AFRL FIGHT'S ON!
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Steady-State Operational Noise Impact (SONIC) Study

Airmen and guardians work in extreme environments to complete mission objectives. The military noise exposure in these environments places stress on cognitive resources and can negatively impact performance. Our work is focused on understanding how external noise affects decision-making and cognitive function in the cockpit of the F-35. This will be an important factor in collaborative combat aircraft management. We are leveraging steady-state cockpit noise at cruise collected in conjunction with the F-35 JPO and played at varying levels under hearing protection (60, 70, 80 dB).

Noise is just one of many environmental stressors that the Holistic Models for Decision-Making Line of Effort (HMDM LOE) is targeting to understand and integrate into cognitive models. The models we build can be generalized and tested to predict not just the degree to which performance may shift but how the holistic environment affects cognitive processing of the tasks. Understanding which cognitive processes are affected and the severity of shift provides insight to calibrated human factors systems design, development of online adaptive intelligent systems, and informed team development and dissemination of task demands.

This study involves reproducing the sound field inside of the F-35 cockpit in the Voice Communication Research and Evaluation System (VOCRES), a 711 HPW/RHWE facility that can recreate high-fidelity audio of aircraft noise. We employ sound-isolating headphones that transmit communication signals while providing hearing protection to reduce noise exposure levels. Daily noise dosage is in accordance with Occupational Safety and Health Administration (OSHA) guidelines such that participants will not be exposed to more than 35% of one's daily noise exposure, and individualized noise levels will be calibrated to mitigate the risk of differences between the fit of hearing protection each day. This facility allows for studying the full body effect of sounds and control of noise level presentation. Overall, this experimental layout provides a realistic representation of what noise within an F-35 cockpit sounds and even feels like by using the VOCRES facility and an operationally fielded communication/hearing protection device.

We utilize laboratory tasks that capture many of the same cognitive demands present in real-world flight operations such as those anticipated for Next Generation Air Dominance (NGAD) programs. Specifically, we will investigate the interference of acoustic noise to complete tasks which demand visual-vocal, aural, spatial, verbal, working memory, and executive control cognitive resources. Our data will inform a more comprehensive model that captures the parametric shifts in information accumulation and threshold for decision-making in the presence of a second, crossmodal working memory task, with low, moderate, and high working memory demands. ☆

Dr. Elizabeth Fox, Research Psychologist, 711 HPW/RHWEM

Mr. Conner Campbell, Research Engineer, 711 HPW/RHWEO

Photo and graphic by
Mr. Will Graver (BAE Systems, Inc.)







A Salute to Dr. Winston 'Wink' Bennett

The Division would like to take this opportunity to congratulate Dr. Winston 'Wink' Bennett, retiring after nearly 40 years of dedicated service to the nation and the warfighter. Wink has most recently served as the 711 HPW Readiness Product Line Lead, but his Air Force career began at Brooks Air Force Base (AFB) in 1984. While a master's student at St. Mary's University, Wink undertook a summer cooperative program at the Human Resources Laboratory sorting through computer printouts and magnetic disks. This led to working with Sherri Gott on the intelligent tutoring system, SHERLOCK, troubleshooting avionics, and developing the philosophy that would guide his research – "Bring the best science and technology to achieve Air Force capability."

Wink soon found himself at Mesa on the former Williams AFB, where his work exposing civil engineering students and cadets to operational environments developed novel, forward-thinking data capture techniques. These and other efforts steered Wink to working for the Distributed Mission Training (DMT) group in roles he calls "Space guy, maintenance guy, medical guy, and intelligent tutor maintenance." Wink and team were soon standing up the first F-15Cs to collect pilot data and briefing the Air Force Chief of Staff on their progress. Alongside these high-profile efforts, work that would later lead to Wink's Not So Grand Challenge (NSGC) and Datapalooza began in Mesa.

Among Wink's enduring achievements, The Gaming Research Integration for Learning Lab® (GRILL®) and its role in developing interest in STEM and DoD careers is hard to overstate. The GRILL began with the idea to leverage developing gaming technologies for military training and has developed great interest from industry to build education and training systems. Each year, the GRILL has evolved to include more students and educators and ultimately more opportunities, with new facilities and exciting programs planned in the Air Force Academy, Australia, and other sites.

Reflecting on a storied career, Wink offered a few words when asked about his accomplishments. "Figuring out what LVC (Live, Virtual, and Constructive) might mean for tactical training comes after a lot of 'no way can we do that' up until folks think, 'why not?'. It takes a village, people in and outside the lab, industry, academia to make it happen. And you have to take care of each other while not forgetting who you work for – not a publisher or the conference, but the warfighter. Keep that philosophy. I didn't invent it, but it's right, and it's still right today. Focus on the direct connection to the warfighter – more connections, more opportunities."

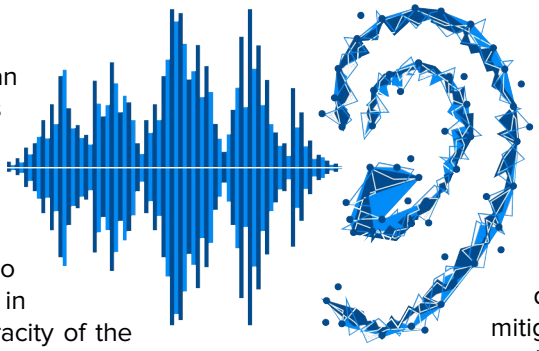
Wink would like to thank his family and all the amazing people he's worked with for pushing him into new opportunities and "beyond any comfort zone I might have imagined and helping me and the collaborators I've worked with to do so many great things for research and practice in the Air Force and beyond. Very proud of all we were able to get done. There's plenty more to get after too, so keep it going!"

The Fight's On! team reached out to Wink on what his next adventure might look like, but the next adventure has yet to be decided. "I don't know! Stay in the fight and contribute to the mission or a similar mission – but home improvement is mighty tempting." ☆

Mr. Dave Hubbell, Editor in Chief, CAE, USA

Auditory Deepfake Update

A core research effort under the Information Mastery in Cognitive Warfare Line of Effort (LOE) focuses on auditory deepfakes. A deepfake uses deep learning and training of neural networks to generate synthetic media such as voice clones. The proliferation of synthetic content on social media and fake news websites is a strategy that our adversaries often employ for cognitive warfare. According to NATO, bad actors target audio content more frequently than visual content because there are fewer auditory deepfake detection tools to enable quick debunking (Fredheim, 2023). To that end, our in-house research effort has two thrusts, (1) Determine how proficient people are at detecting auditory deepfakes to characterize the factors that predict susceptibility, and (2) Build a machine learning model that can classify authenticity and identify the speaker's voice based on audio features.



For thrust one, we set up a human experiment where participants listened to headlines that were vocalized via real audio recordings or deepfakes. Participants then made judgements about the naturalness of the audio and the believability of the content in the headlines they heard. The veracity of the headlines were also manipulated. For example, "76-million-year-old dinosaur skeleton to be auctioned in NYC" is an example of a true headline from a reputable source, while "Study shows that Benadryl can be used to treat rattlesnake bites" is a fake headline that was spread on social media.

The research team is still collecting data, but preliminary analyses suggest that there is variation in deepfake detection accuracy and that this may be based on participants' self-reported strategy. For example, good discriminators focused on audio understandableness and whether the audio sounded "choppy" or "robotic." In contrast, poor discriminators either did not report a strategy or provided vague responses, such as "the way the speaker was talking." Participants were worst at determining headline veracity and more conservative with their ratings than with the audio authenticity metric. Future experiments will include a training session and degrading the audio quality to make detection more difficult.

For the modeling thrust, we are investigating the crucial auditory features necessary for identifying deepfake audio. We are exploring this by utilizing an in-house feature extraction toolbox (PyTimbre) that produces a myriad of auditory features in both the time and frequency domain. By utilizing the human subject data and the acoustic features of the speech signals, we are building machine learning models that can classify real and deepfake audio. We are also building models that can provide subjective human ratings of the naturalness of the speech. Overall, both aspects of this project help us not only better understand the situations where human perception is the most vulnerable to auditory deepfakes, but to develop techniques to mitigate these susceptibilities and build resilience to malign influence. ☆

Reference- Fredheim, R. Virtual Manipulation Brief 2023/2: Verified Propagandists and the Hamas - Israel War. Riga: NATO Strategic Communications Centre of Excellence

Photo by Mr. Will Graver (BAE Systems, Inc.)

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Mr. Conner Campbell, Research Engineer, 711 HPW/RHWEO

711TH HPW/RHW September 2023 - January 2024

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RHW RECOGNITIONS

2023 ANNUAL AWARDS

AFRL

- Civilian Category III:
  Ms. Rachel Vickhouse

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- Airman of the Year:
  SrA Reid Clevenger
- Civilian Category II:
  Ms. Olivia Leung
- Field Grade Officer of the Year:
  Maj Matthew Fagan
- James W. Brinkley Leadership Award:
  Dr. Megan Morris
- Senior Administrative Excellence:
  Ms. Annette Armstrong
- Senior Non-Commissioned Officer:
  MSgt Matthew Boland
- Thomas S. Wells Senior Leadership Award:
  Dr. Christopher Myers

RHW

- Collaboration Award:
  Dr. Eric Gieselman
- Commander's Cup (Junior):
  Dr. Christopher Stevens
- Commander's Cup (Senior):
  Mr. Allen Rowe
- Commander's Cup (Team):
  Rocket Cargo Team
- Company Grade Officer of the Year:
  Capt Vanessannah Deppermann
- Daniel Repperger Mentor of the Year:
  Ms. Jackie Waggamon
- Harry G. Armstrong Scientific Achievement Award:
  Dr. Jerred Holt
- Innovation Award:
  Ms. Kristen "Cuda" Barrera
- International Award (Individual):
  Dr. John "Chris" Brill
- International Award (Team):
  Cognition and Modeling Team
- Non-Commissioned Officer of the Year:
  TSgt Andrew Pauldine
- Scientific/Technical Management Award:
  Ms. Jessica Bartik
- Scientific/Technical Achievement Award Team:
  BOAR Team
- Supervisory Award:
  Ms. Jennifer Brown
- Technology Transition Award:
  NITE Team

RHWE / RHWI / RHWO PUBLISHED CONTENT (AUGUST 2023 - JANUARY 2024)

JOURNAL PUBLICATIONS

Curley, T. M., Borghetti, L., & Morris, M. B. (2023). Gamma power as an index of sustained attention in simulated vigilance tasks. *Topics in Cognitive Science*, 1-16. https://doi.org/10.1111/tops.12700

Etherton, K. C., Bliss, J. P., & Winner, J. (2024). Self-efficacy and its Miscalibration in Cricothyroidotomy Training. *Human Factors in Healthcare, 5*. https://doi.org/10.1016/j.hfh.2024.100066

Fisher, C., Morris, M. B., Stevens, C. A., & Swan, G. (2024). The role of individual differences in human-automated vehicle interaction. *International Journal of Human - Computer Studies*, 185, 103225. https://doi.org/10.1016/j.ijhcs.2024.103225

Howard, Z. L., Fox, E.L., Evans, N. J., Loft, S., & Houpt, J. W. (2023). An extension of the shifted wald model of human response times: Capturing the time dynamic properties of human cognition. *Psychological Bulletin and Review*. https://doi.org/10.3758/s13423-023-02418-8

Mobley, F. S., Bowers, G., Ugolini, M., Fox, E.L., & Gallispie, N. (2023). Modeling aircraft similarity with musical auditory feature extraction. *Applied Acoustics*, 214, 109689. https://doi.org/10.1016/j.apacoust.2023.109689

Morris, M. B., Veksler, B. Z., Krusmark, M. A., Gunzelmann, G., Gaines, A. R., & Jantscher, H. L. (2023). Mobility aircrew fatigue perceptions and mitigation strategies. *Aviation Psychology and Applied Human Factors*, 13(2), 81-157. https://doi.org/10.1027/2192-0923/a000254

Rhodes, L. J., Borghetti, L., & Morris, M. B. (2024). Multiscale entropy in a 10-minute vigilance task. *International Journal of Psychophysiology, 198*, 112323. https://doi.org/10.1016/j.ijpsycho.2024.112323

Salzman, S., Wiser, A., Morris, M. B., Veksler, B. Z., Byrd, K., Wagner, T., & Prestwood, J. (2023). Silver lining study: Missileer fatigue mitigation during 2020 coronavirus pandemic. *Military Medicine*, usad415. https://doi.org/10.1093/milmed/usad415

CONFERENCE PROCEEDINGS

Collins, M., Sense, F., Krusmark, M., & Jastrzembski, T. (2023). Modeling change points and performance variability in large-scale naturalistic data. In Proceedings of the *International Conference of Cognitive Modeling*. Amsterdam, The Netherlands.

Hough, A. R., Stevens, C., Fox, E.L., & Myers, C. (2023). An initial cognitive model of a radar detection task, In *Proceedings of the International Conference on Cognitive Modeling*.

Jastrzembski, T., Harris, J., Sense, F., Collins, M., & Krusmark, M. (2023). Augmented semiautonomous training systems for personalized medical training. In *Proceedings of the Military Health Systems Research Symposium*.

McCoppin, R., Dawson, C., Kennedy, S. M. & Blaha, L. M. (2023). Evaluating Adversarial Robustness with Expected Viable Performance, In *Proceedings of the 22nd IEEE International Conference on Machine Learning and Applications*. https://arxiv.org/abs/2309.09928

Rhodes, L. J., Borghetti, L., & Morris, M. B. (2023). Enhanced bidirectional gamma-band Granger Prediction in fast compared to slow performers in a 3-stimulus oddball task. In *Proceedings of the Human Factors and Ergonomics Society International Annual Meeting*, 67(1), 920-926. https://doi.org/10.1177/21695067231192875

Rhodes, L. J., Borghetti, L., & Morris, M. B. (2023). Multiscale entropy increases at short time scales across time in a 10-minute Psychomotor Vigilance Test [Meeting Abstract]. In *Proceedings of the 45th Annual Meeting of the Cognitive Science Society*, 45(45), 3796. https://escholarship.org/uc/item/3936v9qb

Sense, F., Collins, M., Krusmark, M., & Jastrzembski, T. (2023). Comparing model variants across experimental and naturalistic data sets. In *Proceedings of the International Conference of Cognitive Modeling.* Amsterdam, The Netherlands.

PRESENTATIONS

Cook, A., & Fox, E.L. (2023). Influence of cross-modal load on cognitive processing and decision-making. *Annual Meeting of the Psychonomic Society*. San Francisco, CA.

Fox, E.L., & Bowers, G. (2023). Real-time prediction of attention and performance using neural activity, In the *International Conference on Applied Human Factors and Ergonomics*. [virtual].

Graham, L., Jastrzembski, T., Sense, F., Collins, M., Toukan, M., Mann, S., Krusmark, M., & Aguirre, J. (2023). Investigating the creation of a USAF learning engineering implementation plan. In *Proceedings of the IEEE ICICLE Learning Engineering Conference*. Carnegie Mellon University.

Jastrzembski, T., Sense, F., Collins, M., & Krusmark, M. (2023). Adaptive learning trajectories: Navigating the interplay of learning and forgetting with AI/ML and cognitive models. In *Proceedings of the AI/ML Department of Defense Technical Exchange Meeting*.

Jastrzembski, T., Graham, L., Sense, F., Collins, M., Mann, S., Krusmark, M., Toukan, M., & Aguirre, J. (2023). Ensemble model integration across multimodal training systems for personalized Arabic linguist training at the Defense Language Institute. In *Proceedings of the Learning Innovation Council Symposium*.

Jastrzembski, T., Sense, F., Collins, M., & Krusmark, M. (2023). Optimized linguist curricula and virtual reality training learning for Defense Language Institute (DLI) students. In *Proceedings of the Air Force Research Laboratory Discover Conference*. Wright State University.

WORKSHOPS

Bajaj, G., Pearce, K., Kennedy, S. M., Larue, O., Hough, A. R., King, J., Myers, C. & Parthasarathy, S. (2023). Generating Chunks for Cognitive Architectures. In *Proceedings of the 2023 AAAI Fall Symposia*, 2(1) 246-252. Arlington, Virginia. https://ojs.aaai.org/index.php/AAAI-SS/article/view/27683

Fox, E.L., Gerstenberg, T., & Icard, T. (2023). Causality in Minds and Machines: Probing the Mathematical and Computational Foundations. *Society for Mathematical Psychology and Psychonomic Society*. San Francisco, CA.

Women of Mathematical Psychology (WOMP; including E. Fox & L. Blaha; 2023). Responsible supervision and managing lab dynamics. *Society for Mathematical Psychology and International Conference on Cognitive Modeling*. Amsterdam, The Netherlands.

BOOK CHAPTERS

Kim, J., Ritter, S., Krusmark, M., Jastrzembski, T. (2023). Instructional Strategies of Intelligent Tutoring Systems. In Sinatra, Graesser, Hu, Goodwin, & Rus (Eds.), *Design Recommendations for Intelligent Tutoring Systems: Volume 10 – Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis of Intelligent Tutoring Systems*. Orlando, FL: US Army Combat Capabilities Development Command – Solider Center. ISBN 978-0-9977258-3-4. Available at: https://gifttutoring.org/documents/163.

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711 HPW/RHW Core Research Areas:

- Digital Models of Cognition
- Distributed Teaming & Communication
- Human-Machine Interactions
- Learning & Operational Training