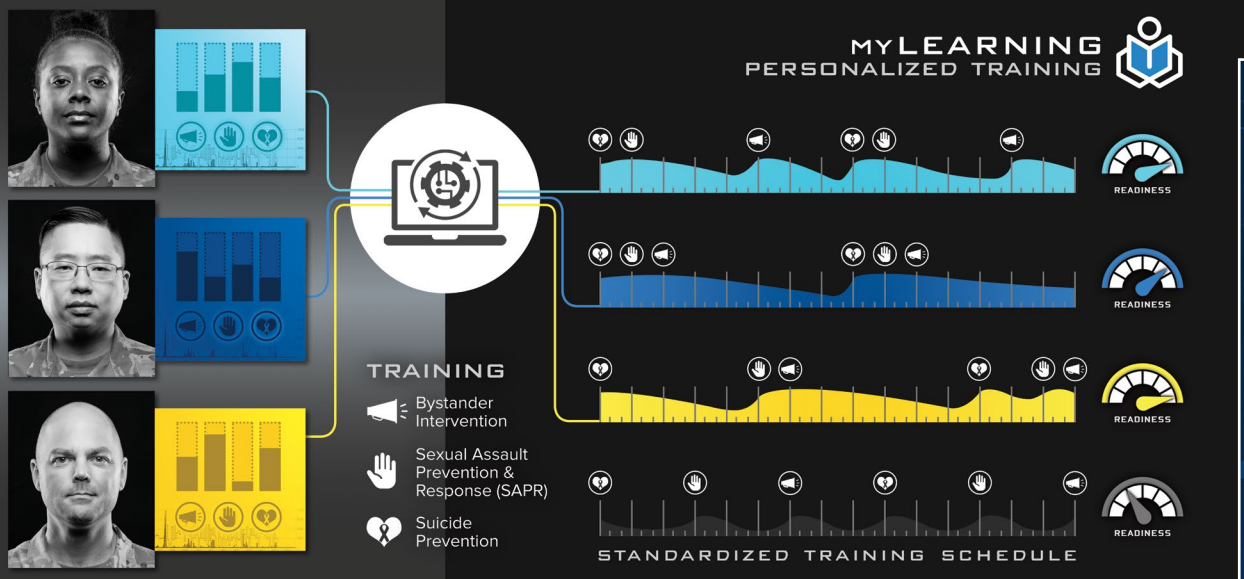
AFRL FIGHT'S ON!

THE AIR FORCE RESEARCH LABORATORY

ISSUE 73
SPRING 2024



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

INSIDE THIS ISSUE

Advanced Learning Technology Transition for Personalized Linguist Training at the Defense Language Institute (DLI)

Predictive Analytics for Learning (PAL) researchers at the Air Force Research Laboratory (AFRL) have piloted innovative integrations of their cognitive modeling and machine learning integrated capabilities into state-of-the-art mobile and virtual reality immersive linguist training technologies. Through a collaboration with Jedburgh Technologies, and as part of the Air Education Training Command's (AETC) Linguist Next project, AFRL is delivering real-time, precision learning capabilities to Arabic students moving through a 64-week curriculum. Students utilizing these immersive technologies receive automated practice for novel items necessary for future classes, plus optimized items to review based on model predictions of decay combined with priorities associated with frequency of items used in the language. Students are empowered to select learning platforms that suit them best and are motivated to study through the delivery of gamified, digestible student-facing personalized learning dashboards. Instructors possess the ability to examine student performance at a higher level of analysis and receive recommendations for daily course instruction to remediate any group-level weaknesses observed.

Results from our initial pilot work gave rise to strong advocacy from both students and instructors to continue development of these technologies and expand existing capabilities to include higher-order linguistic skills. The integration of generative artificial intelligence (AI) leveraging large language models is currently being developed to help students acquire interactive and immersive opportunities to interact with agents in a meaningful, realistic, and valid way. Aspects of intelligent tutoring will be brought to bear to gently coach and assist learners if and when mistakes are made. The goal of these technologies are to produce well-rounded linguists who will better sustain their knowledge and capabilities post-graduation, through the delivery of engaging, relevant instructional materials targeted towards the individual learning needs of each student linguist. The foundational technologies will be transitioned to all language schoolhouses at the DLI, allowing the power of personalized learning to be ubiquitously embedded for all linguist learners. ☆

Dr. Tiffany Jastrzembski Myers, Senior Cognitive Scientist, 711 HPW/RHWEO

Information Mastery in Cognitive Warfare LOE Welcomes New Machine Learning Researcher

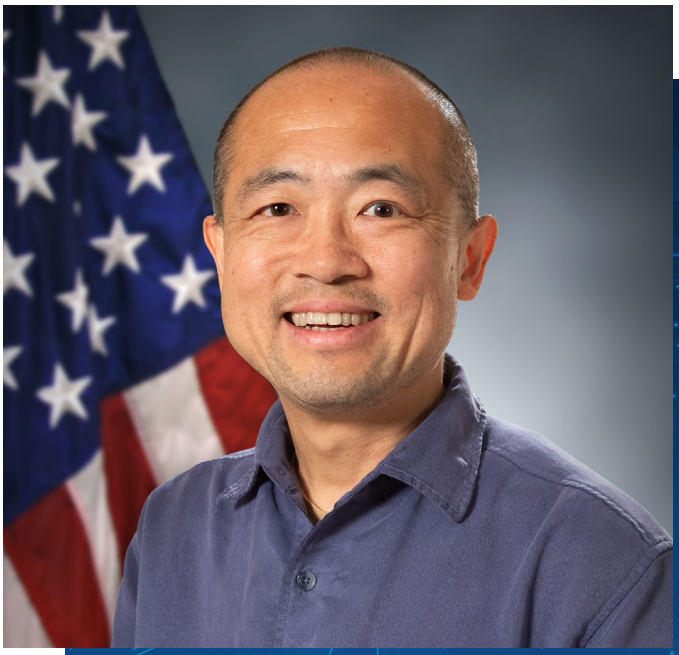
In modern military strategy, there is an increasing importance on public data and machine learning tools in winning the hearts and minds of people in post-Cold War defense. This includes democratization and peacekeeping (the early 1990s), the global war on terror (2001 onwards), the Asia-Pacific rebalance (2010s) and the renewed great power competition (late 2010s to present); and in the changing role of the USAF in global surveillance and reconnaissance, air superiority and combat operations, rapid global mobility, cyber warfare, space operations, partnership building, and humanitarian assistance.

To this end, the Information Mastery in Cognitive Warfare Line of Effort (IMCW LOE) conducts research on the strategic use of information to manipulate the cognitive capabilities of the adversary, disable them from making effective decisions, and gain political, social, and military advantages. Further, we can leverage machine learning to parse petabytes of multilingual data in the public domain to achieve a deeper understanding of the cultural and social complexities of local populations, overcome language and socio-cultural barriers, gain the trust and support of local people, reduce conflicts, enhance operators, support counterinsurgency, and improve stability and reconstruction efforts in a more advanced version of the "Human Terrain System."

Modern deep-learning tools can also help us democratize publicly available data for anti-terrorism and non-traditional warfare. For example, with deep learning, we can quickly turn public opinions on the best use of public data into algorithms for individuals to validate their interactions and behaviors, keeping the algorithms running on the user side and balancing privacy and national security through differential privacy and federated learning.

The wide availability of big data, large language models (LLMs), and generative AI tools also leads to a trend of integrating multimedia chatbot interfaces between humans and machines in place of traditional user interfaces composed of panels of buttons and text boxes. These dialog-based interfaces are more interactive, efficient, and accessible from users' perspectives and more cost-effective and maintainable from developers' perspectives. Integrating social science in human-human and human-machine teaming with LLMs is being pursued through the collaborations across the branch and directorate.

To further strengthen our capability to ground deep learning and other algorithms in social sciences, we welcome Dr. Wen Dong to our branch. Dr. Dong possesses over 15 years of expertise in computer science and deep learning, underscored by seminal contributions to leading machine learning (NeurIPS, AAAI), simulation (AAMAS), and human-computer interactions



Dr. Wen Dong

(UbiComp) forums. Dr. Dong holds a PhD degree from MIT Media Laboratory, and was a faculty in Computer Science at the University at Buffalo before joining AFRL.

With the addition of Dr. Dong's expertise, the IMCW LOE is well positioned to support information warfare missions, such as understanding and influencing opponents' cognition and behaviors, which will increase the DoD's ability to win without fighting. ☆

Dr. Wen Dong, Research Computer Scientist, 711 HPW/RHWEO

711TH HPW/RHW February - April 2024

Hails

Caleb Anthony
Amanda Beckley
1Lt Jaren Boykin
Capt Katelyn Clements
Jenna Cotter
Dr. Wen Dong
Allen Dukes
Capt Denita Guthery
Dr. Beth Hartzler
Elizabeth McKenna
Maj Taylor Paige
1Lt Marco Pirozzoli
1Lt Jacob Weiland
Dr. Ryan Wohleber

Farewells

Dr. Wink Bennett
Major Paul Grossi
John Ianni
Capt Daniel Liska
Theresa Penn
Col Alfredo Rivera
Lt Col Christopher Terpening
Lt Col Dan Williams

Update on "Holding Algorithms Accountable: Detecting Implicit Bias in Machine Learning Human Annotators"

Artificial intelligence (AI) systems and machine learning (ML) algorithms have streamlined decision making in our daily lives, such as when we browse media on a streaming platform or apply for instant approval on a credit site. On a national level, AI is now embedded in cognitive warfare tactics as nations attempt to influence the sixth operational, or the Human (Cognitive/Brain) domain. However, there can be negative long-term consequences when we assume that AI systems are synonymous with "unbiased," or if we fail to study possible vulnerabilities in these systems. All algorithms must be designed by humans, and the choices designers make can introduce bias into the system. Developers are beginning to note how human annotators, or the manpower behind ML algorithms, are likely to rely on systematic/cultural biases, such as gender and race stereotypes, while categorizing data (Chen & Joo, 2021). While much research has gone into developing AI systems, less is known about how human biases become embedded during the development process.

In this seedling project under the Information Mastery in Cognitive Warfare LOE, we are examining how human annotators may rely on their own implicit and explicit biases as they categorize the textual training data for a ML algorithm. Implicit bias (Greenwald et al., 1998) is defined as attitudes that are relatively more unintentional and uncontrollable compared to more explicit (self-reported) bias, which is more controlled and intentional. People may not be fully aware of when implicit biases are activated and may even hold bias against their own in-group (Jiang, Vitiello, et al., 2021). Thus, we are examining bias with differing methods (e.g., self report measures for explicit; timed responses for implicit) to capture the full impact of bias on algorithm development. We are also investigating whether providing training to annotators about implicit bias affects how they annotate the text data.

In summary, the Air Force is battling for information superiority in the cyber battlespace, which often involves quickly organizing multi-source raw data into meaningful intelligence. Studying and addressing how bias affects AI systems will ensure warfighters have the most accurate and trustworthy algorithmic output, which will enable adversary intent identification and rapid decision-making against threats. ☆

Dr. Christine Vitiello, Research Psychologist, 711 HPW/RHWEM

Dr. Kathleen Larson, Research Psychologist, 711 HPW/RHWEM

REFERENCES

Chen, Y., & Joo, J. (2021). Understanding and mitigating annotation bias in facial expression recognition. In *Proceedings of the IEEE/CVF International Conference on Computer Vision* (pp. 14980-14991).

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. (1998). Measuring individual differences in implicit cognition: the implicit association test. *Journal of personality and social psychology*, 74(6), 1464-1480.

Jiang, C., Vitiello, C., Axt, J. R., Campbell, J. T., & Ratliff, K. A. (2021). An examination of ingroup preferences among people with multiple socially stigmatized identities. *Self and Identity*, 20(4), 569-586.

RHW RECOGNITIONS

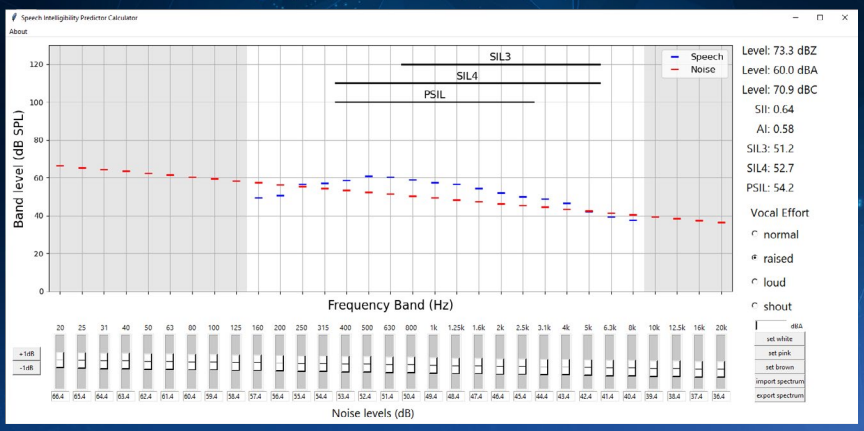
1st QUARTER AWARDS

711th HPW
- Civilian Category III: **Dr. Nina Pryor**

RH
- Air Force Civilian Service Award: **Dr. Chris Brill**
- Field Grade Officer: **Maj Chrisopher Holliday**

RHW
- Company Grade Officer: **Capt P. Alex LaFlam-McFall**

DETHSCAR Releases Speech Intelligibility Calculator



DETHSCAR's Speech Intelligibility Calculator

The Digital Engineering Toolbox for Human Speech Communication and Reception (DETHSCAR) project, as part of the Holistic Models of Decision-Making LOE, released a speech intelligibility calculator that will predict the effect of ambient noise on speech intelligibility using several commonly used metrics, including the Speech Intelligibility Index (SII), the Articulation Index, and the Speech Interference Level (SIL; 3-band, 4-band, and "preferred" band variants). This tool will allow program offices and contractors to reduce risk related to critical communication spaces, such as flying conference rooms on VIP aircraft like Air Force One, or for Air Battle Managers flying on an E-3 aircraft. These designs are being developed and refined by using simulated or recorded noise spectrum data to answer questions such as "what if the noise levels were 5 dB louder in this space?" The calculator can also be used as an education tool to help understand the differences between the calculators and the additional risk that may result from choosing a simpler metric, like the SIL-3, vs a more complex metric, like the SII, for a program requirement.

The calculator works through the user inputting a noise spectrum in 1/3-octave band levels, either by importing data, typing in levels, adjusting sliders, or by setting a level of standard noise spectra, like white, pink, or brown noise. The user can also select a vocal effort level (normal, raised, loud, or shout), as defined in the ANSI standard method for calculating the speech intelligibility index (ANSI/ASA S3.5-1997). Along with the calculator, a demonstration was conducted for members of the Presidential Aircraft program (VC-25B; AFLCMC/WVB) in the acoustic labs in Building 441 at Wright-Patterson Air Force Base. Different calibrated noise environments were generated in the lab, with the speech intelligibility calculator running in real-time, using noise levels from a microphone in the lab, so that the program officers could experience the difference in difficulty of communicating in representative noise environments that had the same level in A-weighted decibels, but had vastly different calculated SII values. They also experienced what effect an increase of a few decibels had on the ability to communicate in the representative noise environments. The DETHSCAR project plans to continue to expand the speech intelligibility prediction tool to include the effects of non-linear communication systems, like vocoders. ☆

Dr. Eric Thompson, Research Engineer, 711 HPW/RHWEM

RHW PUBLISHED CONTENT February - April 2024

JOURNAL PUBLICATIONS

Borghetti, L., Curley, T., Rhodes, L. J., Morris, M. B., & Veksler, B. Z. (2024). Hybrid framework of fatigue: Connecting motivational control and computational moderators to gamma oscillations. *Frontiers in Neuroergonomics, section Cognitive Neuroergonomics, 5*, 1375913. https://doi.org/10.3389/fnrgo.2024.1375913

Fiechter, J. L. (in press). Drawing generalizable conclusions from multilevel models: Commentary on Van de Calseyde and Efendić (2022). *Psychological Science*.

Myers, C. W., Cooke, N. J., Gorman, J., & McNeese, N. J. (2024). Introduction to the emerging cognitive science of distributed human-autonomy teams. *Topics in Cognitive Science*.

Robinson, F. E., Grimm, D., Horning, D., Gorman, J. C., Winner, J., & Wiese, C. W. (2024). An automated content-based measure of closed loop communication among critical care air transport teams. *Military Psychology*, 1-7.

CONFERENCE PROCEEDINGS

Halverson, T., Blacker, K. J., Harshman, S., & Myers, C. W. (2024). Differential cognitive effects of extended hypoxia. *Proceedings of the Annual Meeting of the Cognitive Science Society, 45*.

Mobley, F., Campbell, S., Wall A., Rasband, R. (2024). *Characterization of multi-rotor aircraft using truss support structure.* NOISE-CON 2024.

PRESENTATIONS

Meszaros, D., Stevens, C. A., & Curley, T. M. (2024). *EEG band patterns for top-down vs bottom-up control during the Psychomotor Vigilance Task. Midwest Cognitive Science Conference.*

Morris, M. B. (2024). *FOCUS Mission Readiness App*. 2024 Human Center of Gravity Symposium, Montgomery, AL [Virtual].

Salzman, S., Wiser, A., Prestwood, J., Wagner, T., & Morris, M. (2024). *Silver lining study: Missileer fatigue mitigation during 2020 Coronavirus pandemic*. 94th Aerospace Medical Association Annual Scientific Meeting, Chicago, IL.

Stevens, C., Morris, M., Fisher, C., & Myers, C. (2024). *Profiling cognitive load in an unmanned vehicle control task with cognitive models and physiological metrics.* Research Summit of the American Psychological Association Division 19 – Society for Military Psychology [Virtual].

EST. 2001

Published quarterly since 2001, Fight's ON! continues to serve as the Division publication for our partners and features innovative science and technology that is accelerating and revolutionizing readiness.

To view more issues, visit:
www.afresearchlab.com/FightsOn

Fight's ON! Point-of-Contact
Patricia D. Wood, 711 HPW/RHW
patricia.wood.2@us.af.mil

Cleared / Case # AFRL-2024-3008

711 HPW/RHW Core Research Areas:
- Digital Models of Cognition
- Distributed Teaming & Communication
- Human-Machine Interactions
- Learning & Operational Training