Understanding warfighter performance from the inside out

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Credit: DARPA

A new program out of DARPA's Biological Technologies Office could help the Department of Defense enhance and sustain military readiness both by revolutionizing how troops train, perform, and recover, and by mitigating shortages of highly qualified candidates for extremely specialized roles. The anticipated outputs of the Measuring Biological Aptitude (MBA) program are a set of biomarkers—measurable indicators of biological processes—that correspond to traits of highly

effective performance in a given role, along with new tools to measure and report on those biomarkers in real time. This information will enable individual warfighters to understand and affect the underlying biological processes that govern their success. MBA technologies could improve training, team formation, mission performance, and post-mission recovery, yielding a better prepared, more effective, more resilient force.

At its core, MBA seeks to shed light on the biological factors and processes that support peak performance in each of a set of military specializations. The research will work backwards from phenotypes—that is, how an individual's fixed genetic code expresses as externally observable cognitive, behavioral, or physical traits—and attempt to establish the biological mechanisms that translate underlying genetic makeup into phenotypic traits. At present, those mechanisms of translation—also known as expression circuits—are largely a mystery. MBA researchers will develop new assays and technologies to monitor and report on the biomarkers that reveal the activity of key expression circuits.

"With existing technology scientists are able to read out genotype and measure and observe certain aspects of phenotype. Most of what happens in between is a black box," said Eric Van Gieson, the MBA program manager. "DARPA believes that the information inside the box—these expression circuits—can be predictive of how an individual will respond to a given stimulus or scenario, and more importantly, we believe it will help inform the individual on how to improve their performance throughout their career."

Researchers supporting MBA will initially analyze samples and other data collected from high-performing troops across select military specializations to identify biological signatures of successful performance in each of those roles and determine how they can be

measured. For instance, maintaining a lowered heart rate during combat is a valuable trait and easily measured with existing wearable technology. Adaptable problem solving, resilience, and cognitive flexibility are extremely valuable, but less easily measured. MBA analyses should reveal an array of such traits and the expression circuits responsible for them.

If DARPA succeeds, the resulting MBA system could support military readiness in various ways.

The first improvement relates to how the military initially evaluates recruits and subsequently develops candidates for specialized roles. Many of these roles currently suffer from shortages of qualified candidates, even as more pervasive use of complex technologies and an expanding set of mission profiles are increasing demand for uniquely skilled personnel.

For at least the past 50 years, initial assessment of military service members has remained essentially unchanged, comprising a basic medical screening, a standardized physical readiness test, and a written test known as the Armed Services Vocational Aptitude Battery (ASVAB) for enlisted personnel. Scores on the ASVAB feed into the preliminary determination of an individual's qualification for certain military occupational specialties. As a service member's career advances, future placement into other roles does not follow a prescribed protocol and can be based in large part on subjective measures.

Against this backdrop, MBA technology could increase the objectivity of the criteria used by military selection committees, remove biases, and raise the baseline of performance for incoming recruits. Additionally, by taking biology into account, the results from MBA measurements could reveal to individuals career options that might not be apparent based on commonly accepted, externally observable traits alone.

The second improvement ties to training, both before and after an individual pursues a military career. MBA technology could allow a user to assess his or her personal potential for specialized roles and proactively nurture the traits that are characteristic of successful performers.

"Genotypes are fixed, but phenotypes are not. Biology is fundamentally adaptable, and that is the key to enabling performance improvements," Van Gieson said. "What we're planning to deliver with MBA is a set of continuously updated information that empowers individuals to track their progress throughout their careers and quickly identify what aspects of training and preparation are the most productive."

Third, during missions commanders could employ real-time reporting of changes in service members' biomarkers to inform how a military operation unfolds, adding a layer of biological awareness to provide a more complete assessment of the mission space. Commanders could shift resources or adjust strategies and tactics based on how squad members are performing. Following a mission, biomarker reporting could likewise guide recovery practices and indicate potential health issues.

The overall MBA program will be informed by consultations with independent expert advisors in the ethical, legal, social, and regulatory aspects of the work, with particular emphases on privacy, data protection, and responsible utilization of data by individuals. MBA performer teams will be required to provide medical guidance as part of any human study through an embedded genetic counselor, sports therapist, or similar specialist.

"Human beings are extremely complex, and although we expect to gain valuable new insights by measuring biology, we also understand that people are not locked into predetermined fates," Van Gieson explained.

"Any breakthroughs we achieve in the MBA program will necessarily be used to address shortages in critical roles by expanding opportunities, not limiting them. If we can provide people with information on their unique biology, and empower them to affect and measure gains in key traits, we'll have opened career pathways that they may not have previously considered."

DARPA will hold a Proposers Day on February 12, 2019, in Arlington, Virginia, to provide more information about MBA and answer questions from potential proposers. For details of the event, visit https://go.usa.gov/xEZeT.

A forthcoming Broad Agency Announcement will include complete program objectives, schedules, and metrics. Team should have experience in human performance, phenotyping, multi-scale biology, physiology, biomarker detection and tracking, device development, and various other aspects that will be specified in the announcement.

Provided by DARPA