy governs overall health. All living creatures are composed of a multidimensional energy field that is the life force that governs the development and function of the physical body [1], [3], [4]. One component, the chakra system, represents energy centers in the body that transform and decode energy into information that affects other systems in the body, notably the nervous and endocrine systems [3]. The chakra system is the center of the global information system in the body [1]. Past experiences and related emotions are energetically stored in the chakras, and this may inhibit energy flow which impacts overall physical and emotional health [1], [4].

Emotions bridge eastern conceptualization of energy blockages and western conceptualizations of emotion dysregulation and psychopathology. Chakra theory posits that negative experiences can block chakras with unresolved emotions. Critically, negative experiences are linked to negative attention biases [5]–[9], and research has demonstrated that negative attentional biases may underlie psychopathologies such as depression and anxiety [10], [11]. Research supports the proposition that emotions are stored in the body, but thermal imaging associated with emotions outside of the face and hands are primarily conducted in animal studies [12]–[14].

Our team recently submitted an NIH R21 in response to the call, *PA-18-322: Fundamental Science Research on Mind and Body Approaches*. We argue that stress impacts the central nervous system and emotions, and mind-body techniques may alter individuals' response to stressful stimuli. Yet, scientists do not fully understand the mechanisms. Prior studies focus on cardiovascular and neurological mechanisms, yet research has not incorporated thermal imaging to capture the subtle transfer of energy, or prana, that is at the heart of mind-body practices. Our interdisciplinary team has the breadth of expertise to expand knowledge.

UNC Charlotte is poised to lead discovery in this emerging area because our university has expertise in all of the component parts: notably our broad expertise in energy in combination with our scientific, applied, and social scientific research expertise places us in a strong position to generate ground-breaking knowledge. The initial research team is of a manageable size to generate the foundational research for this *future opportunity and investment*. With a relatively small investment at the outset, we can generate evidence that will open possibilities for further research that could shift knowledge across these disciplines, justifying an even larger investment by UNC Charlotte as we could become a leader in a ground-breaking nascent field.

3. Evidence of Strength and Excellence

We propose an area for future investment and opportunity. This proposal is submitted by a newly formed group of scholars who are eager to transcend boundaries and produce cutting edge research. Our team is beginning to develop a collaborative record of success. We recently submitted an NIH R21 in response to the call, *PA-18-322: Fundamental Science Research on Mind and Body Approaches*. The NIH submission proposed to test 1) whether energy distribution across the chakras, measured through thermal imaging, is associated with stress and emotional responses, controlling for autonomic response; and 2) whether breathwork moderates the impact of exposure to a stressful stimulus on the energy distribution and emotional response. By integrating physics-based thermal imaging studies with traditional biochemical markers and emotional response, we will enhance understanding of the effects of mind-body practices.

The NIH proposal demonstrates our ability to collaborate. We initiated a proof of measurement study and generated preliminary data for our NIH proposal, illustrating that thermal imaging captures shifts in energy (measured through skin temperature) and these shifts over time follow different trajectories along the spine, as chakra theory would predict. We also worked together to articulate how our different fields can be integrated to conduct this research. Our proposal is evidence of success. It is an initial step that could open many possibilities. We are optimistic that the grant will be funded, but the proposal lacks a pilot study. Given that this is a nascent area, and we are a newly formed team, we also have a limited record of collaboration among the broad team. These potential weaknesses could be diminished with university investment.

The research team is prepared to seek external funding to support this research. Members of the team have submitted one grant proposal together (recently), and they have a wealth of success individually securing grants. Since 2016, they individually have five NIH grants (two as single PI), five NSF grants (two as PI), four Department of Defense grants (three as PI), a Department of Education Grant (as PI), and 10 other grants from organizations and foundations. Once we establish the importance of integrating these fields to understand health and behavioral outcomes, the possibilities for funding are broad.

New technological developments with thermal imaging and the support of NIH to create new scientific discoveries that extend beyond traditional biological and biochemical markers provides an opportunity. We have the expertise to lead the country in this area of research. Existing studies, while providing initial support for our proposed study, are very low quality. This research team's unique and overlapping expertise and commitment to excellence positions us to generate innovative discoveries and situate UNC Charlotte as a leader in this field.

Dr. Bellar, a team leader, brings expertise in applied physiology, with specific training in the area of environmental physiology and the measurement of human responses to stressor, both psychological and biological. He has successfully completed more than 30 funded projects during his career. He has successfully collaborated with faculty from psychological and social sciences on funded projects that resulted in patent applications. This research builds upon his previous work examining heart rate variability and blood pressure responses to stressors.

Dr. Moller, a team leader, has managed research teams and graduate programs, has mentored two post-docs, and has collaborated with researchers in the social, physical and computer sciences. Most of her publications are co-authored with graduate students. She has expertise in statistical modeling and survey methods. Dr. Moller is shifting her research area to align with her expertise in mind-body practices. She plans to assess whether the energy distribution interacts with the

social environment to predict student success. We lack baseline rigorous research on the energy distribution, underscoring the importance of creating initial research to permit future studies.

Dr. Trammell, a team leader, also has a collaborative background and project management experience. Dr. Trammell has expertise in biomedical optics, the interaction of light and matter, and instrumentation development. She collaborated with a graduate student to develop a thermal imaging technique that is related to the proposed imaging plan. She has collaborated with researchers in Mechanical Engineering, Biology, Physics, and Chemistry. Her group includes one undergraduate, one M.S. and two Ph.D. students (three are first generation college students).

Dr. Afonin brings bio-chemical expertise to this project. Dr. Afonin currently supervises seven undergraduate students, two M.S. students, six Ph.D. students, a Research Assistant Professor (Dr. Johnson), and one visiting faculty. All the members of his research team are well-trained to carry out the proposed work.

Dr. Cherukuri brings computational modeling expertise. He has over 25 years of experience in computational modeling, including the thermomechanical response of materials due to heat-treatment, the dynamic behavior of materials, and laser heating of tissues. Dr. Cherukuri has graduated more than 40 M.S. and Ph.D. students and currently has six graduate students. Most of his publications are collaborative with graduate students.

Dr. Jiang is the lead statistician. He contributes expertise in biostatistics, longitudinal data analysis, nonlinear time series, and nonparametric modeling. He will develop improved multivariate nonlinear statistical methods to support the exploration of complex mind-body dynamics. Dr. Jiang has supervised 14 Ph.D. students, 28 Masters students and 9 undergraduate projects. He has served on over 30 Ph.D. dissertation committees and 50 master committees.

Dr. Levens contributes expertise in experimental design and emotions, executive function and emotion regulation. She has multiple publications that examine the psychological and emotional mechanisms of wellness-based and mind-body practices. She has designed six experimental tasks to investigate the processing and monitoring of positive and negative emotions. Many of her publications are collaborative with graduate and undergraduate students.

Dr. Bennett, recently invited to our team, brings expertise in the biobehavioral response to acute and chronic stress with an emphasis mind-body stress management, chronic health conditions, and psychoneuroendocrinology. Her record highlights interdisciplinary collaboration and mentoring junior scientists in applying a systems and complexity sciences framework to health.

Members of the research team have previously collaborated. Dr. Cherukuri and Dr. Trammell have a joint publication with an undergraduate student, and they have served on a dissertation committee. Dr. Afonin and Dr. Trammell have collaborated on an NIH proposal, and they have two manuscripts in preparation. Dr. Jiang served as an unpaid collaborator on Dr. Afonin's NIH grant. Dr. Bennett and Dr. Levens co-authored a manuscript and collaboratively supported 2 interdisciplinary Ph.D. dissertations. Finally, the team collaborated to submit an NIH proposal.

It is completely within the reach of UNC Charlotte to become a national leader in this emerging field because we have expertise in its component parts: thermal imaging, thermal data analytics, biochemistry, biostatistics, health, emotions, stress, and mind-body practices. Our discoveries will ultimately allow for more refined measurement that can be incorporated in a broad range of research. The initial study would serve as a foundation for future studies that integrates physics, chemistry, biology, mathematics, kinesiology, data science, psychology, and sociology. There is also potential to incorporate religious studies and philosophy as the research portfolio expands.

4. Alignment with Regional and National Priorities

The proposed R1 Area of Excellence aligns with the university's priority to create cutting-edge interdisciplinary research. It also aligns with NIH Priorities, particularly with the National Center for Complementary and Integrative Health (NCCIH). In their 2016 strategic plan, the NIH NCCIH, identified the mechanisms of complementary and integrative medicine as a top scientific priority. Specifically, their strategic plan states (p. 36) that "In-depth understanding of the mechanisms by which complementary and integrative health approaches may impact physiological systems, including the central nervous system, becomes critical for developing strategies to optimize the beneficial effects of these approaches" [15]. The NCCIH's commitment to funding energetic research and alternative medicine approaches to biology are found in their funding history. NCCIH (and its predecessor, NCCAM) has funded research on biofield therapy; energy healing and its effects on the central and peripheral nervous system; the effects of yoga on metabolic syndrome, obesity, and pain perceptions; the brain's responses to energy healing (notably acupuncture); and the effects of energy healing on meridians.

The proposed Area of Excellence also aligns with two of NSF's BIG Ideas. The first Big Idea is *Convergence Research*: "the merging of ideas, approaches and technologies from widely diverse fields of knowledge to stimulate innovation and discovery" [16]. The proposed Area of Excellence meets this definition as it transcends physics, chemistry, engineering-based modeling techniques, kinesiology, psychology, and other social sciences. The second Big Idea is *Understanding the Rules of Life*. According to NSF, "There... exists an equal amount of complexity within the cells that comprise every living thing within that ecosystem, from the transcription and translation of the organism's genome, to the way a cell creates usable forms of energy" [17]. Once our research team align the thermal measurement of energy along the spine with autonomic and emotional measures, a window opens for additional research to better understand how this energy is transformed at a cellular level.

This research may also be of interest to United States Army Research Institute for the Behavioral and Social Sciences (ARI). One funding priority for this institute is "Identifying, Assessing, and Assigning Quality Personnel"[18]. A potential study focuses on the role of the energy re-distribution in response to stress in predicting the performance of military personnel. We will propose a study where individuals are exposed to gunfire in a virtual environment. We will then assess their bioenergetic, biochemical, behavioral and mental reactions to this stress. We will also apply to the Department of the Navy Minority Institutions Grant Program. One priority of this program focuses on information, cyber, and spectrum superiority. The program seeks proposals that enhances the timeliness of decision-making. We propose that once we establish the importance of relative energy flow to behavioral outcomes, we can then test the applicability to defense-related decision making [19].

Finally, our research may be of interest to foundations. As an example, The John Templeton Foundation might consider this type of project under their strategic priority of Health, Religion and Spirituality. The John Templeton Foundation offers both small and large grants. The research team will explore options for foundation funding.

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