

GREGORY F. LEWIS

Education

Ph.D., Bioengineering, University of Illinois at Chicago, Chicago, IL, 2011.

Dissertation: Assessment of resting middle ear muscle tone by a new measure of energy reflectance.

B.A., Psychology, University of North Carolina at Chapel Hill, Chapel Hill, NC, 2004.

Summary of Work Experience

Dr. Gregory Lewis is an Assistant Professor in the Intelligent Systems Engineering department within the Luddy School of Informatics, Computing and Engineering at Indiana University. Beginning in 2020, Dr. Lewis serves as the Director for Undergraduate Studies for the ISE department. Dr. Lewis also holds an appointment with the Kinsey Institute, where he performs research on human physiological monitoring of peripheral autonomic regulation in relation to trauma, development, mental health and cognitive processes. Dr. Lewis is the director of the Socioneural Physiology lab, which collects data from human subjects using both novel and traditional physiological sensor technologies. He currently manages a noncontact physiological sensing study validating a prototype camera based heart rate monitor for use in real-time feedback of client stress level to a therapist during a talk therapy session. He has managed research projects funded by DARPA, to design and test a noncontact heart rate monitor (DoD W911NF-14-1-0158) while in the Psychiatry Department at UNC Chapel Hill. Prior to joining UNC he developed algorithms for a real-time seizure detection platform based on noninvasive physiological signals. Dr. Lewis has conducted research on the statistical properties of extracted physiological variables, which led to a publication contrasting psychophysiological measures of heart rate variability. He served as the Project Manager for a team developing a prototype noncontact polygraph system for the U.S. government. Dr. Lewis has published research on noncontact measurement of respiration signals in the thermal infrared wavelengths and for the polygraph system developed new algorithms for measuring sweating and cardiac signals. He has supported investigations into mindfulness and biofeedback interventions to mitigate psychological trauma in deployed soldiers. He co-invented a device for measuring dynamic changes in middle ear muscle activity, which led to an international patent publication and supported a study of lactation effects on vascular inflammation (NIH R01HL109216, Grewen-PI). His work is unified by an understanding of physiological systems through their evolutionary development, which serves as the foundation for developing sensors and systems that quantify relevant features of physiological function.

Professional Experience

2017 to date. Intelligent Systems Engineering, School of Informatics and Computing, and Kinsey Institute, Indiana University, Bloomington, IN.

Assistant Professor. Designs sensors and signal processing algorithms to extend psychophysiological research techniques beyond the laboratory. Integrates physiological signal analysis into survey research and behavioral assessments. Instructor for courses in the Intelligent Systems Engineering program (Wearable Sensors, Data science of physiological time-series).

2014 to 2017. Department of Psychiatry, UNC School of Medicine, Chapel Hill, NC.

Research Assistant Professor. Developed software to process video images and extract physiological signals from said images. Studied the interaction of autonomic and sensory systems in clinical populations. Measured autonomic nervous system changes related to emotional and

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cognitive states or to clinical conditions such as post-traumatic stress. Developed software tools to support collaborators in biological and psychological sciences.

2012 to 2014. RTI International, Research Triangle Park, NC.

Research Biomedical Engineer. Designed novel physiological monitoring devices and methods to meet the needs of a research team. Assisted in developing proposals and managing ongoing projects that included human research in psychophysiology.

2011 to 2012. Brain-Body Center, University of Illinois at Chicago, Chicago, IL.

Visiting Research Associate and Project Manager. Oversaw daily operation of a project contracted by the Technical Support Working Group for the development of a noncontact physiological assessment system. Assisted in drafting the application and selected team members and hardware components. Developed control software and signal analysis algorithms for the extraction of measures of respiration, pulse, skin temperature and sweat pore activity.

Professional Service

Peer reviewer, *International Journal of Psychophysiology*, *Sensors*, *Journal of Clinical Medicine*, *Brain Sciences*, *Psychophysiology*, *Journal of Physiology*.

Poster Award Committee, Society for Psychophysiological Research, 2011

Honors and Awards

Distinguished Poster Award, poster titled *Quantification of RSA: What Criteria Define the Best Measure?*, 50th Annual Meeting of the Society for Psychophysiological Research, Portland, OR, October 2010.

Poster Award, poster titled *Non-contact Measurement of Facial Muscle Activity and Respiration with Video Thermography: A Proof of Concept*, 48th Annual Meeting of the Society for Psychophysiological Research, Austin, TX. October 2008.

Publications

Kovacic, K., Kolacz, J., Lewis, G. F., & Porges, S. W. (2020). Impaired Vagal Efficiency Predicts Auricular Neurostimulation Response in Adolescent Functional Abdominal Pain Disorders. *Official journal of the American College of Gastroenterology* | *ACG*, 115(9), 1534-1538.

Kolacz, J., Hu, Y., Gesselman, A. N., Garcia, J. R., Lewis, G. F., & Porges, S. W. (2020). Sexual function in adults with a history of childhood maltreatment: Mediating effects of self-reported autonomic reactivity. *Psychological trauma: theory, research, practice, and policy*, 12(3), 281.

Kolacz, J., Dale, L. P., Nix, E. J., Roath, O. K., Lewis, G. F., & Porges, S. W. (2020). Adversity History Predicts Self-Reported Autonomic Reactivity and Mental Health in US Residents During the COVID-19 Pandemic. *Frontiers in psychiatry*, 11, 577728.
<https://doi.org/10.3389/fpsyt.2020.577728>

- Davila, M. I., Lewis, G. F., & Porges, S. W. (2020). The Physiocam: a novel non-contact sensor to Measure heart rate Variability in clinical and Field. *Heart Rate Variability, Health and Well-being: A Systems Perspective*.
- Punait, S., & Lewis, G. F. (2019, September). Theory informed framework for integrating environmental and physiologic data in applications targeting productivity and well-being in workplace. In *Adjunct Proceedings of the 2019 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2019 ACM International Symposium on Wearable Computers* (pp. 179-182).
- Kizakevich, P. N., Eckhoff, R. P., **Lewis, G. F.**, Davila, M. I., Hourani, L. L., Watkins, R., ... & Meleth, S. (2019, September). Biofeedback-assisted resilience training for traumatic and operational stress: Preliminary analysis of a self-delivered digital health methodology. *JMIR mHealth and uHealth*, 7(9), e12590.
- Porges, S. W., Davila, M. I., **Lewis, G. F.**, Kolacz, J., Okonmah-Obazee, S., Hane, A. A., ... & Welch, M. G. (2019). Autonomic regulation of preterm infants is enhanced by Family Nurture Intervention. *Developmental psychobiology*, 61(6), 942-952.
- Kolacz, J., daSilva, E. B., **Lewis, G. F.**, Bertenthal, B. I., & Porges, S. W. (2019). Using acoustic features of mothers' infant-directed speech to predict changes in infant biobehavioral state. *The Journal of the Acoustical Society of America*, 145(3), 1764-1765.
- Andersen, E. H., **Lewis, G.**, Belger, A. (2018). Aberrant parasympathetic reactivity to acute psychosocial stress in male patients with schizophrenia spectrum disorders. *Psychiatry research*, 265, 39--47.
- Hegarty-Craver, M., Gilchrist, K. H., Propper, C. B., **Lewis, G.**, DeFilipp, S. J., Coffman, J. L., Willoughby, M. T. (2018). Automated respiratory sinus arrhythmia measurement: Demonstration using executive function assessment. *Behavior research methods*, 50(5), 1816--1823.
- Haufler, A. J., **Lewis, G.**, Davila, M. I., Westhelle, F., Gavrilis, J., Bryce, C. I., Kolacz, J., Granger, D. A., McDaniel, W. (2018). Biobehavioral insights into adaptive behavior in complex and dynamic operational settings: lessons learned from the soldier performance and effective, adaptable response task. *Frontiers in medicine*, 4, 217.
- Morgan, J. K., Hourani, L., Tueller, S., Strange, L., Lane, M. E., **Lewis, G.** (2018). Effects of sleep issues on suicidal ideation in a military sample: The mediating role of mental health. *Military Behavioral Health*, 6(3), 234--242.
- Kolacz, J., **Lewis, G.**, Porges, S. (2018). The integration of vocal communication and biobehavioral state regulation in mammals: A polyvagal hypothesis. *Handbook of Behavioral Neuroscience*, 25, 23--34.
- Hourani, L., Tueller, S., Kizakevich, P., Strange, L., **Lewis, G.**, Weimer, B., Morgan, J., Cooney, D., Nelson, J. (2017). Effect of Stress Inoculation Training With Relaxation Breathing on Perceived Stress and Posttraumatic Stress Disorder in the Military: A Longitudinal Study. *Educational Publishing Foundation*.
- Lamb, D. G., Porges, E. C., **Lewis, G. F.**, & Williamson, J. B. (2017). Non-invasive vagal nerve stimulation effects on hyperarousal and autonomic state in patients with posttraumatic stress

- disorder and history of mild traumatic brain injury: preliminary evidence. *Frontiers in Medicine*, 4, 124.
- Davila, M. I., **Lewis, G. F.**, & Porges, S. W. (2017). The PhysioCam: A novel non-contact sensor to measure HRV in clinical and field applications. *Frontiers in Medicine*, 5, 300.
- Haufler, A. J., **Lewis, G. F.**, Davila, M. I., Westhelle, F., Gavrillis, J., Bryce, C. I., Kolacz, J., Granger, D. A., & McDaniel, W. (in press). Biobehavioral Insights into Adaptive Behavior in Complex and Dynamic Operational Settings: Lessons learned from the Soldier Performance and Effective, Adaptable Response (SPEAR) Task. *Frontiers in Medicine*.
- Hegarty-Craver, M., Gilchrist, K. H., Propper, C. B., Lewis, G. F., DeFilipp, S. J., Coffman, J. L., & Willoughby, M. T. (2017). Automated respiratory sinus arrhythmia measurement: Demonstration using executive function assessment. *Behavior Research Methods*, 1-8.
- Wu, H. T., **Lewis, G. F.**, Davila, M. I., Daubechies, I., & Porges, S. W. (2016). Optimizing Estimates of Instantaneous Heart Rate from Pulse Wave Signals with the Synchrosqueezing Transform. *Methods of Information in Medicine*, 55(5), 463-472.
- Davila, M. I., **Lewis, G. F.**, & Porges, S. W. (2016). The PhysioCam: Cardiac Pulse, Continuously Monitored by a Color Video Camera. *Journal of Medical Devices*, 10(2), 020951.
- Yee, J. R., Kenkel, W., Frijling, J., Dodhia, S., Onishi, K., Tovar, S., Saber, M., **Lewis, G.F.**, Liu, W., Porges, S.W. & Carter, C.S. (2016). Oxytocin promotes functional coupling between paraventricular nucleus and both sympathetic and parasympathetic cardioregulatory nuclei. *Hormones and Behavior*, 80, 82-91.
- Gilchrist, K. H., **Lewis, G. F.**, Gay, E. A., Sellgren, K. L., & Grego, S. (2015). High-throughput cardiac safety evaluation and multi-parameter arrhythmia profiling of cardiomyocytes using microelectrode arrays. *Toxicology and applied pharmacology*, 288(2), 249-257.
- Stewart, A. M., **Lewis, G.F.**, Yee, J.R., Kenkel, W.M., Davila, M.I., Carter, C.S., & Porges, S.W. (2015). Acoustic features of prairie vole (*Microtus ochrogaster*) ultrasonic vocalizations covary with heart rate. *Physiology & behavior*, 138, 94-100.
- Lewis, G. F.**, Hourani, L., Tueller, S., Kizakevich, P., Bryant, S., Weimer, B., & Strange, L. (2015). Relaxation training assisted by heart rate variability biofeedback: Implication for a military predeployment stress inoculation protocol. *Psychophysiology*, 52(9), 1167-1174.
- Burtis, D. B., Heilman, K.M., Mo, J., Wang, C., **Lewis, G.F.**, Davilla, M.I., ... & Williamson, J.B. (2014). The Effects of Constrained Left versus Right Monocular Viewing on the Autonomic Nervous System. *Biological psychology*.
- Porges, S. W., Bazhenova, O. V., Bal, E., Carlson, N., Sorokin, Y., Heilman, K.J., ... & **Lewis, G.F.** (2014). Reducing Auditory Hypersensitivities in Autistic Spectrum Disorder: Preliminary Findings Evaluating the Listening Project Protocol. *Frontiers in pediatrics*, 2.
- Kenkel, W.M., Paredes, J., **Lewis, G.F.**, Yee, J.R., Pournajafi-Nazarloo, H., Grippo, A.J., ... & Carter, C.S. (2013). Autonomic substrates of the response to pups in male prairie voles. *PloS one*, 8(8), e69965.

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- Gorka, S.M., Nelson, B.D., Sarapas, C., Campbell, M., **Lewis, G.F.**, Bishop, J. R., ... & Shankman, S. A. (2013). Relation Between Respiratory Sinus Arrhythmia and Startle Response During Predictable and Unpredictable Threat. *Journal of psychophysiology*, 27(2), 95-104.
- Gao, J., Gurbaxani, B.M., Hu, J., Heilman, K.J., Emanuele II, V.A., **Lewis, G.F.**, ... & Lin, J.M.S. (2013). Multiscale analysis of heart rate variability in non-stationary environments. *Frontiers in physiology*, 4.
- Stewart, A.M., **Lewis, G.F.**, Heilman, K.J., Davila, M.I., Coleman, D.D., Aylward, S.A., and Porges, S.W. (2013). The covariation of acoustic features of infant cries and autonomic state. *Physiology & behavior*, 120, 203-210.
- Lewis, G.F.**, S.A. Furman, M.F. McCool, and S.W. Porges. (2012). Statistical strategies to quantify respiratory sinus arrhythmia: Are commonly used metrics equivalent? *Biological Psychology* 89(2):349–364.
- Williamson, J.B., **Lewis, G.F.**, Nyenhuis, D.L., Stebbins, G.T., Murphy, C., Handelman, M., Harden, E., Heilman, K.M., Gorelick, P.B. and Porges, S.W. (2012). The effects of cerebral white matter changes on cardiovascular responses to cognitive and physical activity in a stroke population. *Psychophysiology*, 49(12), 1618-1628.
- Porges, S.W., Macellaio, M., Stanfill, S.D., McCue, K., **Lewis, G.F.**, Harden, E.R., ... & Heilman, K.J. (2013). Respiratory sinus arrhythmia and auditory processing in autism: Modifiable deficits of an integrated social engagement system?. *International Journal of Psychophysiology*, 88(3), 261-270.
- Lewis, G.F.**, Gatto, R.G., and Porges, S.W. (2011). A novel method for extracting respiration rate and relative tidal volume from infrared thermography. *Psychophysiology* 48(7):877–887.
- Williamson, J.B., **Lewis, G.**, Grippo, A.J., Lamb, D., Harden, E., Handleman, M., Lebow, J., Carter, C.S., and Porges, S.W. (2010). Autonomic predictors of recovery following surgery: A comparative study. *Autonomic Neuroscience* 156(1–2):60–66.
- Porges, S.W., and **Lewis, G.F.** (2009). The polyvagal hypothesis: Common mechanisms mediating autonomic regulation, vocalizations, and listening. Pp. 255–264 in *Handbook of Mammalian Vocalizations: An Integrative Neuroscience Approach*. Edited by S.M. Brudzynski. Academic Press: Amsterdam, The Netherlands. Chapter reprinted in the following publication: Porges, S.W. 2011. *The Polyvagal Theory: Neurophysiological Foundations of Emotions, Attachment, Communication, and Self-regulation*. Norton: New York.
- Heilman, K.J., Handelman, M., **Lewis, G.F.**, and Porges, S.W. (2008). Accuracy of the StressEraser in the detection of cardiac rhythms. *Applied Psychophysiology & Biofeedback* 33(2):83–89.

Papers and Presentations

- Lewis, G. (2020). “How Trauma Changes Our Threat Response”. *Meet the experts webinar series, New Jersey Judiciary*. Viewed live by 600+ staff persons in the NJ Judiciary.
- Lewis, G. (2020). “Children with Pain: The Potential Relevance of Vagal Efficiency”. *Novel Target Discovery and Intervention Development Workshop*. National Institutes of Mental Health Neuroscience Center. Rockville, MD.

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- Lewis, G. (2020). "Personalized Medicine, Beyond the Genome". Continuing education series, IU Student Health Center. Viewed live by 30+ medical staff at IU Student Health.
- Lewis, G., Davila, M. I., Porges, S. (2018). Novel Algorithms to Monitor Continuous Cardiac Activity with a Video Camera. *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition Workshops* (pp. 1282--1290).
- Haufler, A. J., Starkey-El, J. A., Davila, M., Fernan, P., Gavrilis, J., Kelleher, J., Lapsansky, B., Lewis, G., McDaniel, W., O'Brien, K., others (2016). Assessing soldier adaptability: decision making to authentic challenge. *PSYCHOPHYSIOLOGY* (vol. 53, pp. S24--S24).
- Lewis, G.F. 2014. *Psychophysiological research with challenging subjects: Getting the most out of recent advances in technology*. Presented at the 26th Annual Convention of the Association for Psychological Science, San Francisco, CA. May 22–25.
- Lewis, G.F. 2012. *Autonomic Reactivity and Auditory Processing Covary in Autism*. Presented at the 52nd Annual Meeting of the Society for Psychophysiological Research, New Orleans, LA. September 19–23.
- Yee, J.R., Frijling, H., Dodhia, S., Saber, M., Onishi, K., Tovar, S., Kenkel, W., Pournajafi-Nazarloo, H., Lewis, G., Porges, S.W., and Carter, C.S. 2011. *The Effects of Oxytocin Pre-treatment on Social and Anxiety-Related Behaviors and Functional Neural Connectivity Following a Novel Environmental Stressor*. Abstract and poster presented at the 9th meeting of the World Congress on Neurohypophysial Hormones, Boston, MA. July 27–30. Also presented at the 51st Annual Meeting of the Society for Neuroscience, Boston, MA. September 14–18.
- Lewis, G.F., Stanfill, S., Davila, M., Macellaio, M., Zageris, D., Coleman, D., Aylward, S., McCue, K., Heilman, K. and Porges, S.W. 2011. *Neural Regulation of Sensory Gating in the Auditory Periphery: Relationship with Listening and Heart Rate Dynamics*. Poster presented at the 51st Annual Meeting of the Society for Psychophysiological Research, Boston, MA. September 14–18.
- Lewis, G.F. 2011. Ph.D. Dissertation: *Assessment of Resting Middle Ear Muscle Tone by a New Measure of Energy Reflectance*. University of Illinois at Chicago, Chicago, IL.
- Lewis, G.F., S.A. Furman, and S.W. Porges. 2010. *Quantification of RSA: What Criteria Define the Best Measure?* Poster presented at the 50th Annual Meeting of the Society for Psychophysiological Research, Portland, OR. September 29–October 3.
- Lewis, G.F., Gatto, R.G., and Porges, S.W. 2008. *Non-contact Measurement of Facial Muscle Activity and Respiration with Video Thermography: A Proof of Concept*. Poster presented at the 48th Annual Meeting of the Society for Psychophysiological Research, Austin, TX. October 1–5.

Patents

- Porges, S.W., and Lewis, G.F. 2012. Method and Apparatus for Evaluating Dynamic Middle Ear Muscle Activity. U.S. and International patent. WIPO publication number WO 2012/082721. Filed December 13, 2011; published June 21, 2012.

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Porges, S.W., Davila, M.I., and Lewis, G.F. 2014. System and Methods for Measuring Physiological Parameters. U.S. and International patent application number PCT/US2014/071602. Filed December 19, 2014.

Teaching Experience

ENGR-E 101, INNOVATION AND DESIGN.
ENGR-E 3/599, TOPICS IN INTELL SYS ENGINEER, 2 courses.
Wearable Sensors
Data Science of Physiological Time-series

Non-Credit Instruction

Guest Lecture, Informatics, 35 participants. (October 2020).
Guest Lecture, ISE, 10 participants. (November 2020).

Directed Student Learning

Doctoral Dissertation, "Nature: A Potential Moderator to the Negative Effects of Psychological Stressors." (September 1, 2018 - Present).
Advised: Sharron Tessneer

High school student intern, research with faculty, "Integrating fNIR into EEG based BCI system." (July 1, 2018 - Present).
Advised: Christine Zhou

Master's Thesis or Equivalent, "Thermal respiration sensor for gating of radiation therapy." (February 14, 2018 - Present).
Advised: Tiffany Lee

Graduate Independent Study, "Wearable Ear Sensor Design." (August 20, 2018 - December 14, 2018).
Advised: Sujata Punait

Graduate Independent Study, "VALIDATING THE EEG BASED BRAIN COMPUTER INTERFACE FINDINGS WITH THE HYBRID EEG-fNIRS BASED BCI." (August 20, 2018 - December 14, 2018).
Advised: Shyam Shah

Completed Trainings

Being Better Research Mentors. Offered by: Center for Faculty Excellence. University of North Carolina at Chapel Hill. February, 2016.

Online Everything You Wanted to Know about HRV. Offered by: The Stens Corporation. October, 2016.

Grants and Contracts

October 1, 2020 – February 28, 2021. Evaluation of the PhysioCam algorithms on a Zoom video feed. \$25,000 fixed fee contract.