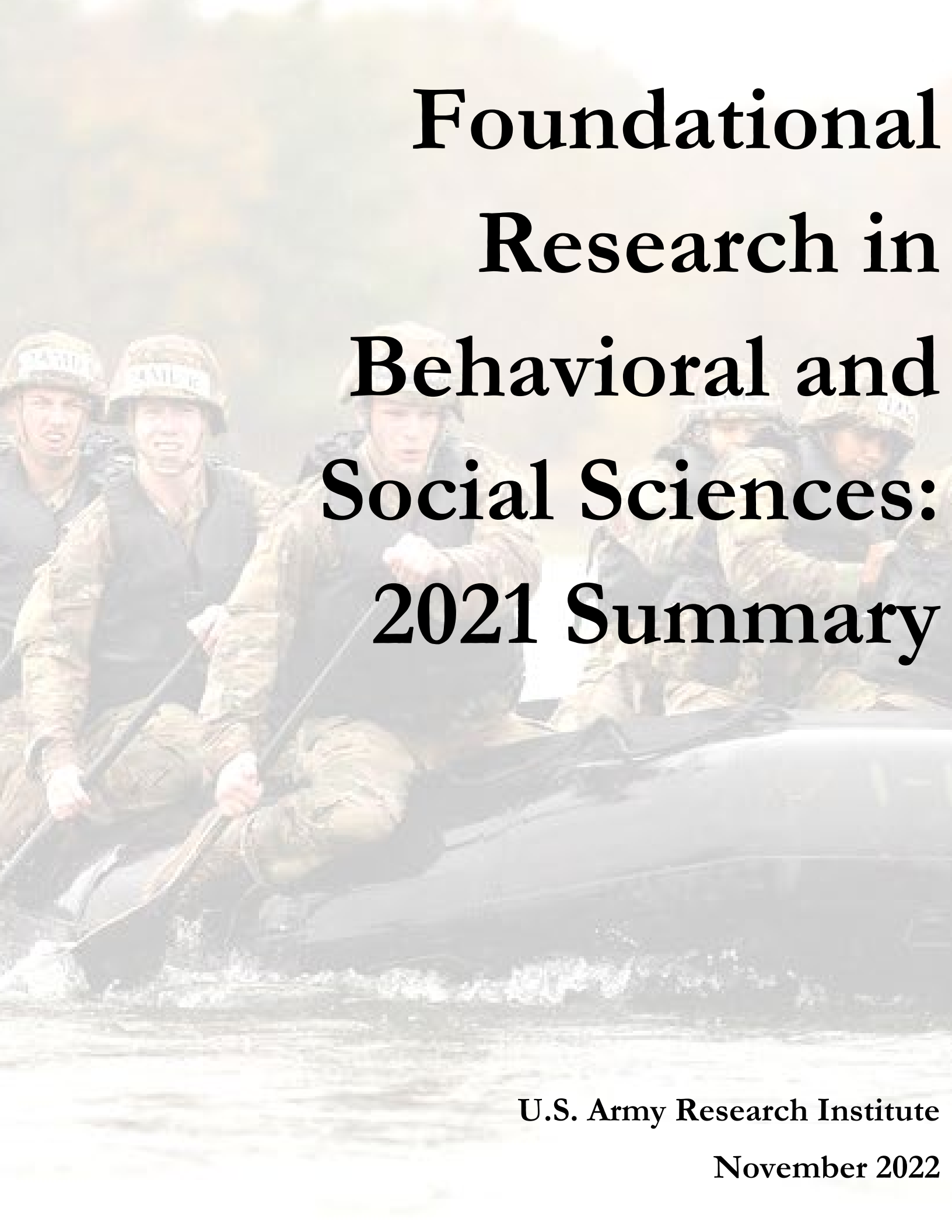


A background image showing several soldiers in camouflage uniforms and helmets, some with "SAILOR" written on their helmets, rowing a black inflatable boat on a body of water. The image is faded to allow the text to be prominent.

Foundational Research in Behavioral and Social Sciences: 2021 Summary

U.S. Army Research Institute

November 2022

**U.S. Army Research Institute
for the Behavioral and Social Sciences**

**Department of the Army
Deputy Chief of Staff, G1**

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Foundational Research in Behavioral and Social Sciences: 2021 Summary

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PROGRAM OVERVIEW

BASIC RESEARCH PROGRAM

Basic Research Program Overview

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) is the Army's lead agency responsible for addressing personnel, organization, training, and leader development issues by conducting research and development in the behavioral and social sciences. ARI is a Field Activity of the Office of the Deputy Chief of Staff (DCS), G-1, Headquarters, Department of the Army. ARI supports DCS, G-1 with the goal to improve Army readiness and performance through basic research, applied research, and advanced technology development.

Basic research is defined as theoretical or systematic experimental efforts directed toward greater knowledge or understanding of mechanisms that underlie psychological phenomena relevant to personnel and organizational science. The intent of basic research findings is to contribute to a broad scientific understanding rather than to develop or improve specific products or processes. The Basic Research Program is within the Foundational Science Research Unit (FSRU) of ARI and focuses on discovering new knowledge, concepts, methods, and tools in support of Army needs via foundational research (6.1) in high-risk, high-reward areas.

The Basic Research Program serves as a critical and essential link between the military and the scientific communities within the behavioral and social sciences. ARI's researchers within the Basic Research Program maintain close contact with ARI's applied research units, as well as other foundational research organizations within the Department of Defense. This regular communication enables the Basic Research Program to identify emerging issues requiring research, coordinate across military services, and facilitate the transition of basic research findings to applied research programs for eventual use by the Army.

The Basic Research Program aims to develop and advance state-of-the-art theories, measures, and methods in the behavioral and social sciences. This work includes research that ranges from incremental theory building to large paradigm shifts. The Basic Research Program provides the scientific basis for the Army to modernize the personnel testing, organizational, training, and leader development systems of the Army, as well as identifies avenues for the Army to maximize unit effectiveness.

Research Portfolios and Goals

The overall goals of the five broad research domains are provided below. Although the research is separated by portfolio here, most efforts combine or cut across multiple domains and execute multi-disciplinary or interdisciplinary approaches. Since FY21, the Basic Research Program has not and will no longer designate new research within the culture portfolio (consult FSRU FY21 Broad Agency Announcement W911NF-21-S-0007). For consistency with prior Foundational Research in Behavioral & Social Sciences summary reports and because research that was designated within the culture portfolio prior to FY21 is still ongoing, a section is still devoted to the culture portfolio in this report.

Personnel Testing and Performance

The personnel testing and performance portfolio aims to: 1) identify and understand the fundamental processes underlying individual differences predictive of Soldier success; and 2) develop efficient, accurate assessment tools and classification measures useful in mass-administration testing contexts.

Leader Development

The leader development portfolio aims to: 1) advance theoretical understanding of leader development within the operational environment and at home station; and 2) develop theory about and methods to cultivate the requisite cognitive, perceptual, and interpersonal skills for effective leadership across all levels of command.

Organizational Effectiveness

The organizational effectiveness portfolio aims to: 1) expand our knowledge of the complex social, cultural, cognitive, and behavioral processes, structures, and characteristics of multi-echelon organizations; and 2) develop and improve theories and methods for identifying, measuring, and modeling social, cultural, cognitive, and behavioral factors in ways that improve organizational performance and effectiveness.



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Learning in Formal and Informal Environments

The learning in formal and informal environments portfolio aims to: 1) advance the theoretical understanding of how learning occurs; and 2) develop learning methods and tools that maximize the development, retention, and transfer of complex tactical, technical, and interpersonal skills in formal and informal learning environments.

Culture

The culture portfolio aims to: 1) develop theories and frameworks of culture that can be used to improve understanding and prediction of individual perceptions, cognition, and behavior; and 2) improve methods and processes for assessing culture and culture-related behavior and cognition.

Research Program Structure and Execution

Basic research at ARI is conducted through extramural, intramural, and collaborative mechanisms. ARI maintains robust support for extramural basic research. Extramural basic research is solicited through a Broad Agency Announcement. Intramural basic research is conducted by research scientists in FSRU and by research fellows from the Consortium of Universities of the Washington Metropolitan Area. Finally, ARI provides support for social and behavioral science research at the military service academies and collaborates with the Army Research Office on Multidisciplinary University Research Initiatives with a behavioral or social science component.

This report provides a listing and brief synopsis of ongoing and recently completed extramural basic research efforts, organized into the five research portfolios.

ARI's Basic Research program is responsible for maintaining an international behavioral science and technology watch and maintaining outreach efforts with academic partners.

Additional information about these efforts is available upon request.

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Chief, Foundational Science Research Unit



Personnel Testing and Performance Overview

Army Need

The success of the Army can be largely attributed to the selection, assignment, development, and retention of highly skilled and exceptional leaders and Soldiers. In order to fulfill the modernization priorities for the Army and ensure continued success, the Army needs to place the right Soldier, in the right job, with the right skills, at the right time. The necessary knowledge, skills, abilities, behaviors, and preference requirements for high-quality leaders and Soldiers need to be assessed efficiently and accurately to place personnel into jobs matched with their capabilities in pursuance of optimizing human performance.

Current personnel testing assesses general cognitive abilities, vocational aptitudes, and temperament dimensions and provides fair prediction of success in initial training, first assignment after training, and career continuance. Advances in measurement technology and statistical approaches provide opportunities to discover new and re-examine existing constructs in order to better understand the individual. Additional understanding and examination of individual differences, situational factors, their interactions, and impact on a wider range of sought-after outcomes could improve existing personnel testing and provide the foundational knowledge needed to create new assessment strategies.

The pervasive method for Army non-cognitive assessments is self-report. This method is useful because it provides an efficient way to assess many constructs in a timely manner in a large number of individuals. However, there are issues with traditional self-report (e.g., faking), thus identification and refinement of measurement methods is needed. Advances in measurement methods that increase test efficiency, accuracy, and coverage by finding ways to unobtrusively obtain information on multiple constructs would contribute to the Army selection and classification practices and research examining dynamic constructs.

Psychometric theory has aided test developers for decades and advancements (e.g., item response theory) have led to the creation of different testing methods. Continued advancement and refinement of psychometric theory is needed to advance and refine methodology, especially with respect to handling complex data and conducting real-time data analytics.

The three goals in the personnel testing and performance portfolio are: a) increased understanding of the predictor and criterion space; b) advancement of psychometric theory; and c) improvement of assessment techniques. These goals are intended to guide advancement in science to improve personnel testing and performance practices. The key research objectives associated with each goal are explained below.

Key Research Objectives

Understand the Predictor and Criterion Space

ARI's Basic Research Program seeks to identify and study new constructs and refine understanding of existing constructs by a) developing new models and metrics; b) identifying useful levels of analysis and measurement; c) understanding how constructs of interest are expected to vary across levels, situational contexts, and temporal scopes; d) understanding potential interactions; e) understanding how situational contexts impact the strength of interactions; and f) understanding the dynamic nature of constructs within and between individuals and the impact on other constructs.

Advance and Refine Psychometric Theory

ARI's Basic Research Program aims to expand the boundaries of existing test theory, develop a better understanding of variability in trait/ability expression and observed score variance (e.g., test context, test-taker motivation, or test-taker perspective), and identify ways to use information about such variability to improve the quality of organizational decisions. The Basic Research Program seeks to develop psychometric approaches for deriving construct score estimates from dynamic flow data or behavioral streams and for more accurately examining complex longitudinal data.

Improve Assessment Methods

The Basic Research Program seeks to identify novel assessment methods that can be used to assess constructs simultaneously, unobtrusively, efficiently, and with increased measurement precision. ARI's Basic Research Program aims to improve methods to decrease testing time, provide incremental validity, improve ability for mass-administered, unsupervised self-testing, and



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minimize socially desirable responding. Methods that improve the efficiency, accuracy, and coverage of assessments of reading, writing, and technical skills are desirable.



Personnel Testing and Performance Currently Funded Research

ARI's Basic Research Program is currently funding eight extramural research projects. Brief descriptions of the projects are provided below, with detailed research summaries of each project provided on the subsequent pages.

Accelerating Research Advances in Collective Spatial Cognition

(W911NF-18-1-0273; 2018-2022)

Dr. Kevin Curtin (University of Alabama) and colleagues brought together an international group of scholars to explore the social, psychological, and behavioral phenomenon of spatial cognition as it occurs in human collectives.

Assessing Spatial Memory Gist and Situational Awareness in Complex Environments

(W911NF-20-1-0291; 2020-2023)

Dr. Brent Chamberlain (Utah State University) and colleagues are utilizing an interdisciplinary approach to examine how different people balance navigation and spatial awareness and create a new construct called Spatial Memory Gist.

Collaborative Problem Solving (CPS) Skill: Estimating an Individual's Contribution to Small Group Performance

(W911NF-19-1-0106; 2019-2023)

Dr. Patrick Kyllonen (Educational Testing Service) seeks to develop and evaluate approaches to measuring individual contributions in a set of collaborative problem-solving (CPS) tasks.

Developing a Multidimensional Psychometric Framework on the Impact of Item Bias on Classification

(W911NF-20-1-0282; 2020-2022)

Dr. Hok Chio Lai (University of Southern California) is developing a statistical method that shows how the presence of item bias affects selection accuracy and indices that detect problematic items from a selection perspective.

Individual Differences in Emotional Reactivity and Cognitive Performance

(W911NF-16-1-0191; 2016-2023)

Dr. Karen Quigley (Northeastern University) aims to link patterns of physiological variability to subjective emotional experiences in everyday life.

Interpersonal Skills: Clarifying a Proliferated Construct Space and a Theoretical Framework

(W911NF-19-1-0068; 2019-2025)

Dr. Eric Heggstad (University of North Carolina at Charlotte) is examining key interpersonal skills concepts and establishing a framework for organizing these concepts.

Trait Complexes and New Ability Assessments

(W911NF-19-1-0400; 2019-2022)

Dr. Phillip Ackerman (Georgia Institute of Technology) aims to design, develop, and validate a new set of measures that focus on ability and non-ability not typically captured or drawn from the traditional assessment of general mental ability.

Validated Measurement of Internalized Prosocial Motivation

(W911NF-20-1-0259; 2020-2023)

Dr. Michael McCullough (University of California San Diego) aims to identify and enable the measurement of autonomous prosocial motivation (APM), or the motivation for prosocial behavior in the absence of external incentives.



Accelerating Research Advances in Collective Spatial Cognition

Project #: W911NF-18-1-0273

Contract Dates: JUL 2018 – JUL 2022

PI: Kevin M. Curtin

Institution: University of Alabama

Co-PIs/Subcontractors: Daniel R. Montello, University of California, Santa Barbara

Abstract

This project explores the social, psychological, and behavioral phenomenon of spatial cognition as it occurs in human collectives such as work teams. It brings together an international group of scholars at the forefront of research about collective spatial cognition to produce an edited volume and special issues of peer-reviewed journals. This approach integrates several bodies of research, notably: the science of spatial cognition as developed by psychologists, behavioral geographers, and others, and the science of team cognition as developed by industrial/organizational psychologists, social psychologists, and others. Enhanced knowledge about how collectives think spatially may benefit the Army's selection, training, and employment of its forces, which frequently conduct complex tasks in unfamiliar spatial environments as teams and systems of teams. This insight becomes especially important in highly urbanized settings, when teams are impaired, or where the complexity, gravity, and scale of an operation reaches a critical operational juncture. The scholars are charged with producing research papers which – when completed and organized into a cohesive whole – will produce the foundation for the research area of collective spatial cognition in the foreseeable future.

Introduction

This project seeks to explore the social, psychological, and behavioral phenomenon of spatial cognition as it occurs in human collectives such as work teams. It brings together an international group of scholars at the forefront of research about collective spatial cognition that produces an edited volume and special issues of peer-reviewed journals. This is a truly transdisciplinary effort, and as such offers the greatest potential to push outward the known boundaries of the sciences. The overall goal of this research is to produce an intellectual foundation for the research area of collective spatial cognition that can drive research agendas for the foreseeable future. The scholars as a group explore such research questions as: How do teams of different size learn about their surroundings and communicate? How does the nature of the team goal (e.g., navigation, search and rescue) influence spatial cognition? How does the scale of operations or the dynamism in the system change the way in which teams learn and operate in space? and What is the influence of leadership in teams on the spatial operations they undertake?

Current practice in the study of collective spatial cognition is limited because the separate research disciplines that study spatial cognition and team cognition have not integrated their research in ways that could open new frontiers. What is under development here is a novel melding of two complementary, but largely separate knowledge domains. While there is certainly some mutual awareness of team cognition among spatial cognition researchers, and vice versa, there has not to date been a concerted effort to identify the commonalities, differences, and opportunities for research advances that may be possible when the two disciplines work in tandem. The research seeks opportunities to identify bridges between the scientific domains and to thereby identify the breadth of potential research topics. That breadth demands research that spans geographic scale (e.g., micro-geographic studies of child play through large-scale studies of international migration), that recognizes differences in team size (e.g., dyads, to small teams, to crowds, to large groups of teams working together), and that demonstrates differences in performance across team work goals (e.g., search and rescue, fire suppression). Perhaps most importantly, the project personnel do not fundamentally wish to define the research area themselves nor to proscribe tight boundaries in which it should proceed. Rather, collective spatial cognition should be outlined organically from the researchers who participate in the knowledge generation process.

Research Approach

The technical plan for completing the research is straightforward: the steps that have been taken to date are to establish an executive steering committee, solicit abstracts followed by Position Papers from researchers across disciplines who possess expertise in any combination of teams research, spatial analysis, or cognition, and who may be able to extend their research to include all three elements, invite the best proposals to be discussed and enhanced at a Specialist Meeting held in April 2019, to assess the strengths and weaknesses of the individual papers and of the foundational research effort as a whole, and to begin processes of revision and partnering to address the weaknesses and to build on the strengths. In the past year, the proposal for



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an edited volume was accepted and is now under contract at Taylor and Francis/Routledge. The editors continue to move chapters/articles through revisions, and through a journal-level peer review process. In the remainder of the period of performance the team will meet the terms of the contract to publish the edited volume, provide final edits/revisions in preparation to delivery for publication. If funding is secured the team will convene a second Specialist Meeting in conjunction with an appropriate international conference, with a likely focus on journal special issues.

Accomplishments

The activities and accomplishments since the beginning of the project consist of administrative processes and critical development that move the team toward the project's research goals. The former category included, most importantly, planning and executing Specialist Meeting I held in April 2019 in Santa Barbara, CA. The Specialist Meeting consisted of two days of presentations and discussions. The major accomplishments coming from this meeting were a comprehensive group review of the individual papers with feedback to authors and a series of breakout meetings where the broad directions of the foundational research effort were reviewed and discussed. There was an opportunity to assess the strengths and weaknesses both of the individual papers and of the research effort as a whole. Other administrative processes included the support and engagement of three graduate and one undergraduate researchers on the project, the development and modification of a dedicated project website as necessary, and continued interaction with the external steering committee to review progress.

In concert with these administrative accomplishments, significant progress toward project research goals was made. As a basis for moving forward, a diverse international group of experts was identified with expertise in Education, Cognitive Science, Architecture/Design, Psychology and Brain Sciences, Information Studies, Geography, Engineering, Architecture, Environment and Planning, among other research areas. Twenty-seven abstracts were received from the solicitation efforts with 54 authors among those submissions. Twenty-four Position Papers were generated and presented at Specialist Meeting I. Those presentations represented a range of collective size, although the dominant collectives were dyads and triads, with only a few small teams, crowds, and multi-team systems represented. We view this as a consequence of the traditional focus of spatial cognition on individuals and the difficulty of moving research into this novel area. There was a consensus on the need to expand participation among teams and multi-team systems researchers. This has led to an aggressive second phase of recruiting for teams researchers that will continue into the next year.

Many of the Position Papers have transitioned into chapters for the edited volume. These cover a wide range of topics, including but not limited to: the display of spatial information for collectives; coordination and integration of spatial information among team members; the use of virtual reality in collective spatial cognition; navigation behaviors of teams; the characteristics of interior spaces for collectives; perspective taking among team members; the use of simulation; transactive skill systems; and incomplete information by teams. The team review process, along with a multi-stage journal-level peer-review process, has narrowed the selected submissions to 15 chapters. The process of pursuing a book contract for the edited volume deliverable was successful and the book is under contract at Taylor and Francis/Routledge.

Contributions to Basic Research

The fundamental contribution to basic science is that this work has the potential to advance not only a single scientific discipline, but several. The disciplines of geography, psychology, operations research, architecture and design, and potentially many more stand to gain knowledge from the joint exploration of the research area of collective spatial cognition. The contribution to each is the definition of a research area that exists not in any traditional discipline but only in the intellectual space shared by scientists whose interests lie in spatial analysis, by those who study group interactions, and by those who study the ways in which knowledge is gained and used (cognition).

The expected end product of this research is – at a very practical level – an edited volume and peer-reviewed journal special issues that define the foundation for the study of collective spatial cognition. The structure of this volume is evolving as the research products are reviewed and revised (as described above), and much of its content is being decided based on discussion and consensus achieved at Specialist Meeting I and with the further consensus as the review and revision process continues. The more significant end product is – of course – not the edited volume, but the foundation for research that it describes. The value of this project will be not in the research questions that it answers (although some may be significant) but in the research inquiries that it prompts as we move forward. In many cases, very fruitful scientific advances are found at the boundaries of scientific disciplines and it is this boundary space that we are exploring here. We posit that the physical outcome of the research (edited volume and journal special issues), which is by its nature trans-disciplinary, will open consistent and deep avenues for collaboration that have previously been pursued only tangentially. We hope for the development of young



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researchers who will see collective spatial cognition as their own research area, rather than as a tangent to their own disciplinary work. This project will be a success if the foundation we lay leads to fruitful research in the years (perhaps decades) to follow.

Potential Army/Military Applications

Given that this is a basic research effort, the specific discoveries cannot be known in advance. However, we envision some possibilities using the Doctrine, Organization, Training, Materiel, Leadership, Personnel, Facilities (DOTMLPF) framework.

Doctrine. The results of this project could help enhance doctrinal concepts like decentralized maneuver, in which collectives at multiple echelons autonomously rationalize the spatial component of combat action. The results could inform considerations such as principles of task organization (what kinds of collectives work best, spatially, in what missions?) and/or command and control relationships (in what spatial cognitive situations is Tactical Control advisable?). Even fundamental concepts like “battlespace” of “areas of operations” might be informed if we better understood how organizations rationalize space.

Organization. The organization of command elements at multiple levels could be informed by a greater understanding of how collectives rationalize space. If it can be shown that collectives with a certain structure (e.g., size, capability mix, relationships) have tendencies to perform in particular spatial manners (e.g., exhaustive search, hub and spoke) then collectives can be expressly organized for the purpose of operations that can benefit from those spatial tendencies. It may well be that the fundamental geographic concept of scale is a controlling factor in how collectives behave in space. If so, command decisions such as team size and composition can be tailored to the scale of the task. Models for location decisions (position resources, route teams, or tactically cover an area) can be improved with greater knowledge of how collectives successfully operate in space.

Training. Training is an area where the application potential of the project is most evident. Land navigation in the U.S. Army is primarily instructed as an individual-level skill. Soldiers are trained individually and evaluated according to their own ability to wayfind; however, military units regularly wayfind as a collective by sharing, processing, and acting on a wide variety and high volume of spatial information. Furthermore, training on wayfinding abilities is often cast in terms of situational dependency, resulting in an essentially ad-hoc approach. If we better understood how collectives wayfind, this approach could be more formal and relevant. Deliberately training land navigation as a team-level or headquarters-level skill might yield benefits.

Materiel. An understanding of how collectives use spatial information in military operations may lead to the development of tools to store, retrieve, and display spatial information to teams in ways that most effectively support their operations. Consider that both movement and communications information is essential for team spatial cognition. It may well be that tools can be developed (e.g., headphones, smart cartographic displays) that encourage superior performance of teams on spatial tasks. Improvements to the design, development, and use of wayfinding aids, command and control interfaces, decision support tools, and planning tools are potential applications of the insights to be gained through this project.

Leadership. Like training, leadership is a topic very likely to be informed by better knowledge of collective spatial cognition. How do leaders make spatial decisions in concert with their teammates, superiors, and subordinates? How do they rationalize the spatial behaviors of enemies, allies, and others? What considerations should leaders take into account when rationalizing the space of their operations as understood by the forces they lead? All of these questions may be informed through the construct of collective spatial cognition and associated insights pertinent to leadership development.

Personnel. Understanding how collective spatial cognition can improve the ways we select, assess, develop, promote, and apply human capital that engages in highly spatialized missions and tasks. The U.S. Army and other military forces have a long history of testing spatial thinking at the individual level as a means of selecting personnel. Establishing the most effective combinations of knowledge, skills, and attributes for successful collective spatial operations may be an extraordinarily valuable tool in making personnel decisions.

Facilities. Recent research indicates that distinctive spatial patterns emerge when teams are engaged in competitive goal-oriented activities. Examples of spatial clustering and propensity to locate along boundaries have been observed in experimental settings of team spatial behavior. If these behaviors are found to be consistent at team and higher echelons, this



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predictability could be applied to inform the construction of facilities. More specifically the security of facilities could be enhanced by designs that can best thwart the spatial behavior of small illicit teams. Likewise, the design of training facilities could be enhanced by introducing spatial structures that would encourage successful movement behavior.

Future Plans

Over the final year of the period of performance the following accomplishments will be pursued. The research team will continually encourage revision and finalize acceptance of papers through the journal-level external peer review of all revised and completed chapters and potential special issue articles. The team will meet the requirements of the book contract with a publisher. The introductory and concluding chapters for the edited volume will be completed. We will establish consensus regarding organization of chapters and division among special issues, receiving final revisions of papers/chapters, and delivery to publisher/editors. If funding should appear available, there will be extensive planning and execution efforts for Specialist Meeting II in conjunction with an international conference. We will determine a consensus location and conference focus where most participants can benefit from both the conference itself and the add-on Collective Spatial Cognition meeting. Invitations and offers of travel support will be made to potential participants. The focus will likely be on the generation of peer-reviewed journal special issues.



Assessing Spatial Memory Gist and Situational Awareness in Complex Environments

Project #: W911NF-20-1-0291

Contract Dates: AUG 2020 – AUG 2023

PI: Brent Chamberlain

Institution: Utah State University

Co-PIs/Subcontractors: Sarah Creem-Regehr, University of Utah; Jeanine Stefanucci, University of Utah

Abstract

The purpose of this research is to create a new measurable construct. We call this construct Spatial Memory Gist (SMG). SMG combines approaches from scene gist research, environmental psychology, landscape architecture and spatial sciences. We expect SMG to offer a higher-level grasp of spatial memory. We argue that SMG is the ability to construct quick representations of the meaning of spaces. We use 3D virtual environments to test our hypotheses. Further, we assess individual differences and performance measures. These are used to explore how individuals form and apply SMG. This research aligns with ARI's mission to build new theoretical constructs.

Introduction

There are few studies about spatial memory connected with navigation through large, complex spaces. Current studies test accuracy of visuo-spatial abilities to recall spatial layout. For instance, by recalling locations of targets or drawing maps. SMG extends these methods to create a higher-level grasp of large-scale recall. We propose the following research objectives:

1. **Form a psychometric construct for spatial memory gist (SMG).** We will define and test SMG as a new construct in spatial cognition. First, we will develop a framework for spatial memory gist that borrows from the scene perception literature by assessing memory for boundaries of objects or spaces and recognition of objects seen in spaces, as well as other measures and theories from scene gist. Second, we will use existing and new empirical data to test and modify these theories. **Key question:** How do we characterize and reliably measure spatial memory gist (SMG) in the context of large complex environments?
2. **Evaluate the extent to which temporal, spatial and environmental properties influence the acquisition of SMG.** The focus of this objective is to understand the role that time and scale (physical environment) play in the formation of SMG because it may help us understand how to optimize SMG to reduce working memory that can be allocated to more important tasks. To accomplish this objective, we will manipulate the scale of the physical environments and the time of exposure to the environment and will compare the degree to which architectural changes in the environment influence SMG. **Key question:** How is the acquisition of SMG affected by temporal and environmental properties?
3. **Evaluate Spatial Situational Awareness in Real-Time (SSART).** This objective will identify how SMG is used to form navigational strategies amidst real-time changes to the environment. These changes may include building implosions, loss of key landmarks, movement of hostile actors into previous routes, and identification of objects that do or do not correlate with the gist of the space. Amidst these changes, we will mimic on-the-ground circumstances by requiring an individual to immediately change course and safely navigate to a new location. **Key Question:** How does SMG contribute to spatial situational awareness (SA) in real-time?

Research Approach

Our approach centers on building a theoretical foundation first. We iteratively test and update our SMG theory with empirical research. We test our working theory, primarily by designing a significant number of laboratory virtual reality (VR) environments. Individuals navigate these environments and we collect relevant data. Data include eye tracking and performance measures on spatial memory recall tasks. We also collect individual differences, such as demographics and intelligence tests. Our process is highly modular, allowing us to quickly adapt to changes in expectations and theories. Each VR environment builds upon previous.



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Accomplishments

We have conducted three research studies to date. We have run over 100 subjects during COVID-19 laboratory restrictions. The first study, *Landmark Study*, builds on PI Chamberlain's previous virtual environment. We changed the environment to evaluate the role of landmarks on forming spatial memory. Our second study, *Linear VE Pilot*, is a new virtual environment. This was made to help discover how architecture and building density influence recognition of environmental change. For this study we created a new technique to measure when participants note a change in the environment. Preliminary results showed changes in architecture and density of buildings had the highest identified magnitude of change, relative to just architectural changes. We have since modified the pilot study to increase reliability and measures. *Linear VE* (see Figure 1) study is now in progress.

Methods and Tools. Our findings from *Landmark Study* include significant differences in how accurately participants recalled the route they saw. Participants remembered the route with landmarks better than the route without landmarks. Preliminary analysis suggests that district size may be correlated with memory recall. We are now trying to identify the role of individual differences in performance on different recall tasks. Recall tasks include having participants remember the route, landmark, or district. We have found that older adults perform worse than younger adults. We see no recency effects for landmark recall. This suggests aspects of the environmental design influence how well or poorly a landmark was remembered. Interestingly, individuals with more 3D gaming experience were more accurate at recalling the end point location for the route.

Products. We have conducted a major literature review. This review guided the *Landmark Study*, a new *conceptual virtual design*, and a new *modular virtual environment* (for *Linear VE*). We also developed eye-tracking software. The software allows us to collect data in 3D to identify how design elements influence perception. We have also created a new tool to optimize road construction in our virtual environments. This is important for our *conceptual virtual design*. Finally, we created new geospatial software to analyze participant district delineations. This is a new contribution to spatial memory measures.

Figure 1

Example Scene from Our Linear VE Virtual Reality Environment



Note. The figure shows three environments. The first is a traditional urban high-rise architecture. In the distance, partly covered by fog, is a lower density steam punk architecture. We are evaluating when participants notice the change in architecture and their sensitivity to the magnitude of change.



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Personnel Development. This project has supported three Ph.D. students, three masters' students, and eleven undergraduate students. Students come from three disciplines (landscape architecture and planning, computer science, psychology) across the three degrees. The multidisciplinary nature of this work has created new opportunities for learning and engagement across fields. One undergraduate student has completed a capstone project and we have several ongoing theses.

Contributions to Basic Research

The most important contribution of this project is the advancement of the science of measurement of individuals. This is done through our new construct, SMG. SMG and related techniques to evaluate situational awareness will result in new scientific theories. It also has applied potential for military training and testing.

The second major contribution is our modular approach to environmental design and accompanying data collection. While the use of VR in laboratory settings has grown, these projects are often insular and not readily shared. They may also lack compatibility with other construct testing. We have designed an approach to expand basic research. We do this by creating a method to rapidly mock new environments (stimuli) and evaluate user interaction. When this project is complete, we will share the virtual environment modules for use in other related studies.

The final contribution of this work is in the analytical techniques. We have developed analytical techniques to understand the relationships between environmental design characteristics and the influence these have on perception of environmental change. Likewise, we are developing and validating measures for eye tracking in 3D. This will help bridge the connection between subjective assessments of spatial memory and objective measures (e.g., gaze and fixation) of environmental design.

Potential Army/Military Applications

We will further ARI's mission by developing and validating measures of a new spatial memory construct (SMG). This offers a potential application for enhancing readiness through knowledge of individual differences. SMG will stimulate new basic behavioral research and could facilitate building more effective teams through new measures. This effort builds upon a previous Early Career award (W911NF-17-1-0280; PI-Chamberlain), adds value to existing initiatives in collective spatial cognition (W911NF-18-1-0273) because it can be scaled to collective studies in the future (see section 3.8), broadens the ARI research network through multi-university partnerships with new investigators (Co-PI Creem-Regehr and Co-PI Stefanucci) and addresses high priority research questions.

The recent report by the Committee on Measuring Human Capabilities (CMHC, National Research Council, 2015) highlights the need for further study of spatial abilities. The Committee suggested *creating better testing methods* to ascertain individual differences in spatial abilities. The greater use of autonomous and remote technologies used to introduce Soldiers to a new environment further exacerbates the need to identify individual differences. This is because it entails a new way of learning than previously used maps, narrative and first-person experience. This proposal will improve *strategic knowledge on the assessment of individual spatial abilities* (CMHC Research Recommendation B). The research demonstrates the *development of effective and low-cost computerized* tests not previously used (CMHC Research Recommendation A). The ability to assess individual differences provides a strategic advantage for addressing conflicts. This is because it can help leaders make better use of the inherent gifts and skillsets of their personnel.

Using SMG as a measure of spatial memory and its interaction with working memory capacity aligns directly with ARI's mission to *maximize performance and readiness to meet operational requirements*. SMG tested within the virtual environments could provide a more useful measure of spatial memory in the context of military operations. Especially where decisions and actions often need to happen in real-time with little information. Adaptations of our methods could aid Soldier training by improving memory of new places before and during training.

Future Plans

This next year we will focus on four major elements focusing on building empirical evidence and dissemination. We aim to finish the *Linear VE* study this month. This will provide the first formal evidence of how environmental elements relate to SMG. Our *Linear VE Pilot* study gave us confidence that our methodology will provide intriguing findings. Thus, we are now optimizing our *modular virtual environment* and have started incorporating additional environmental design components. Our original design just used buildings. Now we are adding vegetation and other design elements like landmarks. We are also developing a new context that follows *Linear VE* but is entirely wilderness. This enables us to test the efficacy of the SMG construct across entirely different contexts. We aim to conduct several studies at different scales and times (Objective #2) as



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well. The overwhelming efforts will be on the production of the virtual environments and the recruitment of participants. We expect recruitment to be easier under university policy changes related to COVID-19.

The remaining efforts will be spent on advancing and validating metrics to assess SMG and critically on dissemination. Our eye tracking software is currently in testing but shows promise. However, the most significant challenge we will address this year is how to create meaning from the metrics we receive. Here we focus on how our metrics translate to the development of SMG and to identify potential correlations with existing individual difference measures. As these efforts progress, we will continue to disseminate in conferences, but will focus more attention on the development of manuscripts.

Associated Publications

Chamberlain, B., Creem-Regehr, S. Stefanucci, J. Abusham, M. Saxon, M. Fernberg, P. & Garrett, B. (2021). *New metrics and analytical tools for measuring spatial memory* [Symposium]. ISCS-2021, Rome, Italy.

Fernberg, P., Chamberlain, B., Howard, C., Simrayh, S., & Jenson, D. (2021, March). *Assessing imageability in immersive virtual environments*. Proceedings of the 2021 Council of Educators in Landscape Architecture. https://thecela.org/wp-content/uploads/CELA-Abstract-Proceedings-v5-2021_4_1-for-CELA-Website.pdf

Fernberg, P., Chamberlain, B., Saxon, M., Creem-Regehr, & S. Stefanucci, J. (2021). *'Imageable' numbers: Theory-based urban design for immersive psychometrics research* [Poster]. Spatial Cognition, Riga, Latvia.

Saxon, M. Fernberg, P., Creem-Regehr, S. Stefanucci, J. & Chamberlain, B. (2021). Individual differences in spatial memory for a large-scale virtual environment. In *Navigation and environment representation: personality and individual differences* [Symposium]. ISCS-2021, Rome, Italy.

Saxon, M. A., Klemser, B. H., Fernberg, P., Creem-Regehr, S. H., Stefanucci, J. K., & Chamberlain, B. (2021). *The effect of landmarks on learning the gist of spaces* [Poster]. International Conference on Spatial Cognition, Rome, Italy.



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Collaborative Problem Solving (CPS) Skill: Estimating an Individual's Contribution to Small Group Performance

Project #: W911NF-19-1-0106

Contract Dates: JUN 2019 – JAN 2023

PI: Patrick C. Kyllonen

Institution: Educational Testing Service

Co-PIs/Subcontractors: Jiangang Hao, Educational Testing Service; Jonathan Weeks, Educational Testing Service

Abstract

The purpose of this 3-year research program is to develop and evaluate approaches to measuring individual contributions in a set of collaborative problem-solving (CPS) tasks. The tasks include letters-to-numbers problem-solving, hidden-profile decision-making, and “new recruit” negotiation. We explore a set of issues related to developing and evaluating individual and team performance. We administer tasks in both face-to-face and online contexts. Online studies are underway. Face-to-face studies will be conducted in the fall of 2021 and spring of 2022. Online participants are drawn primarily from the Prolific Academic Ltd platform and online data collection website, using ETS's Platform for Collaborative Assessment and Learning (EPCAL) for task administration. Face-to-face data collection will involve the use of automated data capture. Analyses focus on identifying individuals' contributions to team success and compares the nature of the conversations engaged in by successful versus less successful teams.

Introduction

An emerging body of evidence recognizes the importance of interpersonal skills — teamwork, social, and communication skills—for success in the schoolhouse, the workplace, and life. A recent employer survey identified “leadership,” “work in a team,” “written communication skills,” and “problem solving” as the four most important skills employers seek (NACE, 2015). Technology, including artificial intelligence, is rapidly changing work requirements in military and civilian jobs (Frey & Osborne, 2015). However, social and interpersonal skills in combination with complex cognitive skills will remain or become increasingly important (Deming, 2015) as the capability for communication—using social intelligence, creativity, tacit knowledge—is difficult for computers to master.

The study will develop methods for evaluating performance in teamwork tasks. It will evaluate results to address a set of key research questions. The main research questions of this 3-year study are first, can we measure an individual's contribution to collective performance, either based solely on collective performance outcomes or based on contribution to group process variables that are related to collective outcomes? Prior research is limited in addressing the question of individual contributions based on actual performance in the team setting. Second, are there individual knowledge, skill, ability, and other factor determinants of an individual's contribution? Third, how generalizable are individual contributions to collective outcomes across different tasks and task types? Fourth, are there differences in individual contributions in 2- vs. 4-person teams? And finally, are there differences in individual contributions in online vs. face-to-face tasks? The answers will increase our understanding of team dynamics and what specific actions individuals take that lead to better outcomes. The research might ultimately also lead to our ability to develop an individual test of “teamwork” ability. As a result, it could inform better training and job aid approaches to develop teamwork ability.

Research Approach

We administer problem solving, negotiation, and decision-making tasks to approximately 1200 participants in 300 online 4-person groups, 300 participants in 150 online 2-person groups, and 400 participants in 100 face-to-face 4-person groups. Online participants are drawn primarily from the Prolific Academic Ltd platform and online data collection website (80% U.S. citizens, mostly ages 20-30; varying in education, some military experience). Online delivery is through ETS's Platform for Collaborative Assessment and Learning (EPCAL, Hao et al., 2017), which will be made available to ARI upon research completion. Face-to-face data collection will be collected at several sites (Mississippi State, Alcorn State, and Kean College in New Jersey), and will also use the EPCAL platform. EPCAL has several useful capabilities including the ability to collect data via public online panels, tools for automatically categorizing verbal exchanges in chat events (process data) in real time, and complete multimodal flexibility in the kinds of tasks presented.



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A research design has been developed that will enable identifying individual attributes and process-level variables contributing to team success and quantifying individuals' team contributions. Our concern ultimately is with 4-person face-to-face performance, but we are also interested in differences between situations. For example, we will evaluate the degree to which 2-person situations capture the same skills and dynamics as 4-person, and the degree to which online skills and dynamics transfer to face-to-face situations.

Accomplishments

Our main accomplishments this year have been in the areas of a) task development, b) data collection, and c) process data coding. We a) developed all three of the collaborative problem-solving (CPS) tasks and covariate measures, b) subjected them to user testing to eliminate bugs and streamline administration, c) built virtual waiting room infrastructure necessary for collaborative tasks, d) built software to monitor and direct persons to teams, necessary for repeated session administrations, which we have here, and e) began testing with human subjects.

One CPS task was a set of *Hidden Profiles Decision Making* tasks, with three options (A, B, C) and four scenarios. The four scenarios, designed for college students, are themed choosing a class, evaluating a job promotion, finding an apartment, and selecting a party venue. In each case, positive, neutral, and negative features are assigned to each option. The task is to order options based on those features, first in self-study, then following group discussion. Some features are shared across participants; some are nonshared (private). One option order is best when considering information available to the individual; a different option order is best when all information, shared and unshared, is pooled. So, the task is to share private information so that the group can make the best decision.

The second task developed was the *Letters-to-Numbers Problem-Solving* task. This involves determining a random letter-to-number mapping of 10 letters (a – j) to 10 numbers (0 – 9) by asking the computer to solve letter equations (e.g., $e + f = ?$). In a trial, the participant first proposes an equation, the computer answers it (provides a response such as $e + f = g$), the participant then proposes a mapping hypothesis (e.g., $e = 3$), the computer indicates whether that is correct or not, then the participant proposes a mapping for all 10 letters, and the computer indicates whether the entire mapping is correct. If not correct then the participant attempts another trial, until he or she gets the entire mapping correct, or trial 10 is completed, whichever comes first. The task involves a first phase with the participant working alone, and then a second phase with (two or four) participants working together (for each trial, one of the participants is identified as the recorder, responsible for entering equations, hypotheses, and mappings). The primary score is the number of trials it takes to arrive at a solution, and the number of letters used per equation (more letters used is associated with fewer trials to solution).

The third task is the “*New Recruit*” *Negotiation* task, in which participants negotiate a set of six issues to resolve for one of two contexts (building a robot, planning a fund-raiser). Issues are either distributive (zero-sum), integrative (trade-off), or compatible (aligned). The different parties to the negotiation have different, private payoff schedules which determine the nature of the six issues. The goal of the task is to discover through conversation which issues are of what type, then to choose the appropriate negotiation strategy (e.g., to maximize points on compatible issues, to give in some in order to get on others for integrative issues, and to split the difference on distributive issues). Both joint and individual point totals are tallied.

In addition to these three tasks, we have completed task development for a set of additional tasks. These include cognitive ability, Big-5 personality, emotional intelligence, and a subjective team member contribution survey.

We also have finalized a coding framework that will be used to summarize the conversational data participants engage in while taking the tasks. To do this, we synthesized coding frameworks from several different collaborative problem solving projects, and then retained categories that could be reliably distinguished (based on coding data collected from two-person tasks) and that could apply across all three tasks—decision-making, problem solving, and negotiation. Our coding framework is general enough to accommodate communications from different tasks and specific enough to focus on the aspects we are interested in, that is, to make sure that features of conversation that might be associated with team or individual contributions are identified. Our framework is multi-level with 15 primary conversational turn categories and 4 higher-order categories. We developed a platform, the ETS Platform for Collaborative Human Annotation (EPCHA), that facilitates coding to an arbitrary rubric, providing a number of features (such as definitions, examples, highlighting) to enable more reliable categorization of conversational turns to rubric categories.



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Contributions to Basic Research

The fundamental contribution we expect for this research will be our ability to measure an individual's "teamwork ability" (or characteristic collective contribution) across a range of tasks, based on actual performance. Today, such an ability, or contribution, is primarily measured by responses to survey questions such as "are you [or 'is s/he'] a good team player?," "do you make significant contributions to groups you participate in?," or "how much did you contribute on the last task?" Being able to measure and quantify individual contributions in a team task is fundamental to addressing questions such as "is there a general teamwork ability?" and "what is the range of tasks across which such an ability extends?," rather than on survey responses. A basic research finding would be simply to be able to determine whether the concept of a general teamwork ability, or skill, possessed by an individual, is a viable concept. An alternative is that there is no general teamwork ability, but that situations themselves determine information sharing. Another alternative is that group performance is a function of the cognitive knowledge and skill requirements for the task, rather than of the teamwork abilities of the participants. The key basic research findings will relate to determining the extent to which these alternatives are true, and the tasks and circumstances for which they might be true or not.

There are numerous potential products and research applications. Teamwork ability could be a screener that could sit aside other constructs and measures such as ASVAB and TAPAS for military entrance testing and personnel selection and classification systems generally. Measuring teamwork ability could be useful in team assembly. For example, it might be useful to distribute effective team players across different teams to improve overall performance of a larger unit. Alternatively, it may be that some tasks (or specialties) are inherently more team oriented. Additionally, it might be useful to have teamwork ability screening qualification for such tasks and specialties. This would be similar to the way classification composites are used now for screening applicants into specialties. A third application would be diagnostic testing for teamwork ability. Based on it, examinees would be evaluated and sent to remedial teamwork training for further skills development if needed. Skills development might include training on how to share information and acknowledge others' contributions, or how to negotiate. A fourth application would be for program evaluation in which a teamwork battery would be administered at pretest, then following training at posttest. This will help determine the efficacy of a teamwork training program. A fifth application would be a specialty certification in which successful performances on a battery of teamwork tasks, like the ones being developed here, would be recognized with a certificate designating the holder as a strong team player who could receive special assignments that require such skills.

Potential Army/Military Applications

The primary Army and military applications for this research are likely to be in the domains of personnel selection and classification and training. Regarding personnel selection and classification, the research should lead to a new approach for testing teamwork skill, per se. A teamwork skill test could be used in the same way that personnel selection and classification tests are currently used—to qualify individuals for military service, to provide MOS options (or AF specialty codes, Naval ratings) to individuals based on their qualifications. In addition, it could contribute to assessments of force readiness, and the determination of quality of the existing force. It will take a change of habit and culture to use teamwork scores this way, but an argument is that teamwork performance would provide a hard metric more easily accepted than results from surveys. A challenge in moving forward along these lines is that while individual testing depends only on the skills and engagement of the individual test taker, team testing depends not just on the individual but also on the abilities of the other members of the group. What this means is that it is necessary to separate an individual's performance from the confounding influences of other team members. This can be done in two ways. One is to use simulated group members, agents, in a team task. Perhaps the research here can be used to make more realistic agents, based on the conversational and response data captured in the course of the research. Another approach is the "round robin" approach in which the individual participates on many teams. This is not feasible if testing time is done at designated centers, such as the Military Enlistment Processing Stations (MEPS). However, with remote testing, individuals can participate in testing for longer periods of time than might be feasible under current practices. One of the goals of this research is to estimate the amount of time and the number of different teams an individual might have to participate in to get a reliable "teamwork" score on that individual.

A second application area is training. This research is intended to identify the behaviors and interactions associated with individual and team success on a variety of tasks—negotiation, decision-making, and problem-solving. The research should identify factors such as information sharing and acknowledgement, integrative negotiation strategies (e.g., giving a little on an issue that is not important to you to get what you want on another issue that is), and insights through observation, which should prove to be important in task success. The hope is that these specific skills and process behaviors should be directly translatable into training regimens. For example, training can be developed around information sharing, acknowledgement,



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and finding issues to tradeoff. The research should help define the most important issues, the ones that lead to group success at both the individual and team levels.

Future Plans

We await the final ARI HRPO review, which will be an approval for all data collection, including the 4-person face-to-face data collection. We expect HRPO approval to happen soon, as all material has been submitted and approved through ETS's IRB process.

Two-person data collection is underway, and we will begin 4-person data collection as soon as we receive HRPO approval. We expect both the 2- and 4-person online data collections to be completed in the next quarter. We also plan to finalize arrangements and contracts with the participating schools for the 4-person face-to-face data collection this quarter, with data collection likely to begin next quarter. Once 2- and 4-person online data collection is completed, we will begin the response analysis, the coding using EPCHA, and then a process analysis based on rubric codes and keystroke patterns. Analysis approaches that we will take were identified in Hao et al. (2019).

Data collection is organized according to our original plan, which was to have participants do several tasks within a session and then to return for an additional second day session. The design ensures that we can address the questions we originally posed, which were to determine whether there are better and worse teams across tasks, determine the individual's contribution to team performance, and determine what it is that good team playing individuals do and what good teams do to maintain top performance.



Developing a Multidimensional Psychometric Framework on the Impact of Item Bias on Classification

Project #: W911NF-20-1-0282

Contract Dates: AUG 2020 – AUG 2022

PI: Hok Chio Lai

Institution: University of Southern California

Abstract

Psychological test scores are commonly used to select individuals. However, item bias—systematic bias in some test items that leads to a higher score for some subgroups—may lead to ineffective and unfair selections. Despite tremendous growth in research over the past two decades on statistical methods for detecting item bias, little research has investigated the impact of item bias on classification/selection procedures. This research aims to develop a) a statistical method that shows how item bias affects selection accuracy and b) indices that detect problematic items from a selection perspective. A software program will be developed to perform the proposed analyses.

Introduction

Scores on psychological tests are widely used when making selection, diagnostic, and admission decisions. However, the use of these tests is only valid when the test items are free of systematic biases. In other words, they should measure the target attributes or traits in an equivalent and comparable way across demographic subgroups and modes of test administration (e.g., paper-and-pencil vs. computer-based). As an example, many workplaces use the personality trait of conscientiousness in personnel decisions. However, due to translation issues or cultural differences, an instrument measuring conscientiousness may yield more favorable scores for some cultural groups than others, leading to unfair selections.

When test items demonstrate systematic biases against one or more subgroups, the consequences can be devastating. For example, in personnel testing, item bias may lead to the selection of unqualified candidates for special military operations or rejection of well-qualified job applicants.

In the past two decades, there has been a lot of research development in statistical approaches to detect item bias. Most of them rely on the statistical significance testing framework. However, statistical significance is highly dependent on sample size. On the other hand, little attention was given to how item bias affects the quality of the classification decisions, such as personnel selection, diagnosis, and admission. Moreover, while most research focuses on bias in a single, unidimensional, psychological test, real-world selection usually involves multiple tests or tests with multiple components, with differential weights for different subtests. Therefore, there is a clear need for a formal and comprehensive approach to better understand the relation between item bias and classification accuracy and to accommodate the multidimensional nature of the selection procedure.

The overarching goal of the current research is to develop a psychometric framework that quantifies the impact of item bias on classification/selection procedures involving multiple psychological tests. Two main objectives guide the current research: a) to formalize a multidimensional selection accuracy framework that quantifies the overall impact of item bias on the fairness and effectiveness of a selection procedure; b) to develop statistical indices for identifying specific biased items (meaning items with different item parameters across subgroups) that substantially impact decision accuracy.

Research Approach

To quantify the combined effect of item bias, we first derived the mathematical relations between item parameters and selection accuracy indices and validated these derivations using Monte Carlo simulation. The required computational steps of the framework have been implemented using the statistical software R. We have started building an R package for the functions we developed under the first objective of expanding the selection accuracy framework to a multidimensional setting. In addition to preparing the R package for other researchers' use, our current work is focused on synthesizing and building on prior applied and methodological research to develop novel item-level indices that will efficiently identify biased items that negatively impact selection accuracy. The item-level indices will similarly be validated using simulations and be implemented in R. In addition, we will re-analyze an applied selection example in the literature using our framework.



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Accomplishments

A major part of the project is to develop a method for evaluating test bias in the context of personnel selection when the selection process involves multiple target qualities. Our proposed method includes three steps. First, researchers identify biased items via traditional psychometric analyses. Second, researchers compute two sets of item parameters for all items: one assuming all items are unbiased and the other accounting for the biased items. Third, using these item parameters, researchers determine how much impact the test biases have on selection accuracy across subgroups. Figure 1 shows a hypothetical example where test bias adversely affects selection such that one subgroup is twice as likely to be selected than the other subgroup, even though they are matched on their target qualities.

In Year 1, we successfully derived the formulas and the computational steps needed to convert item parameters into five selection accuracy indices: proportion selected, success ratio (proportion of true positives out of all positives), sensitivity (proportion of true positives out of all truly qualified), specificity (proportion of true negatives out of all truly not qualified). We tested our R program with a personnel selection example using data from a published report featuring a five-factor personality inventory. The research questions are whether the scale is measurement invariant across gender and how item bias will influence the selection accuracy. We found five items (out of 20) were noninvariant; 0.8% more female candidates were selected due to bias; and the adverse impact ratio was 0.93, indicating a slight disadvantage for male candidates. The proposed framework provided results more closely aligned to how item biases affect the actual classification decisions overall compared to the traditional unidimensional framework.

We have also created a preliminary R statistical program that performs our method. This includes the creation of several R functions for the multivariate selection accuracy framework, an interactive web application, and an R package for the developed analyses. To use the web application (see Figure 2), users simply need to input the target selection proportions and item parameters for each item in the test and for subgroup, which can be obtained in conventional item bias analysis. The web application will return the computed selection accuracy indices for each subgroup, the adverse impact ratio, and a graph similar to Figure 1 for users to visually examine the impact of test bias on the effectiveness and fairness of the selection process.

Contributions to Basic Research

The vast majority of existing literature on item bias is focused on statistical significance testing for deciding whether item bias is zero or not. However, statistical significance is highly dependent on sample size, as an item that is highly efficient for selection purposes and has negligible but nonzero bias may still be flagged as biased and get discarded. Furthermore, statistical significance tests yield no meaningful metric to help researchers understand the effect of item biases. The proposed selection accuracy framework fills a significant gap in psychometrics by focusing on an important but often-neglected test purpose—classification—to arrive at an impact-oriented approach for evaluating item bias. While a preliminary framework for tests with unidimensional items has been developed, selection criteria in real-world situations, such as personnel hiring and employee placement and promotion, are usually based on scores of multiple tests with varying weights. Therefore, a new framework to accommodate the multidimensional nature of the selection procedure is needed.

By proposing a multidimensional framework, the project will contribute to the psychometric understanding of the influence of item bias on the quality of decision-making based on a combination of psychological tests. Furthermore, the proposed framework better aligns the literature on item bias with the way psychological tests are used in practice—to make classification decisions. Thus, the proposed framework substantially expands the scope of methodological work in evaluating item bias in personnel testing research and will spark research interests in user-oriented psychometric analyses, such as developing algorithms that optimize the weights for each test for selection. Finally, although the proposed framework will be developed mainly in the context of personnel selection, it can be broadly applied to many other situations of using psychological tests, such as diagnostic criteria for mental and developmental disorders and educational tests for making admission decisions.

We envision our framework and R program to be valuable tools that allow researchers to evaluate how bias translates into actual consequence in different contexts, such as demographic subgroups, linguistic differences, prior exposures to testing materials, and administration modes. By putting different sources of test bias on a common metric—change on selection accuracy—our work will encourage future research to identify what source of bias is most salient for different types of tests (e.g., cognitive and non-cognitive) and to develop tests and items that maximize selection accuracy and fairness.

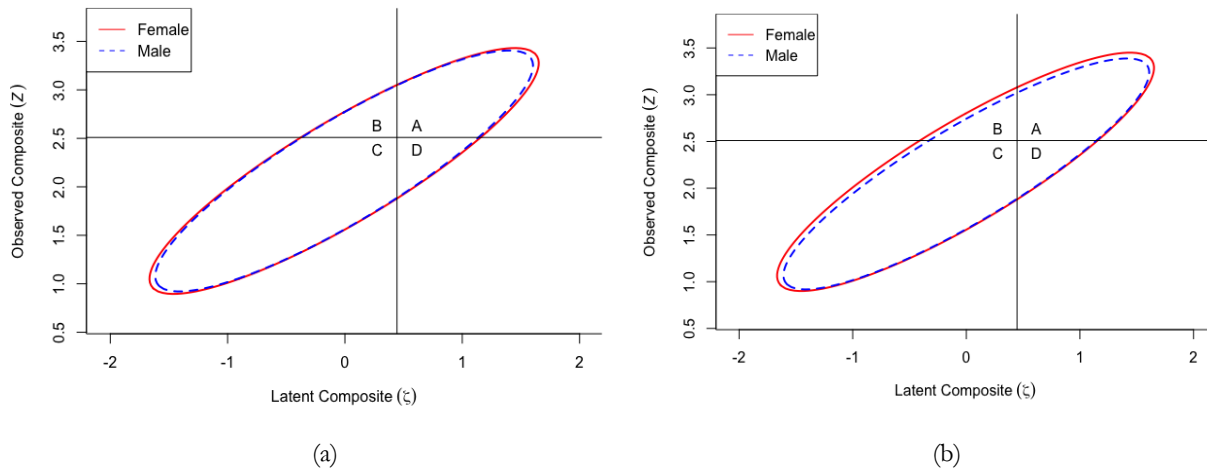


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Figure 1

Graph Generated from the R Program to Demonstrate the Impact of Item Bias on Selection Accuracy Using the Proposed Multidimensional Framework



Note. Relationship between true qualification status (x-axis) and observed test scores (y-axis) for (a) a test with no item bias and (b) a test with biases against male participants. Quadrants A, B, C, and D indicate the proportions of true positives, false positives, true negatives, and false negatives.

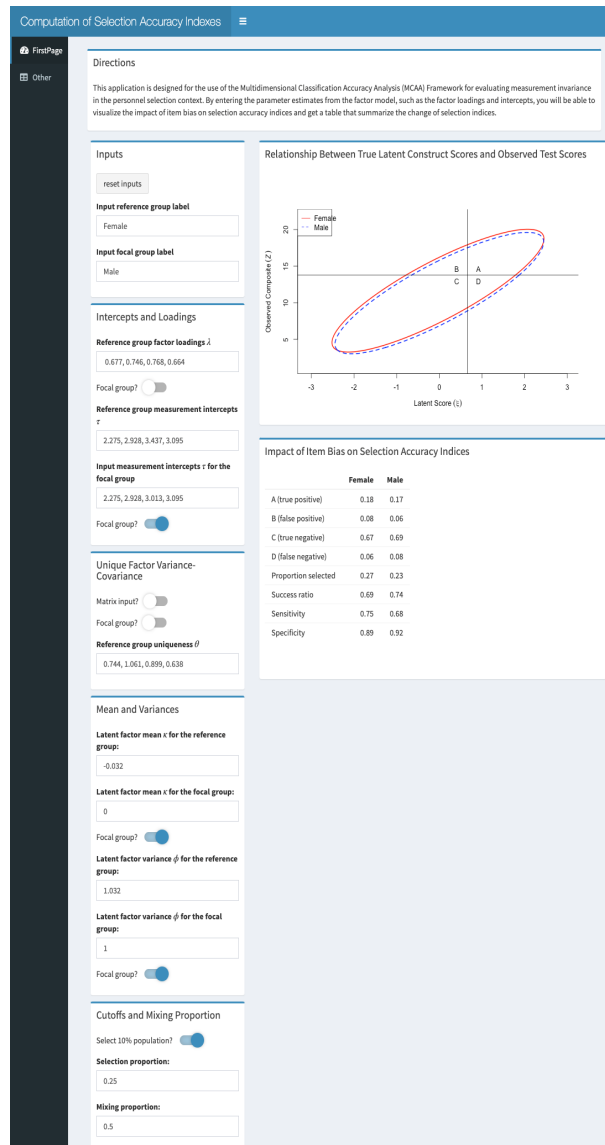


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Figure 2

Snapshot of the R Shiny Interaction Web Application



Note. The application can be accessed at <https://partinvmmmm.shinyapps.io/partinvshinyui/>

Potential Army/Military Applications

The U.S. Army has become more racially and ethnically diverse, which means that current and potential Soldiers might react differently to personnel testing items due to their diverse background and experiences. This poses a serious challenge to ensuring that the Army's hiring, promotion, and assignment procedures are fair and effective. The current research can address the potential consequences of item bias in three ways.

First, this project provides a new perspective on the evaluation of item bias and test fairness. Rather than relying on arbitrary cutoffs for item bias that are often hard to interpret, the proposed framework will provide direct information on how item bias affects selection accuracy using meaningful metrics such as change in selection ratio and change in false positive/negative rates.



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Second, this project facilitates future investigations on the use of psychological tests for existing selection and assignment procedures of the Army. For example, a selection process may be based on a combination of tests assessing general cognitive abilities, vocational aptitudes, and temperament. It is not uncommon to detect bias for 20-30% of the items across racial, ethnic, gender, or other types of subgroups, or across administration modes. The proposed framework can identify tests and items that maximize selection accuracy while minimizing the impact of item bias, which could benefit the Army in its efforts to refine its selection and assignment processes using psychological tests.

Third, this framework can be used to compare different sources of test score variance. For example, both test-taker motivation and mode of administration can be major sources of observed score variance, but they may affect selection accuracy in different ways. Test-taker motivation may affect most of the items in a test in the same direction by favoring those with higher motivation. On the other hand, the paper-and-pencil version of a test may yield higher scores for some items but lower scores for other items compared to the computerized version. In this case, because item biases due to mode of administration are more likely to be cancelled out, it may have a smaller impact on selection accuracy than item bias due to test-taker motivation. Thus, results of the proposed research can help the Army focus on sources that are most relevant based on the actual decision-making criteria, so that resources are allocated more efficiently to improve those aspects of the tests to ensure an effective and fair selection process.

Future Plans

For the remainder of Year 2, we will continue working on Objective 2 in creating item-deletion indices. These indices inform researchers and test users whether dropping a biased item makes the selection process fairer without compromising efficiency. Thus, they allow researchers to efficiently determine whether deleting a biased item will improve or harm the fairness and accuracy of selections. We will validate these indices using both computer-simulated and real-life data and develop guidelines for interpreting the magnitude of these indices. A manuscript for Objective 2 is underway. In addition, we will consolidate functions we have developed as part of Objectives 1 and 2 into an R package that will be made available freely and open access to all researchers. The R package will also contain features developed in relevant prior studies. We will develop functions in R that will compute item deletion indices based on a set of user-defined parameters, and we will incorporate these functions into the R package to work seamlessly with functions built under Objective 1.

Associated Publications

- Lai, M. H. C. (2021). Adjusting for measurement noninvariance with alignment in growth modeling. *Multivariate Behavioral Research*, Advance online publication. <https://doi.org/10.1080/00273171.2021.1941730>
- Lai, M. H. C., & Zhang, Y. (In Press). Classification accuracy of multidimensional tests: Quantifying the impact of noninvariance. *Structural Equation Modeling: A Multidisciplinary Journal*. <https://doi.org/10.1080/10705511.2021.1977936>
- Zhang, Y. & Lai, M. H. C. (2021, July 19-23). *Classification accuracy of multidimensional tests: Quantifying the impact of noninvariance* [Oral presentation]. Conference of the Psychometric Society (IMPS), Virtual.
- Zhang, Y. & Lai, M. H. C. (2021, August). *Classification accuracy of multidimensional tests: Quantifying the impact of noninvariance* [Poster]. American Psychological Association (APA) Convention, Virtual.
- Zhang, Y., Lai, M.H.C., & Palardy, G. J. (In Press). A Bayesian Region of Measurement Equivalence (ROME) approach for establishing measurement invariance. *Psychological Methods*.



Individual Differences in Emotional Reactivity and Cognitive Performance

Grant #: W911NF-16-1-0191

Grant Dates: MAY 2016 – MAY 2023

PI: Karen S. Quigley

Institution: Northeastern University

Co-PIs/Subcontractors: Jolie Wormwood, University of New Hampshire

Abstract

Growing evidence indicates that there is variability in emotional experiences. Our lack of scientific understanding of this variability makes it difficult to understand how emotions impact decisions. This project will link patterns of physiological variability to subjective emotional experiences in everyday life. We will measure physiological activity (i.e., heart rate, sweat gland activity), emotional experience, and cognitive performance both in participants' everyday lives, as well as in the lab under both stressful and non-stressful conditions. We will use these data to create biologically-based patterns or categories for each person, and assess whether these categories generalize across people. Finally, we will use these categories to predict cognitive performance during stressful experiences. These findings will provide the basis for future studies that will create and test assessments of these individual differences for use in determining the capabilities and potential performance of each Soldier.

Introduction

Emotional experiences, even those identified by a single emotion term (e.g., anger), vary a lot both across people and within people across different contexts. For example, when she is angry, a person might yell, so heart rate and blood pressure will sometimes rise, such as when one driver cuts another driver off in traffic. On the other hand, a person experiencing anger might calmly explain a rule, sit very still and smile while being insulted, or tease a friend instead of criticize. During these instances, the person's blood pressure and heart rate might go up, down, or stay the same. The scientific study of emotions has mostly ignored this variability in emotional experience or treated it as error. Instead, many studies have focused on searching for a specific and consistent linkage or mapping between an emotional experience and a physiological pattern across all instances of an emotion, such as anger. However, research reveals a lot of variability in emotional experiences and the physiological patterns associated with those experiences both within a person and across different people. The lack of scientific understanding of this variation is a critical barrier to understanding how emotions can influence behavior and how people make decisions in the real world. The goal of this grant is to map the recurring patterns of change in physiology that occur in everyday life to a person's emotional and affective experiences. We will use unsupervised machine learning clustering methods to detect these patterns in the physiological data. The classification analysis will detect patterns of physiological change, such as a change in heart rate, across multiple contexts and across time within a person. We first assess the number and nature of these patterns within a person. We then will compare the similarity of these patterns across people. This is different than classifying patterns using emotion words like anger, fear, or sadness, which is the usual approach. The data collected and the clustering analysis will help us meet three scientific aims: 1) identify new biologically-based categories of experience, 2) examine whether these categories generalize across people, and 3) examine whether these physiological patterns can be used to improve predictions of decision behavior during intense emotional experience within and across people.

Research Approach

This research builds off our previously completed data collection on this grant (i.e., Study 1), and extends to a second, confirmatory sample (Study 2). As in Study 1, participants in Study 2 will wear a device to record physiological activity (e.g., heart rate, respiration; Figure 1) during daily life. The participant receives prompts on a cell phone asking them to report their current emotions, current environmental context, and complete a single-item temporal discounting task to assess willingness to give up a smaller immediate reward for a larger future reward. Most prompts are triggered by increases or decreases in cardiac activity when the person has not just moved or changed their posture (along with a couple of random prompts each day). The goal is to prompt a report of experience during moments when the person is most likely experiencing a psychologically salient event. We also collect behavioral, self-report, and physiological data from the same participants in the lab during standard emotion inductions. In Study 2, we have added measures of cardiac interoceptive sensitivity and awareness, to assess how much participants can perceive internal sensations from their heart (i.e., heartbeats). Results from

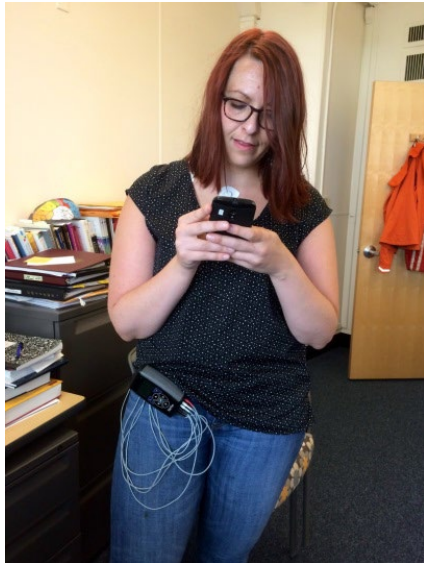


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Figure 1

Ambulatory Physiology and Experience Sampling Hardware in Use



our prior ARI project (W5J9CQ-12-C-0049 to L. Feldman Barrett) suggested that cardiac interoceptive sensitivity may moderate the relationships between peripheral physiological measures and experience. A third study (Study 3) at the University of New Hampshire will be run at the same time as Study 2. Study 3 will focus specifically on measures of emotional granularity and their relationship to decision making and learning in high-arousal situations. We will also assess changes in emotional granularity over time within each person.

Accomplishments

We have begun data collection on Study 2 at Northeastern University (NU). As of October 29, 2021, we have enrolled two participants in Study 2 (with a third one scheduled to be enrolled on November 1, 2021). Due to the COVID-19 pandemic and some delays in shipping new devices, we have been slower to start data collection than anticipated. The beginning of data collection for Study 2 is the culmination of over a year of preparatory work, including extensive piloting of new equipment, refining research protocols, and training our new postdoctoral scholar, undergraduate research co-op student, and other undergraduate research assistants. We have developed and implemented protocols to minimize risks related to potential COVID-19 exposures and to meet NU safety requirements. This included the need for all staff to use personal protective equipment during any close-contact, in-person research (such as the placement of sensors for physiological recordings) and the use of HEPA filters for each data collection space. We will continue to take all other necessary precautions to reduce risks and enhance the physical health and safety of our staff and participants.

We are also prepared to begin data collection on Study 3 at the University of New Hampshire (UNH). We have a cohort of 4 pilot participants scheduled to begin the 6-week study protocol during the first week of November 2021. During the COVID-19 pandemic, all research personnel assigned to the project at UNH were allocated to other projects, and therefore, spending on the UNH sub-award was frozen from August 2020-August, 2021. Beginning in August 2021, with the anticipation of the re-opening of University facilities for in-person data collection, we on-boarded two new graduate students to help with data collection for Study 3, finalized the pre-registration for Study 3, and implemented several important modifications to the planned study protocol. Specifically, to minimize risks to participants and staff, and to avoid any interruptions in data collection that may accompany any potential (and unforeseeable) changes in access to in-person lab facilities at UNH associated with COVID-19, we decided to move much of the data collection for the later points of this 6-week study protocol to a remote format (keeping only one mandatory in-person session at the start of the protocol). This change necessitated re-programming multiple tasks to operate remotely, as well as updating testing protocols and the IRB documentation to reflect these changes. The modified IRB was recently submitted to HRPO and is pending approval. We feel confident these alterations will enable us to recruit a more diverse sample of participants, successfully retain more participants



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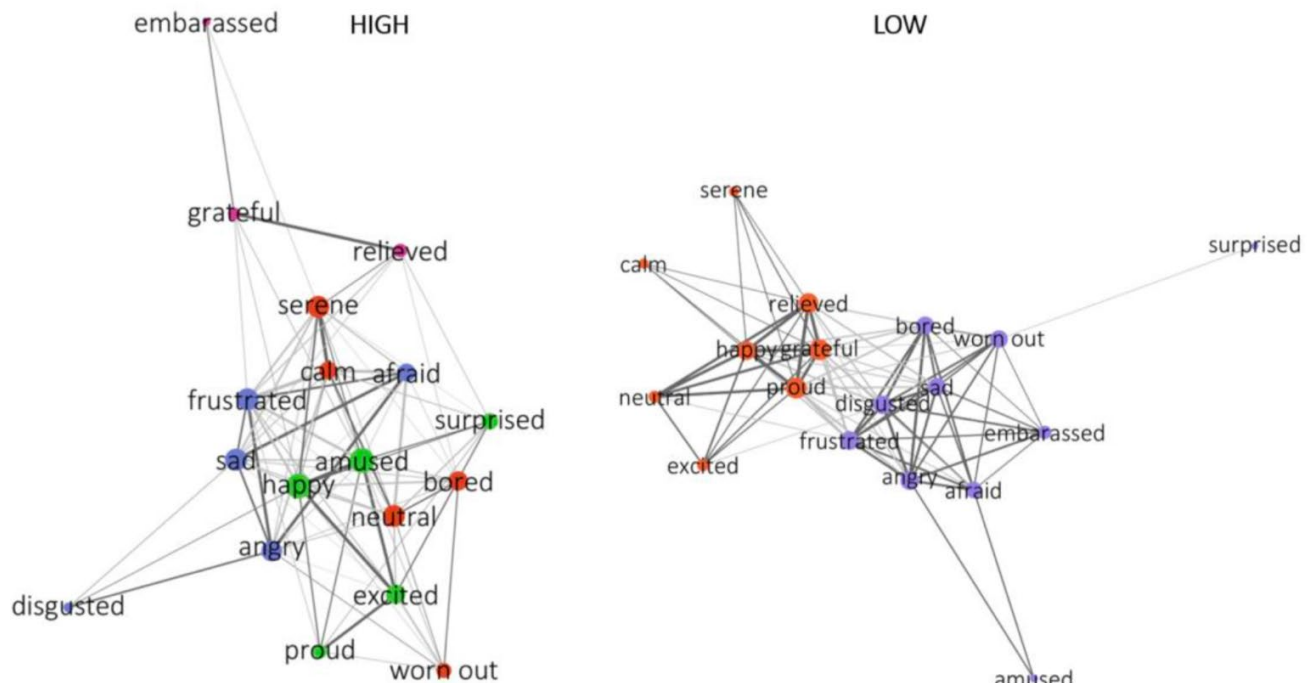
throughout the entire 6-week protocol (even in the event there is another COVID-19 surge), and increase the number of participants we are able to enroll each semester.

We have completed another three manuscripts using the data from Study 1. One of our psychology team members, Katie Hoemann, spearheaded three manuscripts using data from Study 1, two of which were published in the last year. The first developed network-based measures of emotional granularity (both overall measures and time-based measures; see Figure 2), the second examined the relationships between resting respiratory sinus arrhythmia, an estimate of parasympathetic function, and emotional granularity (see Figure 3; Hoemann et al., 2021), and the third identified factors that influenced increases in emotional granularity over time in Study 1 (Hoemann et al., 2021). We are going to await the Study 2 data before completing the network manuscript because we want to assess the generalizability of the Study 1 effects using the Study 2 data.

Over the last year, we have **continued working with our engineering collaborators**, Dr. Jennifer Dy and her graduate student, Zulqarnain Khan, to analyze data from Study 1, building on and refining our analytic approach. In our initial scientific questions, we used the physiological data alone to determine clusters of biologically-defined patterns of change and then assessed whether (and how) these patterns mapped to other features of the person or context. In our next analyses, we want to use unsupervised analyses that can combine the physiological data with the subjective and contextual data. This has proven to be an interesting challenge, because it is more complex to fuse multimodal data of different kinds (i.e., quantitative and categorical) within the same models. This has required considerable work by members of the team. We now have a viable

Figure 2

Participants with Higher Emotional Granularity Show Greater Complexity of Emotion Word Networks



Note. For example, the network for the participant with lower granularity (right panel) has only two communities, shown here with orange and purple nodes, which seem to generally represent normatively pleasant (orange; e.g., happy, calm) and unpleasant (purple; e.g., sad, bored) words. In contrast, the network for the participant with higher granularity (left panel) has four nodes (purple, orange, green and pink) and these communities have complex and overlapping relationships. Also, the emotion terms that appear in the communities of the person on the left (happy in the green community, frustrated in purple, and calm and bored in orange) look different than those of the person on the right.

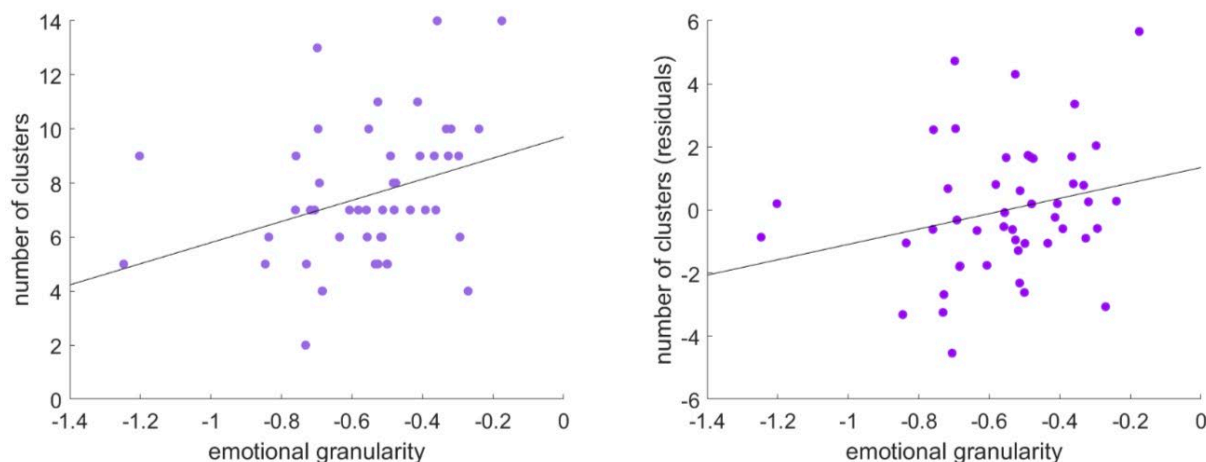


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Figure 3

Emotional Granularity is Positively Related to Number of Clusters Discovered in Cardiorespiratory Physiological Activity During Periods of Seated Rest in Everyday Life



Note. Left panel: The raw number of clusters and the positive relationship with emotional granularity. Right panel: The residualized number of clusters after controlling for number of seated rest periods. This demonstrates that the effect shown in the left panel still holds even when controlling for the number of seated rest periods, which varied across the sample.

analytic approach that we can use with one dataset (Study 1) and then apply to our new dataset (Study 2) to assess the generalizability of findings across the datasets. From these analyses, we will be able to assess the relative importance of different sets of features that distinguish among events at a person-by-person level.

Finally, we have continued our work on a **literature review of individual differences in arousability**, or affective reactivity. PIs Quigley and Wormwood, as well as Psychology graduate student Catie Nielson, have been meeting at minimum biweekly to write a manuscript based on this synthesis.

Contributions to Basic Research

One key innovation of this project is the use of physiologically-triggered experience sampling. This method allows us to more efficiently sample experience at the most psychologically-relevant moments. This efficiency is not possible with traditional random experience sampling. Also, we are recording multiple peripheral physiological measures at these psychologically important moments during participants' real lives. Our innovative experience-sampling methodology also allows us to study decisions made in the real world soon after these psychologically meaningful moments. To the best of our knowledge, this project is the first to attempt such a comprehensive sampling of decisions made in the real world along with experience sampling and recording of ambulatory physiological measures. We are using a data-driven approach to identify, for the first time, biologically-based patterns and testing how those patterns are related to individual variations in emotional and affective experience, and context. Finally, we also can test the reliability of these classifications using standardized measures of affective responding and decision making in the lab under both non-stressful and stressful conditions. This will allow us to see which person-specific patterns in the real world also appear as patterns in the lab. In the future, these findings will contribute to creating more powerful predictive models of emotion and decision making that can be used to achieve more accurate assessments of important individual differences relevant to performance of complex cognitive tasks.

Given the delays imposed by COVID-19, we were able to use this time and **leverage PI Quigley's startup funds to further improve our experience sampling methods** in preparation for Study 2. Our staff have worked with MindWare Technologies to develop and test the next generation of mobile devices for measuring movement and posture, along with a more reliable and user-friendly web application for delivering experience sampling prompts. Additionally, we invested some of PI Quigley's startup funds to obtain new mobile devices to better measure ambulatory electrodermal activity. These



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investments promise to improve the quality and reliability of our experience sampling data, and to reduce staff time needed to troubleshoot equipment.

Potential Army/Military Applications

This program of research is very consistent with priority areas in the 2015 BAA. These include: 1) understanding differences between Soldiers in cognitive and behavioral capabilities and 2) using these insights to enhance the capabilities and resilience of each Soldier. This project explores individual differences based on physiological changes and then assesses the relationships between these physiological patterns and both emotional experience and cognitive performance. These are all variables critical to a Soldier's unique skills and abilities. These insights will forward the goals of the BAA to better understand the relationship between biology and psychology. These insights will come from exploring how physiological changes are related to a person's experience and performance. These insights also could be useful for Army leaders by explaining how person-specific differences in physiological patterns could relate to a person's resilience to work-related stressors and the effects of these stressors on decision making.

By meeting our aims, we hope to expand scientific understanding of how emotional experiences influence decision making and cognitive performance. We also want to improve future research that translates basic research in emotion science to real-world applications. A major future goal is to enhance cognitive performance under stress. These findings will also serve as the basis for future studies that will create and test brief performance assessment methods. These assessments would have strong potential for use in Army hiring and for assessing aptitude for specific military occupational specialties. Specifically, Soldiers must have cognitive capacities for complex cognitive function and excellent decision-making skills. These abilities must be maintained even during intense emotional experiences, which are common in high op-tempo Army contexts. This work uses innovative methods and theory to assess differences between people that are important to Army leadership who must recruit, assess, and retain successful, high-performing Soldiers.

Future Plans

In the next year of the grant, we will focus on three main research tasks. First, we will **continue data collection for Study 2 (at NU) and begin data collection for Study 3 (at UNH)**. Now that data collection for Study 2 has begun, we anticipate data collection to be complete around August 2023, with potential spill-over into September 2023 depending on the attrition rate for participants and the number of participants we are able to enroll during the slower summer months. Specifically, Study 2 is projected to enroll 4 participants in Fall 2021, 10 participants in Spring 2022, 8-10 participants in Summer 2022, 10 participants in Fall 2022, 10 participants in Spring 2023, and 8-10 participants in Summer 2023. For Study 3, at UNH, we plan to have 3-4 participants complete the entire protocol prior to the end of calendar year 2021, and anticipate being able to enroll approximately 40-50 participants per semester starting in Spring 2022. This pace keeps us on track for our projected end date of Fall, 2023. The delays caused by the COVID-19 pandemic will require an extension to this project to enable completion of the work. We have spoken to GOR Dr. Alexander Wind about requesting an extension and we plan to do so in the coming months.

Second, we will **continue data analysis** with our engineering collaborators, Dr. Jennifer Dy and her graduate student, Zulqarnain Khan, in preparation for the next manuscripts we will submit for publication. The full team will continue working on our multimodal data fusion and clustering of the Study 1 data that expands on the initial hypothesis-driven analysis of physiologically-based clusters. Additionally, using the analytic approach we developed for use with Study 1 data, we will conduct cluster analyses using the physiological data from Study 2 as it is collected.

Finally, we will continue to make progress on **summarizing the research on individual differences in arousability or affective reactivity**. We have begun writing this second manuscript which will overview some emerging themes from this large literature. We anticipate submitting this manuscript for publication in 2022. We also intend to write a methods paper over this next year that describes our novel method for physiologically-triggered experience sampling.

Associated Publications

+ indicates authors contributed equally

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Interpersonal Skills: Clarifying a Proliferated Construct Space and a Theoretical Framework

Grant #: W911NF-19-1-0068

Grant Dates: FEB 2019 – FEB 2025

PI: Eric D. Heggstad

Institution: University of North Carolina at Charlotte

Co-PIs/Subcontractors: George C. Banks, University of North Carolina at Charlotte

Abstract

People with interpersonal skills are able to develop and maintain strong relationships with other people. Individuals with these skills also tend to be seen as leaders and can be highly effective in leadership roles. Although there has been considerable research on interpersonal skills, the scientific literature as a whole is disjointed and chaotic. There are three key problems. First, dozens of concepts have been proposed and investigated with little attempt to ensure that they are different from one another, making it quite likely that there is conceptual overlap between the concepts. Second, the concepts are also often conflated, such that objective behaviors are used interchangeably with evaluations of those behaviors. Third, no framework has been adopted to organize and integrate these concepts. Our research seeks to address each of these issues. We believe this research will help the Army better identify and develop leaders and create more effective, high-functioning teams.

Introduction

There is a long history of research on social effectiveness and interpersonal skills within psychology and related fields. Some of this research indicates that interpersonal skills are important for Army-relevant issues, such as leadership, team effectiveness, and cultural sensitivity. However, there are three key problems that prevent the research from moving forward in a meaningful and impactful way. First, a large number of concepts capturing interpersonal skills have been proposed and discussed in the scientific literatures across several disciplines. Good science demands that when a new concept is introduced to the literature, that concept is carefully defined and distinguished from other related concepts that have already been proposed. Unfortunately, that carefulness is missing in the study of interpersonal skills. Consequently, there is a notable lack of clarity in the true number and nature of unique concepts that make up the interpersonal skills domain.

Relatedly, the literature also suffers from conflation of concepts. Objective behaviors are often referred to interchangeably with evaluations of those same behaviors, leading to a tautological bias in which the concept is often defined by its anticipated outcome. For instance, a leader is said to be charismatic only when followers evaluate that individual as charismatic on a questionnaire or when they report being inspired by the leader. Both behaviors and evaluations of those behaviors are important to study, but must not be confused with one another. To fully understand precisely how interpersonal skills operate, we need to delineate how particular behaviors influence the reactions and behaviors of others.

Third, there is no accepted organizing scheme for this large set of concepts. Having a clear organizing scheme for these concepts would make it much easier to understand the domain and, ultimately, how these personal characteristics and behaviors lead to socially effective behavior. Such an organizing scheme would also be useful for applying these concepts to real-world situations, such as leader emergence, leader effectiveness, and the quality of team functioning.

Our research is directed toward 1) bringing clarity to this currently chaotic research base by figuring out the key interpersonal skills concepts, and 2) establishing a framework for organizing these key concepts. The ultimate outcome of this research will be a better understanding of how and why interpersonal skills lead to socially effective behavior, which, in turn, can be applied to real-world contexts such as leadership and work in teams.

Research Approach

To identify the key interpersonal skills constructs, we are using sophisticated text analysis procedures to evaluate how similar and different 26 interpersonal skills concepts are from one another. We will also conduct a meta-analysis of these 26 concepts to understand how they relate to one another on an empirical, measurement level. These analyses will allow us to identify concepts that aren't differentiated conceptually or empirically.



PERSONNEL TESTING AND PERFORMANCE

BASIC RESEARCH PROGRAM

To build a framework for interpersonal skills, we are interviewing people about how they have perceived people with and without interpersonal skills (qualitative research). Finally, after pulling all of this together, we will develop an evaluation of our new perspective. Specifically, we will design a large-scale research project and ask researchers from around the world to collaborate on data collection. We will put all of the data from these individual studies together and analyze it as one large dataset (i.e., a prospective meta-analysis).

Accomplishments

Over this last year, we have made a great deal of progress on three of our projects: the qualitative study, the text analysis study, and the meta-analysis. A manuscript describing the results of our qualitative research is currently under peer-review, and a manuscript describing our findings from the text analysis study is planned to be submitted for peer-review.

Qualitative Research. We talked to 32 people from all walks of life about their experiences with people they saw as interpersonally skilled and people they identified as lacking interpersonal skills. These conversations led us to identify a number of characteristics and behaviors associated with being interpersonally skilled. We presented these ideas to two focus groups who evaluated whether the concepts we identified resonated with their experiences with interpersonally skilled individuals. Using the focus group information, we refined our understanding of the identified interpersonal skills concepts.

Beyond identifying concepts associated with socially effective/ineffective behavior, we were also able to organize the concepts into a theoretical framework. To do so, we adapted a framework proposed by John Campbell and his colleagues (1993) to understand job performance. A representation is provided as Figure 1. We located each of the concepts identified in the conversations and focus groups within the elements of this framework. For example, within the social performance (i.e., behavior) element, positive evaluations of social effectiveness were associated with good nonverbal communication behaviors (e.g., making eye contact), leadership behaviors (e.g., setting a vision), and networking behaviors (e.g., making introductions, drawing attention to similarities between people within a group). Participants also gave examples of behaviors that might lead to evaluations of social ineffectiveness, such as engaging in “oversharing” and discussing personal topics that make people uncomfortable.

Text Analysis Research. To examine the conceptual overlap between concepts, we conducted a text analysis on definitions for 26 interpersonal skills concepts. Specifically, we identified a large number of papers that provided a definition of one or more of these concepts. From these papers we created a database consisting of 756 definitions. Text analysis is a sophisticated machine-learning process which can identify key topics within the set of definitions. Though this analysis, we found several places where the original concepts were defined using similar sets of words, suggesting conceptual redundancy. Ultimately, we identified 12 distinct concepts that can largely account for the original 26 concepts.

Meta-Analysis. We are meta-analyzing the relationships between the 26 interpersonal skills. Our data includes more than 3,325 relationships. The strength of the relationships can point to concept redundancy. We will conduct supplementary regression analyses to establish relative importance and incremental predictive validity for social effectiveness.

Contributions to Basic Research

Our research will make three key contributions to the basic research literature. First, we bring clarity to a literature that is chaotic and disjointed. Work on interpersonal skills-related concepts has developed in a non-integrated manner, and the domain of study can be defined as a “proliferated construct space.” Our qualitative, text analysis, and meta-analysis research address the number and nature of interpersonal skills concepts using three very different methods. When considered together, this work will provide scholars with a common set of concepts from which to work.

Second, our work will disentangle the conflation of interpersonal skill behaviors with other concepts in the literature. Both behaviors and outcomes deserve research attention, but concepts within these areas should not be studied in an interchangeable fashion as is currently done. As we work to refine the number and nature of the interpersonal skills concepts, we will focus on avoiding the conflation of behavior and its outcomes. This will have important implications for defining concepts and improving alignment of theory, methods, and assessment.

Third, we have proposed an organizing scheme for interpersonal skills (see Figure 1). In the middle of the framework is *social performance*, which are the actions and behaviors taken by an individual to achieve a social goal. An individual’s social

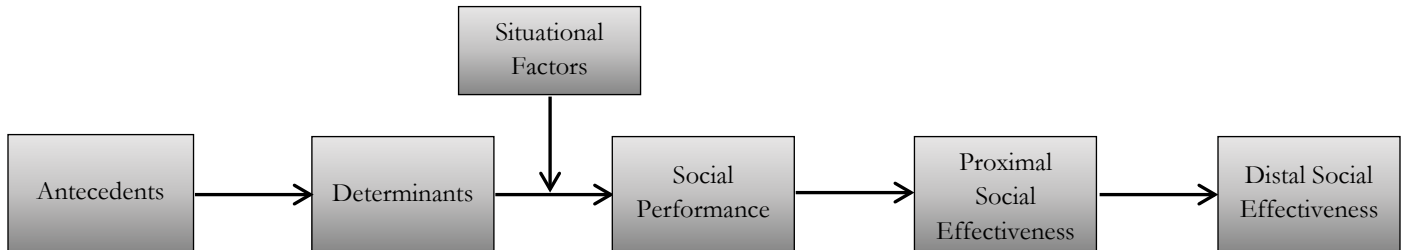


PERSONNEL TESTING AND PERFORMANCE

BASIC RESEARCH PROGRAM

Figure 1

The Social Performance Framework



Note. This framework is adapted from Campbell, J. P., McCloy, R. A., Oppler, S. H., & Sager, C. E. (1993). A theory of performance. In N. Schmitt & W. Borman (Eds.), *Frontiers in I/O Psychology: Personnel Psychology* (pp. 35–70). San Francisco: Jossey-Bass.

performance will be a result of his/her antecedents, determinants, and the nature of the situation. *Antecedents* of social performance are a person's characteristic way of thinking, feeling, and acting in social contexts and include concepts such as social intelligence, extraversion, social anxiety, and ability to appropriately read situational cues. *Determinants* of social performance include knowledge of appropriate behaviors in different classes of situations, an awareness of social obligations and protocols, and motivation to enact the appropriate social behavior. *Situational Factors* are environmental factors that influence the enactment of social behavior.

We have also identified two key outcomes of social performance. *Proximal Social Effectiveness* includes the reactions of others to the social performance of an actor. We see trust, liking, and genuineness as important indicators of proximal effectiveness. *Distal Social Effectiveness* includes longer-term reactions and perceptions based on repeated observations of an actor's social performance. Distal social effectiveness outcomes of most interest to the Army include perceptions of leadership and perceptions of the individual as a valued member of a team.

Through our research we have begun to identify/propose specific concepts that reside within each of the elements of the framework. This populated framework will provide much needed structure to the interpersonal skills domain, facilitating communication between and among research teams and, ultimately, allowing for a clearer articulation of how these personal characteristics and behaviors lead to social effectiveness.

Potential Army/Military Applications

Once fully developed, the social performance framework will be useful to the Army in a number of ways, including selecting people for jobs, developing leaders, identifying ways to enhance cultural awareness, and improving team functioning. Each of these applications depend on identifying key interpersonal characteristics associated with social effectiveness and a series of taxonomies of behaviors for various social situations.

Selection. The social performance framework can be useful to the Army for establishing processes to choose people for jobs or career paths in which social effectiveness is important for success. That is, for jobs in which social effectiveness is necessary, candidates could be given the interpersonal skills assessments, and scores from these assessments would be used to determine who to select for the job. We expect that this work will be particularly valuable when identifying individuals for leadership positions.

Developing Leaders. Individuals being developed for leadership positions could be assessed on interpersonal skills either by having them complete the interpersonal skills assessments or through a process of obtaining information from supervisors, peers, and direct reports (so-called 360 degree feedback systems). Leadership development activities (such as classroom sessions, experiential learning experiences, coaching, etc.) could then be prescribed for individuals with identified growth areas, leading them to develop stronger interpersonal skills. As the existing literature is dominated by perceptual questionnaires, there is very little guidance on what behaviors should be trained. Our work will help to rectify this situation.



PERSONNEL TESTING AND PERFORMANCE

BASIC RESEARCH PROGRAM

Cultural Awareness. A key element within the interpersonal domain is the ability to “read people” in social situations. For example, a person with higher levels of interpersonal skills will better perceive when his or her actions were not received well from those in the social environment. Recognizing their social missteps, these individuals can adjust their behavior to be more socially appropriate going forward. Because what is considered socially appropriate will differ across cultural contexts, people with stronger interpersonal skills more quickly understand and adjust to cultural contexts where there are differences in what is socially appropriate. Our work should provide a foundation for examining the role of interpersonal skills in understanding cultural differences and developing cultural awareness.

Team Functioning. Our work also has important implications for the effective functioning of teams. Working in teams involves high levels of social interaction, as team members must set a direction, communicate about work processes, and deal with team conflict. Individuals with higher levels of interpersonal skills should be better equipped to work in team contexts and drive team effectiveness. Our framework should allow researchers to derive and test ideas about the ways in which interpersonal skills are related to important team outcomes, such as team cohesion and team effectiveness.

Future Plans

In the coming year, we hope both our qualitative and text analysis papers will be published in the scientific literature. Most of our effort will be focused on the meta-analysis. We have coded data from almost 9,000 published articles to date. We have begun the process of analyzing the data and have drafted the introduction section of the manuscript. We plan to have the project under peer-review by late spring.

We will also be conducting a second text analysis project this year. Our input for this study will be items from interpersonal skills measures. The emerging topics will help us refine our thinking about the number and nature of social skills concepts. Importantly, because these topics will be associated with items, we have the opportunity to evaluate the sets of items as a new measure of these concepts. We have done a “proof of concept analysis” to ensure we can get meaningful information from the short items and we will be gathering additional items and running the analyses this year.

Although the prospective meta-analytic review will be conducted over the latter years of our award, we have begun some initial work. We are writing a white paper detailing our research, establishing a list of researchers to invite to partner with us, and planning a two-day workshop. The goal of the workshop is to design research that will be conducted by our research partners in their own labs. Unlike traditional retrospective meta-analytic reviews, this initiative will lead to the pre-registration of dozens of experimental data collections that will demonstrate when and under what conditions interpersonal skills cause attitudinal and behavior outcomes in followers.

Associated Publications

Ross, R., Toth, A. A., Heggstad, E. D. & Banks, G. (2020, October). *Construct redundancy in the interpersonal skills literature: An inductive evaluation of 26 constructs* [Symposium]. Annual Meeting of the Southern Management Association, St. Petersburg Beach, FL. *Selected as the Best Overall Doctoral Student Paper of the 2020 SMA Annual Meeting

Ross, R. L., Toth, A. A., Heggstad, E. D., & Banks, G. C. (2021). *Redundancy and theoretical conflation in the interpersonal skills literature: An inductive evaluation of 26 concepts* [Manuscript under review at *Psychological Bulletin*].

Toth, A. A., Banks, G. C. & Heggstad, E. D. (2019, May). *Interpersonal skills: Clarifying a proliferated construct space and proposing a theoretical framework* [Poster]. 20th Congress of the European Association of Work and Organizational Psychology, Turin, Italy.

Toth, A. A., Sandoval, R. G., Heggstad, E. D., Banks, G. C., Bochantin, J., & Stetyick, A. (2021). *What is socially effective behavior? A qualitative approach for building an organizing framework* [Manuscript under review at *Administrative Science Quarterly*].



Trait Complexes and New Ability Assessments

Grant #: W911NF-19-1-0400

Grant Dates: AUG 2019 – FEB 2022

PI: Phillip L. Ackerman

Institution: Georgia Institute of Technology

Abstract

Existing approaches to selection in the U.S. Army are generally cost effective, but essentially have not changed over the past decades from a focus on general mental ability and a small number of occupational abilities/skills. The current research draws on developments in theory/application to provide a more complete assessment of individuals. In the ability domain, new measures include: a) complex perceptual speed, b) judgement and planning, c) practical problem solving, d) oral comprehension for meaningful material, e) use of electronic aids for solution of mathematical and spatial tasks, and f) domain knowledge. In the non-ability domain, the focus is on a relatively small number of assessments that integrate across personality, interests, self-concept, and motivational traits. Expanding the scope of assessments in this manner is expected to provide the basis for a substantial increase in predictive validity for Army-relevant training and field success.

Introduction

There are two related goals of this research project. First, the design, development and validation of a new set of ability measures that are not typically drawn from the traditional assessment of general mental ability. Rather, the new measures focus on ability traits and skills that are not captured by existing measures of abilities in use for occupational or military selection, but that represent the nexus of adult cognitive/intellectual capabilities. The new ability measures are being developed to assess aspects of: oral comprehension for meaningful material, practical problem solving, judgement and planning, use of electronic aids for solution of mathematical and spatial tasks (including for example, performance of procedural tasks after viewing multimedia demonstrations that have spatial and perceptual/motor demands), and domain-specific knowledge. In addition, these ability measures will be supplemented by adaptations of 'complex' perceptual speed ability measures, which have been shown to have substantial incremental predictive validity for a variety of different occupations with technical and procedural skill demands. Many of the domains described above have indicated substantial potential for applied uses, but they have received much less attention from the basic and applied research communities than have, for example, studies of working memory or abstract reasoning. In addition, over the past two decades, there has been a surge of research on 'critical thinking' abilities, but very little of this work has been developed into useful tests for application purposes.

Second, the use of the trait-complex approach (e.g., see Ackerman & Heggestad, 1997) to draw on a small set of "constellations" of traits that are facilitative or impeding of learning and performance on cognitively demanding tasks. The trait complex approach incorporates assessments of key non-ability traits, including self-concept, self-efficacy, selected personality traits, motivational traits and skills, interests, attitudes, and preferences. These trait complex assessments will be examined to determine both their theoretical (construct) validity, along with the new ability assessments, and in terms of criterion-related validity (i.e., real-world tasks performance) for learning and task performance criteria relevant to a set of operational tasks that require extended on-task time and effort.

Research Approach

The research approach adopted here is three-pronged. First, it involves the adaptation and expansion of assessments of previously investigated abilities that have been shown to be distinct from general mental ability assessments, yet where there exists both a theoretical and empirical basis for supporting the idea that such assessments will provide substantial incremental predictive validity to extant selection batteries. Second, it involves development of new assessments of abilities that are essential determinants of individual differences in training and field success. Third, the approach involves an integrated 'trait complex' approach to incorporating non-ability traits into the prediction of success, over and above the variance accounted for by traditional ability and personality measures. In the evaluation of these assessments, existing tests, lab-based measures, and real-world tasks will be used for establishing the validity of this approach to improving the 'whole-person' assessment of individuals for predicting occupational success.



PERSONNEL TESTING AND PERFORMANCE

BASIC RESEARCH PROGRAM

Accomplishments

During FY21, we struggled to deal with the implications of the COVID-19 pandemic, which made it impossible to conduct in-laboratory studies until the end of the FY. However, we continued to make progress on creating, adapting, and evaluating several tests, including Following Directions, Math Approximations, Ted Talk summaries, Technology Knowledge (open-ended), Health Knowledge, Civics and Public Policy (open-ended), Practical Math (with access to Internet resources), Tool use knowledge and skills, and Technology Attitudes. Data collection proceeded entirely on-line, which precluded administration of several of the timed tests (e.g., Following Directions, Math Approximations). However, in the major study completed in FY21, with 188 participants, we were able to collect useful data on two new extensive tests -- one on Technology and Public Policy (TPP) and the other on Tool Use Problem Solving (TUPS). Both of these tests provide the subjects with open-ended problems and require construction of responses (as opposed to multiple-choice tests). The TPP test items state a controversial topic of a particular kind of technology, present two options, and ask the subject to choose one option and provide justification for his/her choice. There are no 'correct' or 'incorrect' choices -- rather the test items are scored based on the depth, breadth, and logic of the individual's justification. The TUPS test items present the subjects with a practical scenario problem, for which they need to identify what tools would be needed to solve the problem, and what procedure would be followed with those tools. Both of these tests showed substantial promise in being internally consistent (for TPP $\alpha = .89$, and for TUPS, $\alpha = .90$), and in capturing variance across individuals that is not accounted for by either a traditional measure of Science/Technology knowledge or a general ability composite (g). That is, a traditional multiple-choice Science/Technology Knowledge Test administered to this sample correlated $r = .80$ with a general ability composite, suggesting a high degree of overlap. In contrast, the TPP test correlated $r = .39$ with the general ability composite, and the TUPS test correlated $r = .38$ with the general ability composite. The tests also showed a high degree of discriminant validity with the Science/Technology Knowledge Test ($r = .35$ and $.27$ for TPP and TUPS, respectively), and moderate correlations with each other ($r = .50$ between TPP and TUPS composite scores). Moreover, while the traditional Science/Technology Knowledge Test showed significant gender differences $t = 2.85$, $p < .01$ favoring males, neither the TPP nor the TUPS indicated any significant gender differences in average performance.

Contributions to Basic Research

After 100 years of modern intelligence assessment, many researchers who study adult intelligence have adopted a subset of traditional assessments, originally designed for children and adolescents, and continued to use them without substantial modifications for adult intelligence assessment. The fundamental problem with this approach is an incomplete understanding of what constitutes adult intellect and an inability to generalize results to behaviors that are directly relevant to intellectual challenges in the day-to-day activities of adults. However, exploring these domains requires a fundamental shift away from the traditional foundations of ability assessment and a focus on the kinds of abilities, knowledge, and skills that today's young adults are likely to use to perform cognitively demanding tasks. That is, given that we are in an era when there is complex technology to operate, there is a variety of multimedia sources for reference to operate, maintain, and repair such equipment. Operators are more likely to consult on-line resources, such as narrated videos, for maintenance and repair tasks, yet there is nothing in existing adult ability assessments that examines an individual's attention and integration of information provided in this format to solve real-world problems. Thus, there is an incomplete assessment of what 'intelligence' means in the modern world. Moreover, the most central aspect of new learning for adults is transfer-of-knowledge and transfer-of-training. Focusing on general abilities -- which arguably are most important for learning 'novel' content -- especially for children, ignores the real-world nature of adult learning and cognitive development.

What is needed is a more comprehensive understanding of the intellectual tasks adults are likely to encounter, assessments that reflect these tasks, and validation of findings from various sources against the criteria of day-to-day intellectually demanding activities. Predicting individual differences in these behaviors can be expected to yield better understanding of the construct of adult intelligence as fundamentally different from child intelligence, more comprehensive understanding of the effects of aging on adult intellectual development, and satisfactory criteria for evaluating the effectiveness of interventions designed to improve adult intelligence. The current research program is expected to provide theoretical and empirical support for this approach.

The inclusion of the trait-complex approach assessment of non-ability measures provide an additional opportunity to merge the new selection approach with information about individuals that can supplement both the selection problem *and* provide useful profile information (with a small set of key trait complexes) that can be used for a better understanding of the nature of adult development.



PERSONNEL TESTING AND PERFORMANCE

BASIC RESEARCH PROGRAM

Potential Army/Military Applications

Existing measures of cognitive abilities that are used in Army selection (e.g., the ASVAB) provide a relatively robust estimation of general mental ability and some aspects of domain knowledge (Mechanical Knowledge, Electronics Information, Auto and Shop Information). Nonetheless, these assessments do not tap several key aspects of cognitive abilities and skills that could provide substantial incremental predictive validity for training success and field performance. Expanding the assessment of the predictor space to account for other abilities and skills that are also critical for success, while not sharing high levels of overlap with existing measures, may have important implications for criterion-related validity in the selection context.

In addition, by drawing on the overlap that has been found among numerous non-ability traits (see Ackerman & Heggstad, 1997), it may be possible to further elaborate the predictor space to include assessments of a small set of key constellations that represent 'facilitative' and 'impeding' characteristics for acquiring knowledge/skills and for later field performance.

The overall approach is one that takes 'whole-person assessment' as an overarching framework, along with the empirical foundation upon which these assessments are based, to provide a greater precision in the selection problem (and potentially the classification problem, which focuses on person-job fit) relevant to the U.S. Army. Providing the theoretical and empirical foundations for improving selection efficacy represents a potential to decreasing attrition and increasing overall force effectiveness.

Future Plans

In the remaining 4½ months of this project, our goal is to complete the final large-scale study using both in-laboratory and on-line capabilities. The in-laboratory testing will be limited, to reduce exposure of subjects and staff to COVID-19 (because the State of Georgia prohibits either vaccination requirements or mask requirements), and as such will involve administration of tests that can only practically be administered with direct supervision of subjects. The remaining tests/tasks/surveys will be completed by the subjects at home. The tests and other instruments to be administered include revisions and refinements that we have explored throughout this project, namely: a) complex perceptual speed, b) judgement and planning, c) practical problem solving, d) oral comprehension for meaningful material, e) use of electronic aids for solution of mathematical and spatial tasks (including for example, performance of procedural tasks after viewing multimedia demonstrations that have spatial and perceptual/motor demands), and f) domain knowledge. Together with the previous studies conducted during this project, we hope to be able to collect enough data to be able to provide robust indicators of reliability and validity of at least most of the new measures, along with self-report measures that assess non-ability traits (e.g., personality, interests, self-concept, and motivation).



PERSONNEL TESTING AND PERFORMANCE

BASIC RESEARCH PROGRAM

Validated Measurement of Internalized Prosocial Motivation

Project #: W911NF-20-1-0259

Contract Dates: JUL 2020 – JUL 2023

PI: Michael McCullough

Institution: University of California San Diego

Co-PIs/Subcontractors: Eric Pedersen, University of Colorado Boulder

Abstract

Effective teams need members who are ready and willing to help the team, and each other, during times of need. Science has thoroughly investigated how to motivate prosocial behavior by managing group members' material and social incentives. However, science's understanding of autonomous prosocial motivation (APM)—which is based on personal convictions and moral principles, and motivates helping even in the absence of external incentives—is rudimentary at best. This knowledge gap is unfortunate because autonomous motivation yields prosocial behavior that is highly reliable and highly responsive to others' needs. Our goal here is to advance scientific understanding of prosocial behavior through a program of research that will identify and enable standardized measurement of APM. This research will set the stage for applied work on measuring APM in personnel selection and performance for the military.

Introduction

Teams and other groups commonly motivate their members to behave in ways that benefit the team or its individual members with both carrots and sticks. These incentives have been studied extensively (e.g., Barclay, 2013; Fehr & Gächter, 2002; Rand et al., 2009), but humans' propensity for prosocial behavior wanes when such external inducements are missing. Indeed, much of the work required to cooperate or to stay coordinated must be carried out autonomously and anonymously, far beyond the reach of agents who could provide contingent rewards or punishments. In such cases, prosocial behavior must be autonomously motivated (i.e., by factors that are internal to the actor, rather than by recognition of social or material inducements). However, our current empirical understanding of APM and its relevance to team functioning is limited.

One key reason why APM remains dimly understood is the lack of validated tools for measuring individual differences in APM. In a modern understanding of validity (Borsboom et al., 2004), developing and validating such tools requires the experimental development of behavioral tasks that are distinctly effective at eliciting prosocial behavior even after the plausible external motivators for prosocial behavior have been experimentally removed. After such tasks have been developed, they can be used as measures of APM in their own right and can also be used as targets for the validation and metric calibration of more convenient methods for measuring autonomously motivated prosocial behavior (e.g., self-reports, observer reports, structured interviews). Scientific progress on APM therefore awaits experimentally calibrated behavioral measures of APM. Through this project, our goal is to advance scientific understanding of prosocial behavior by conducting research that will identify and enable standardized measurement of individual differences in APM.

In the Base Period, our two objectives are to: 1) Experimentally develop behavioral assays of APM; and 2) Identify key traits (measured via self-report) that predict behavioral measures of APM. Pending encouraging results from the Base Period, we would pursue Objectives 3, 4, and 5 in two successive Option Periods, which are to: 3) Assess whether the behavioral and self-report measures of APM developed in the Base Period are valid for non-student adults; 4) Assess whether the behavioral and self-report measures of APM developed in the Base Period are valid predictors of prosocial behavior in daily life; and 5) Evaluate whether APM predicts effective coordination and efficiency in work teams.

Research Approach

This project's Base Period includes six experiments to be conducted in the laboratory and online. In all six experiments, subjects experience social situations in which they can help another individual (or individuals). In at least one condition in each experiment, we experimentally and/or statistically remove variation in prosocial behavior that could be caused by externalized prosocial motivation (e.g., a desire to help in order to obtain social or material benefits). By inference, the prosocial behavior we observe in these "de-externalized" conditions is plausibly attributable to APM. This approach enables us to address Objective 1 (Experimentally develop behavioral assays of APM). Subjects will also complete a large set of questionnaires to assess individual differences that theory implicates are related to specific forms of prosocial motivation. When combined with data on subjects' prosocial behavior in the experiments, these individual-difference data enable us to address Objective 2 (Identify key traits that predict behavioral measures of APM).



PERSONNEL TESTING AND PERFORMANCE

BASIC RESEARCH PROGRAM

Accomplishments

So far, we have completed data collection and analysis for two experiments. In the first study, we replicated the reinforcement learning model used by Lockwood et al. (2016) to estimate the rates at which people learned to help others in a two-armed bandit task— an experimental task that measures how well a person learns the differential value associated with a pair of symbols (Figure 1). We extended the scope of Lockwood et al. (2016) by manipulating four different targets for which subjects learned to earn rewards (Figure 1) and by expanding the investigation of self-report traits that might be associated with learning on behalf of others through the 489-item battery of questionnaires we compiled to measure beliefs, values, and traits that are empirically associated with prosociality. This battery is administered at the end of every study that is part of this project.

We collected data from a sample of $N = 215$ undergraduate students, each of whom completed 192 trials of the bandit task. Figure 2 shows the rewards that subjects earned for each target. We found that subjects who were faster at learning to help the identifiable needy target (but not the other three targets) endorsed higher scores on a self-report measure of empathic concern, replicating the basic finding from Lockwood et al. (2016). We also found novel evidence that subjects who were more adept at learning to earn rewards on behalf of a charitable organization endorsed more religious belief.

The second study used the Who Said What paradigm (Pietraszewski et al., 2014; Taylor et al., 1978)— which reveals the extent to which observers of a social interaction have implicitly categorized the individuals involved— to test whether people track displays of need and concern. Subjects were presented with photos of individuals along with statements that fit into one of the following categories: a bland aphorism; concern for another person in need; concern for one's self in need; concern for one's self in COVID-19 related need. Subjects were then asked to recall which individual said which statement and to complete the battery of questionnaires. In a follow-up study, we focused on the personal need category by including only COVID-19 need topics. We also included an additional manipulation of empathic concern by asking subjects either to remain objective or to take the perspective of the person saying the statements.

We found that subjects do categorize by statements of need and concern for others in need and that the effect of categorizing by need statements is moderated by perspective-taking (i.e., categorization is suppressed when asked to remain objective). However, the effect of categorizing by concern for others is not moderated by perspective-taking, which suggests that a different motivation and mechanism is in use for this kind of categorization.

Contributions to Basic Research

This project will yield new scientific information about a) the existence of APM; b) the individual differences that underlie APM; and c) the extent to which these insights generalize to subjects in different cities (around the country), different stages in life (e.g., college vs. non-college adulthood), and diverse settings (e.g., laboratory, online, and real life).

The research conducted under the umbrella of this project is use-inspired basic research (Stokes, 1997). We seek to develop lab-based behavioral measures of APM and then identify the traits that undergird individual differences in those lab-based behavioral measures. This work is relevant to BAA Topic Area 1 (Personnel Testing and Performance): We aim to improve the scientific theory and practical measurement of APM to predict the behavior and propensity for success in individuals. The tools that result from our work may be useful in the future for team design and personnel assessment and selection, particularly for work contexts that require a high level of coordination (e.g., in mass administration contexts).

This research is also relevant to Topic Area 3 (Organizational Effectiveness). By clarifying the motivations underlying prosocial behavior, which is at the heart of the cooperation and coordination that effective teams require, our research seeks to understand and explain theory that connects individual differences to team coordination and performance.

Potential Army/Military Applications

The U.S. Army's global operating environment is becoming more complex, more contested, and more lethal. As General David G. Perkins (TRADOC) noted some time ago, our adversaries have developed new capabilities in the land, air, maritime, space, and cyber domains that enable them to deny our battlefield access, disrupt our efforts to coordinate, and restrict our tactical degrees of freedom (McCormick & Hunter, 2018). To address these new challenges, the Army and other service



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Figure 1

Task Schematic for the Experiment Described Here

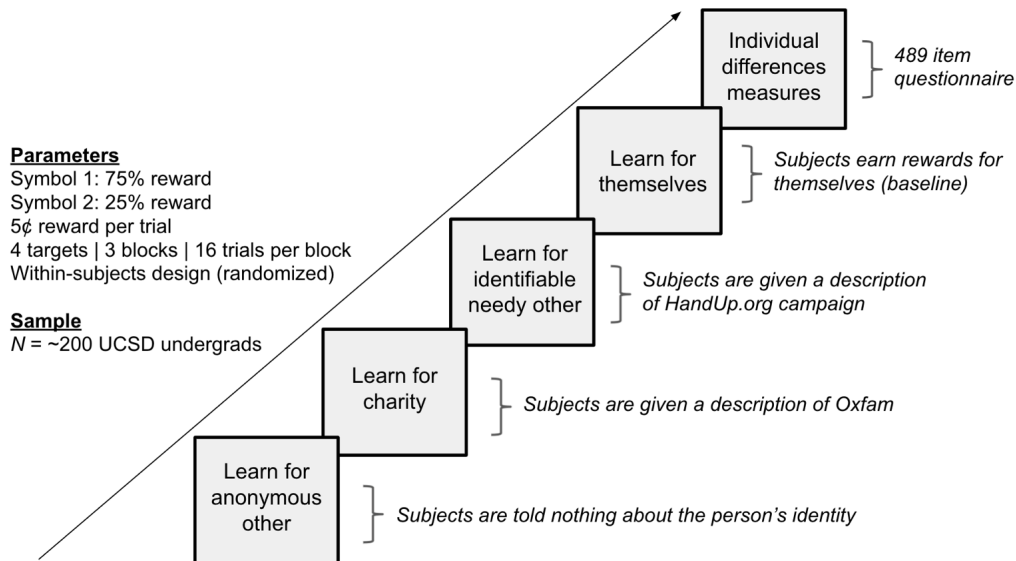
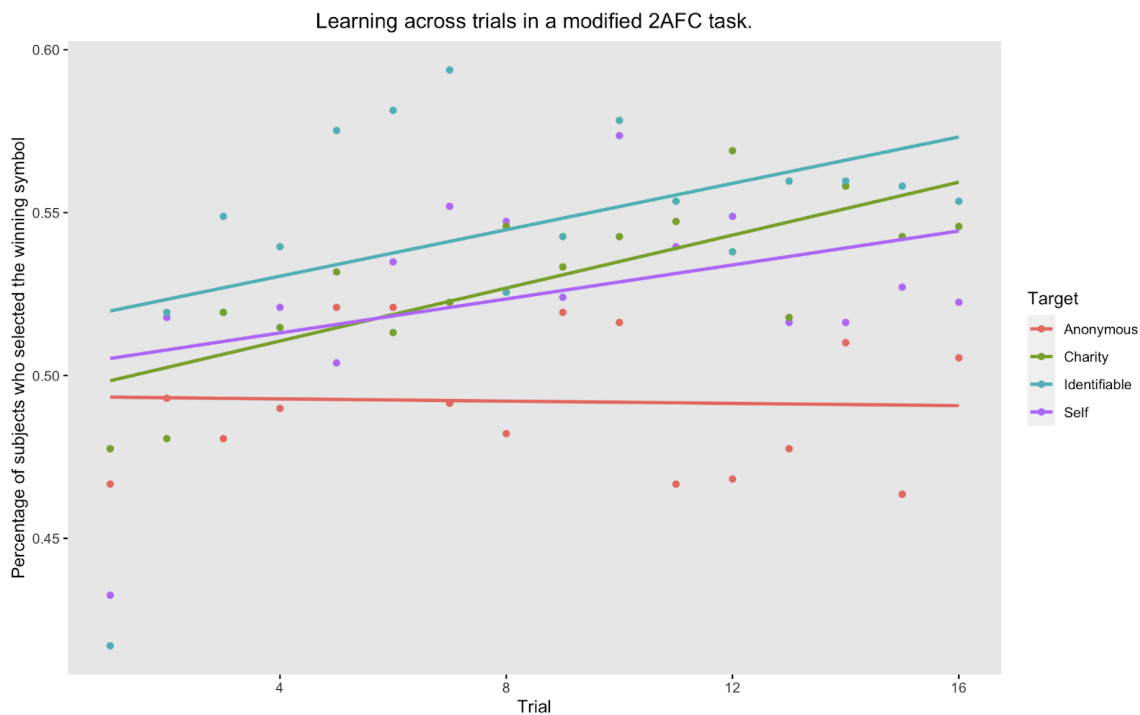


Figure 2

Subjects' Aggregated Reward-Learning Earned Across Trials, Collapsed within Blocks





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branches have been thinking about strategy in light of the concept of The Multi-Domain Operations (or MDO). MDO depicts our adversarial relationships as repeating cycles of non-lethal Competition (designed to prevent lethal aggression through deterrence and degradation of the enemy's capabilities for aggression) and Armed Conflict (highly coordinated operations that create temporary windows of opportunity for armed engagements that can be executed in days, not months).

Multi-Domain Battle (MDB) success will require new investments in physical capital, and in human capital as well. Maintaining our human capital superiority will require selecting personnel and designing teams with new knowledge, skills, and abilities (KSAs) in mind. A critical feature of MDB is convergence: "the integration of capabilities across domains, environments, and functions in time and physical space to achieve a purpose" (TRADOC, 2017, p. 25). The need for convergence will place new demands on U.S. personnel for efficient cooperation and coordination across multiple time scales and battle domains. "At some point," after all, "the abstract elements (cognitive, virtual, informational, and human) [of MDB] demonstrate their effects physically at a place or in an area through a system of people" (TRADOC, 2017, p. 8). Meta-analytic work has already clearly revealed the importance of traits such as trust (Dirks & Ferrin, 2002) and agreeableness (Prewett et al., 2009) for coordinated team performance, but in recent years, researchers have begun to discuss a related but distinct prosocial trait as a potentially powerful KSA for team effectiveness (Bolino & Grant, 2016), which we propose to study here: autonomous prosocial motivation.

Future Plans

Our research plan for the upcoming year is to complete data collection for the remaining experiments included in this project. We have completed the design phase for the set of within-subjects tradeoff studies and are in the process of programming them. This set of studies will be conducted online and will require piloting to determine the most effective and efficient means of collecting data (e.g., number of trials, cost per trial, combination of conditions). We plan to use MTurk to start collecting data for these studies by the new year.

We will run a large-scale replication of the Who Said What studies on MTurk with some methodological and analytical improvements, as well as a follow-up to the reinforcement learning study. Data collection for the directed attention study is underway with the University of California San Diego (UCSD) undergraduate student subject pool and we will soon begin planning for a replication study using a different attention tracking mechanism. We are excited to begin collecting data in the laboratory at UCSD for the remaining experiments that we initially designed as in-person, but had to postpone, due to COVID-19.

While collecting data, we will also continue analyzing data and this year will begin more rigorous analysis of participant responses to the battery of questionnaires administered at the end of each study. And lastly, we plan to travel to academic conferences to present this research.



LEADER DEVELOPMENT

BASIC RESEARCH PROGRAM

Leader Development Overview

Army Need

The Army has a constant need for the highest quality leaders, necessitating an understanding of how to identify, develop, and retain those leaders. The Army faces multiple unknown challenges in the upcoming years; increased leader capabilities are required in order to be adaptive across the full range of operations (e.g., combat, stabilization missions, hybrid operations) and contexts (e.g., deployment, in garrison). Leaders at all levels in the Army must possess the critical strategic thinking, command, sense-making, perceptual, and interpersonal skills to effectively influence a variety of stakeholders both inside and outside the organization (e.g., up and down the chain of command, interagency partners, local populations). Leader development also entails developing young Soldiers, which requires an understanding of how leaders can develop, mentor, and motivate their Soldiers in both the operational environment when deployed and at home station. Overcoming such challenges requires a systematic reevaluation of how the Army's leadership development process can optimize leader growth over time.

The three research goals in the leader development portfolio are to a) advance theoretical understanding of leader development, b) advance knowledge of leadership processes within the operational environment and at home station, and c) develop leadership assessments that support the training of requisite cognitive, perceptual, and interpersonal skills for effective leadership across all levels of command. The key research objectives are explained below.

Key Research Objectives

Leader Development

ARI's Basic Research Program seeks to develop and refine theory and methods for training the skills and behaviors necessary for leaders to effectively mentor and develop subordinates. The program also focuses on developing and refining theory and methods to increase leader flexibility and adaptability (e.g., quickly learning from positive and negative on-the-job experiences). The Basic Research Program aims to develop theory to understand the training and retention of quality leaders, including construct definition of high potential talent development programs and identification of the individual-, unit-, and organization-level consequences of these development programs. A key goal is to understand shocks and their impact on leader development, gain and loss cycles in leader development, and sense-making, including how each impacts the development of leader identity.

Leadership Processes

The Basic Research Program intends to develop and refine theory and methods for identifying the requisite knowledge, skills, and abilities (e.g., critical strategic thinking, command, sense-making, perceptual, and interpersonal skills) for effective leadership and how those characteristics impact leader influence from a multi-level perspective. ARI's Basic Research Program strives to develop theory for understanding how leaders make effective, ethical decisions during both positive and negative emotionally-laden situations, as well as how they build a positive, ethical organizational climate to guide behavior of their subordinates. Developing and refining theory and methods related to leader dyads and leadership contextualized by networks and systems is also a primary objective.

Leadership Assessment

ARI's Basic Research Program strives to develop techniques to objectively measure effective and ineffective, verbal and nonverbal leader behaviors. The program also seeks to develop and refine theory and methods related to leaders' own seeking and integration of feedback for the purpose of self-development.



LEADER DEVELOPMENT

BASIC RESEARCH PROGRAM

Leader Development Currently Funded Research

ARI's Basic Research Program is currently funding four extramural research projects. Brief descriptions of the projects are provided below, with detailed research summaries of each project provided on the subsequent pages.

Advancing Leadership Research

(W911NF-18-2-0049; 2018-2024)

Dr. Robert Lord (Durham University) and colleagues use field and experimental designs capitalizing on quantitative and qualitative research to correct measurement issues to advance leader development.

Episodic and Semantic Memory Effects on Leadership Measurement and Prediction of Leadership Outcomes

(W911NF-18-1-0049; 2018-2022)

Dr. Roseanne Foti (Virginia Tech) is exploring how the type of memory subordinates use when rating leader behavior and the linguistic qualities of items used in leadership scales can improve ratings of leader behavior to improve the assessment of leadership behavior.

Leadership as Event Management: Toward a Contextualized and Dynamic Theory of Leadership

(W911NF-20-1-0205; 2020-2023)

Dr. Frederick Morgeson (Michigan State University) aims to develop a theory of leadership (Leadership as Event Management) wherein leadership is defined as a collective process deployed to manage dynamic events within the organizational context.

Switching Gears: Training Team Leaders and Members to Adapt Leadership Behaviors in Dynamic Conditions

(W911NF-16-1-0545; 2016-2023)

Dr. Gerardus Uitdewilligen (Maastricht University) and colleagues are examining the underlying processes in adaptive leadership to understand how team leaders effectively transition between different leadership styles.



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Advancing Leadership Research

Project #: W911NF-18-2-0049

Contract Dates: FEB 2018 – FEB 2024

PI: Robert G. Lord

Institution: Durham University

Co-PIs/Subcontractors: Susanne Braun, Durham University; Olga Epitropaki, Durham University

Abstract

This four-year Cooperative Agreement (CA) supports eleven separate multinational research projects. Four projects focus on improving leadership measurement. The other seven projects focus on identity development. All four Year 1 projects have been completed and have spent their funds. Most Year 2 and Year 3 projects are currently collecting data. Most projects were delayed due to the COVID-19 pandemic, but they have been extended. These extensions provided time for these projects to be completed. The CA also supports annual meetings of this research group. This year, our meeting was on-line, which avoided travel. It also freed up funds which can be used to support the shift to online research for many projects.

Introduction

This four-year CA integrates the efforts of top researchers from all over the world to advance theories and measurement related to the study of leadership. One major focus is on understanding the effects of rater cognitive processes on leadership measurement. We also emphasize the effects of leadership identity on leadership motivation and development.

Year 1 Projects

Measurement. Ratings of leadership style depend on both the behavior of a leader and the rater's cognitive processes. However, the relative contribution of each of these sources to the ratings is unclear. With this issue in mind, the CA focuses on understanding *rater* information processes as a fundamental aspect of measurement.

One of the Year 1 research projects focused on semantic compared to episodic memory when reporting on one's identity. Semantic memory is general knowledge that is independent of context. Episodic memory is memory for context-specific events. A general finding was that items that specify a context for ratings and start with a reference to the rater elicit episodic memory. Data from 5 different studies were used to develop measures of identity which emphasized episodic memory, and the structure of measures was found to generalize across all these samples. This measure has six factors: two each at individual, relational, and collective identity levels.

The second Year 1 measurement project addressed bias in measuring leadership. It used a forced-choice procedure to minimize raters' withholding of relevant but unfavorable information. It also developed a Likert scale measure of toxic leadership. Data collection has been completed, and data are being analyzed. Results indicated that the Likert format measure of toxic leadership showed high validity, even when liking for the leader was controlled statistically. Current activities focus on preparing manuscripts for publication and developing a computer simulation of the rating process. This project also developed a website for scoring measures: (<https://hanges.drasgowassessments.com/>)

Identity. In general, people's identity affects how they set goals and the leadership skills they acquire. Yet, many people do not recognize their own leadership potential. The third and fourth Year 1 projects addressed this concern. One project examined self-perception as a leader. They did this by using writing exercises to influence students' self-perceptions. This project has now been completed and publications are being prepared.

The other Year 1 project examined early career stages when leadership identities are likely to develop. Four different waves of data collection have now been completed. These data are now being analyzed. This study also examined how leadership identities relate to young adults' motivation to pursue leadership activities. An additional sample was collected to determine whether ILT profiles replicated in a separate sample. There was substantial overlap between the two sets of profiles.



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Year 2 Projects

Measurement. One project developed implicit measures of the accessibility of student's implicit leadership theories. Word fragment completion techniques were used as the primary methodology. Results based on 1000 participants support the factor structure of the implicit measurement which corresponds to previous research on self-report ILT. Additional data will be collected to further improve the measurement.

Identity. Three Year 2 projects addressed identity. One project examined the effects of internal and external constraints on identity dynamics. The first experiment in this project found that internal constraints were influenced by asking participants to think about themselves in the near or distant future. Data collection for the second study is ongoing. Future experiments in this project will look at the effects of feedback on perceptions of internal constraints and external constraints.

The second Year 2 project examines the role of personal and shared goals in developing the leader identity of individuals recently promoted to a leadership role. Because approximately 30 leaders are promoted every 3 months, the data collection has started gradually. As of today, only samples 1 and 2 have gone through all four waves. Total responses have been obtained from 221 managers. The co-PIs presented a theoretical paper at 2020 Academy of Management Annual Meeting.

The final Year 2 project examines changes in identity associated with retirement. Due to the COVID-19 pandemic, it was not possible to carry out interviews with retired leaders. Consequently, the investigators have reconfigured their methodology to use survey procedures to examine the effects of fear of losing power and its relationship to retirement.

Year 3 Projects

Measurement. One project uses both archival and experimental data to examine the effects of the 360-degree feedback process. This research looks at the type of memory elicited by questionnaire items. It posits that relying on episodic memory will increase rater agreement. Current activities focus on collecting and analyzing data for Study 1. Planning for collecting archival data for Study 2 in collaboration with Jean Leslie from Center for Creative Leadership is ongoing.

Identity. One project examines the complexity of identity. It posits that complexity stems from variety in career experience. Identity complexity is also expected to increase flexibility in leadership behavior. Three pilot studies among British (N = 239), American (N = 241), and Chinese (N = 239) participants were conducted to generate a leadership role list and a leader trait list to measure leader self-complexity. Current activities focus on collecting extra data to validate the measure of leadership complexity. We are also collecting longitudinal data to investigate the proposed theoretical model.

The final Year 3 project addresses conflict between professional identities and work roles. It is a multi-wave study. Data collection for a large-scale longitudinal study is ongoing from multiple hospitals in Turin, Italy. Face-to-face data collection was limited by the COVID-19 pandemic. However, researchers were able to collect data from approximately 65% of the expected sample.

Research Approach

Our research approach has a core theoretical framework in terms of cognitive and identity-related processes. This conceptual core helps to integrate activities across multiple research teams. We deliberately use multiple methods. Further, we are building a set of measurement tools and interventions that can be used by our CA members. These results will be communicated to the academic community and ARI for broader application.

Accomplishments

We are 44 months into this CA. All of our studies are collecting data or have finished data collection. We have addressed many administrative details associated with the grant. In addition, we have changed many research and coordination processes due to the COVID-19 pandemic. We have instituted monthly Zoom meetings and used the Zoom format to conduct our annual meeting and have developed two separate research groups that meet monthly via Zoom. We are also developing a web site to enhance coordination.

Through the CA activities we have developed a better understanding of problems and techniques for advancing leadership research and practice. These developments are reflected in a recently published book, *What's Wrong with Leadership? Improving*



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Research and Practice (Riggio, 2019). Also, a review of ILT research and findings by CA members appeared in the 2020 *Annual Review of Organizational Psychology and Organizational Behavior*. Two journal articles reflecting ARI-supported activities were published. Several chapters are also being prepared for the Oxford Handbook of Leadership, Followership, and Identity. Additional manuscripts are being developed for publication.

Contributions to Basic Research

Our contribution so far has been to develop ways to advance leadership research. We have managed a network of leadership scholars for 7 years now. In the last four years, ARI's financial support has sustained these activities. This multi-team approach to research is a big undertaking; it moves slowly. However, there is substantial conceptual progress as shown by publications and works in progress. We are now translating conceptual ideas into empirical research and publications.

Potential Army/Military Applications

The primary applications are in managing leader identity development in the military or in civilian organizations, including university settings. Both theory and intervention techniques are promising based on initial findings. To illustrate, one Year 1 study developed techniques to accelerate the development of leadership identities. We also can provide new measures of implicit leadership theories based on word fragment completion. Such measures gauge the accessibility of mental constructs like leader categories, which should increase with leadership development. Further, one measurement project is now developing software to assist in writing leadership items that elicit reliance on episodic or semantic memory. In addition, we will provide measures of identity level which promote the use of episodic memory which is the memory for actual events.

Future Plans

Finishing data collection and analysis are our major short-run goals. Publication and application are longer range objectives. Several publications have resulted from ARI's support of this research and others are being developed. Most notable is a book with chapters to be written by project teams. The objective is to communicate the practical lessons learned. It is also hoped that actual exercises for developing leadership skills in readers will be developed.

Associated Publications

- Acton, B. P., Foti, R. J., Keller Hansbrough, T., Lord, R. G., Kim, E., Elfeki, Y. (2021, April). *More than liking: The role of memory systems and language in leadership ratings* [Poster]. 36th Annual Society for Industrial and Organizational Psychology Conference, Virtual.
- Acton, B. P., Hansbrough, T. K., Foti, R. J., Lord, R. G. (August, 2021). *An application and tutorial for creating within-person memory-sourced leadership scales* [Symposium]. 81st Annual Meeting of the Academy of Management, Virtual.
- Adriasola, E. & Lord, R. G. (2020). From a leader and a follower to shared leadership: A review of identity as antecedent of shared leadership. In Z. Jaser (Ed.), *The connecting leader: Serving concurrently as leader and a follower*. Charlotte, NC: Information Age.
- Braun, S., Zheng, X., & Lord, R. G. (2019, May). *Who will I be if I'm betwixt and between? A review and extension of the literature on identity dynamics* [Symposium]. Annual Conference of the European Association of Work and Organizational Psychology (EAWOP), Turin, Italy.
- Braun, S., Zheng, X., & Lord, R. G. (2021). *Who will I be if I'm betwixt and between? A review and extension of the literature on identity dynamics* [Manuscript in preparation for submission to *Organization Theory*].
- Epitropaki, O., Hall, R. J. & Gatti, P. (2019, May). *The impact of early career experiences on leadership/followership identity and motivation to lead* [Symposium]. Annual Conference of the European Association of Work and Organizational Psychology (EAWOP), Turin, Italy.
- Hall, R. J., Lord, R. G., Morgan, R., Zheng, X., Gatti, P. & Graham, L. (2021). *Refinement and construct validation of the Levels of Self-Concept Scale – Revised (LSCS-R)* [Manuscript in preparation for submission to *Journal of Applied Psychology*].
- Hanges, P. J. (2019). *Consequences of abusive and toxic leadership*. Strengthening U.S. Air Force Human Capital Management board on human-systems integration for the National Academies of Sciences, Engineering, and Medicine.



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- Hanges, P. J., Grand, J. A., Epistola, J. J., Stark, S. (August, 2021). *A new multidimensional destructive leadership scale: Ideal point IRT scoring of a forced-choice measure* [Symposium]. 81st Annual Meeting of the Academy of Management, Virtual.
- Jokisaari, M., & Adriasola, E. (2020). *Exploring new approaches to leader identity development* [Symposium]. 80th Annual Meeting of the Academy of Management, Virtual.
- Keller Hansbrough, T., Lord, R. G., Schyns, B., Foti, R.J., Liden, R. & Acton, B. (2021). Do you remember? Rater memory systems and leadership measurement. *Leadership Quarterly*, 32(2), 101455.
<https://doi.org/10.1016/j.leaqua.2020.101455>
- Keng-Highberger, F., Avolio, B., Lord, R. G., Hannah, S., Schaubroeck, J., & Kozlowski, S. (2020). How leaders and follower prototypical and antitypical attributes influence ratings of transformational leadership in an extreme context. *Human Relations*. <https://doi.org/10.1177/0018726720958040>
- Lord, R. G., Hall, R. J., Gatti, P. M., Zheng, X. (J.), Morgan, R. (August, 2021). *Item characteristics and personal semantics as predictors of episodic memory and factor loadings in the Levels of Self-Concept Scale – Revised* [Symposium]. 81st Annual Meeting of the Academy of Management, Virtual.
- Lord, R. G., Hall, R. J., Gatti, P., Morgan, R., & Zheng, X. (2021). *Measuring leadership identity: Complexity, risks, and recommendations* [Chapter in preparation]. In O. Epitropaki & R. Kark (Eds.), *Leadership, followership and identity* (Oxford Handbook).
- Lord, R. G., Epitropaki, O. Foti, R. J., & Hansbrough, T. K. (2020). Implicit leadership and followership theories and dynamic processing of leadership information. *Annual Review of Organizational Behavior and Organizational Psychology*, 7, 49-74.
<https://doi.org/10.1146/annurev-orgpsych-012119-045434>
- Nieberle, K. W., Acton, B. P., & Braun, S. (2021, August). *Identity dynamics in the wild: Applications of the leader-follower identity grid* [Symposium]. 81st Annual Meeting of the Academy of Management, Virtual.
- Nieberle, K. W., Acton, B. P., Braun, S., & Lord, R. G. (2021, June). *Modeling leadership identities in context: A dynamical systems approach* [Symposium]. Journal of Applied Psychology Paper Development Workshop, Virtual.
- Morgan, R., Zheng, J., Hall, R. J., & Lord, R. G. (2019, August). *Do I know or do I remember? The role of memory processes in enhancing the accuracy of leadership measurement* [Symposium]. 79th Annual Meeting of the Academy of Management, Boston, MA, USA.
- Rivin, J., Van Wagoner, H. P., & Johnson, S. K. (August, 2020). *Implicit measures of implicit leadership theories* [Panel]. 80th Annual Meeting of the Academy of Management, Virtual.
- Van Wagoner H. P., Johnson, S. K., Keplinger, K., & Murphy, S. E. (August, 2020). *Looking forward and looking back: An intervention for the development of leader identity* [Panel]. 80th Annual Meeting of Academy of Management, Virtual.
- Van Wagoner, H. P., Rivin, J., & Johnson, S. K. (May, 2020). *Implicit measures of implicit leadership: Development and validation* [Panel]. Accepted at the Annual Interdisciplinary Leadership Symposium (IPLS), Corfu, Greece. (Conference canceled due to COVID-19).



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BASIC RESEARCH PROGRAM

Episodic and Semantic Memory Effects on Leadership Measurement and Prediction of Leadership Outcomes

Project #: W911NF-18-1-0049

Contract Dates: FEB 2018 – SEP 2022

PI: Roseanne J. Foti

Institution: Virginia Tech

Co-PIs/Subcontractors: Tiffany K. Hansbrough, Fairleigh Dickinson University; Robert G. Lord, Durham University

Abstract

The leadership field relies on ratings of leader behavior both to test leadership theories and to develop leaders. Using subordinates to rate the behavior of leaders may bias leadership evaluations. Our program of research deals with this problem. We explore two factors to improve ratings of leader behavior. The first factor is the type of memory subordinates use when rating leader behavior. The second factor is the linguistic qualities of the items used in leadership scales. Once we understand how these two factors combine, we can develop ways to improve the measurement of leadership. Ultimately, this research program will aid the U.S. Army's leadership development mission by improving the assessment of leadership behavior.

Introduction

The goal of leadership measurement is to rate *leader* behaviors. However, data support the idea that leadership ratings measure qualities of the subordinates making the ratings in addition to the actual behavior of leaders. This calls into question the value of subordinate evaluations of leaders. Most leadership scales ask subordinates whether their leader completed a series of behaviors. To do so, subordinates must combine many instances of leader behavior across time and events (Shondrick et al., 2010). Thus, subordinates must rely on memory to answer the questions. The type of memory subordinates rely on is *semantic memory*. Semantic memory is general knowledge of people. It is the automatic mode of processing information due to its general relevance and ease of use. Unfortunately, reliance on semantic memory may create false memories. That means, subordinates agree with behaviors that seem familiar and are consistent with a general impression of their leader, even though these behaviors did not actually happen.

A different type of memory, *episodic memory*, is key to improving ratings of leader behavior. Episodic memory is memory for personal experiences and specific events. Episodic memory consists of rich, vivid details of prior events. Using episodic memory to rate leader behaviors has two benefits. First, it is more likely to activate memories of behaviors that *actually happened* (Foti & Lord, 1987). Second, ratings based on episodic memory may also better predict future events important to leadership, like trust in leaders.

The overall goal of our research program is to create leadership items that cue episodic memory. To do so, we evaluate the memory basis for each item in commonly used leadership scales. We manipulate factors that should cue episodic memory. We also examine the linguistic qualities of leader behavior items. We will use this information to develop better leadership scales and to improve the results drawn from leadership research.

Research Approach

The research approach uses both survey methods and experimental designs. Our samples included working adults and ROTC students. We used survey methods to measure the memory basis for each item for five leadership questionnaires. This research approach allowed us to collect data from a broad sample of working adults. Experimental methods were used to manipulate instruction type and linguistic qualities of the leadership items.

Accomplishments

Our results across three studies shows increased episodic processing influences leadership item responses in multiple ways. Consistent findings across three studies found that leader liking had weaker influence on leadership judgments based on episodic memory. The first study used a large dataset of working adults (N = 1401). We found that when subordinates relied on semantic memory to make leadership judgments, there was a stronger relationship with leader liking. In contrast, when subordinates relied on episodic memory to make leadership judgments, the relationship with liking was significantly lower. The second study used a pseudo-experiment with military cadets (N = 243). We found that instructions designed to increase reliance on episodic memory reduced the impact of liking on the endorsement of leadership ratings. The third study design

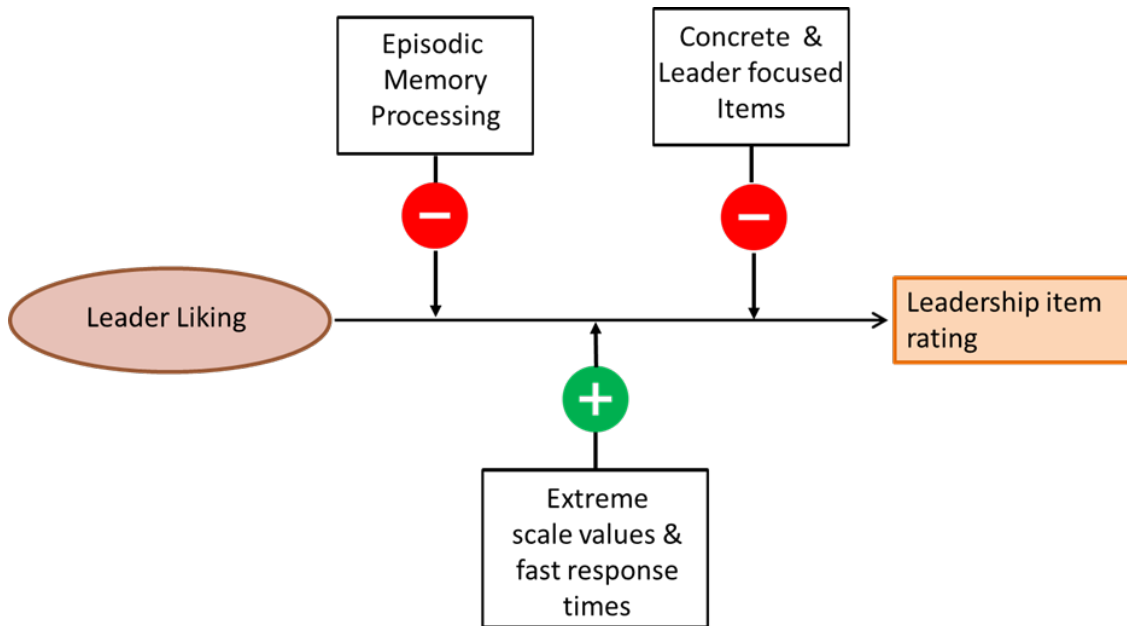


LEADER DEVELOPMENT

BASIC RESEARCH PROGRAM

Figure 1

The Influence of Memory Type, Item Linguistic Characteristics, and Response Patterns on the Relationship Between Leader Liking and Leadership Ratings



was experimental ($N = 311$), in which we manipulated the linguistic qualities of leadership items. We found concrete items and items focused on the leader had a weaker relationship with leader liking. These results appear in Figure 1.

Current measurement assumes that scale intervals are equal and reflect the same underlying construct (John & Benet-Martínez, 2000). Our results on type of memory and response patterns directly challenge this assumption. We separated subordinates based on their responses to leadership items rated on a 5-point Likert scale. One group used the middle scale values ($2 < x < 4$) and the second group used the extreme scale values ($x < 2$ or $x > 4$). Those who used the outside scale values based their leadership judgments on semantic memory. Thus, scale intervals did not relate equally to the underlying construct. This is because the type of memory that forms the basis for responding is not the same across scale values.

If people who tend to use different parts of the scale are using different types of memory, this suggests different reaction times. Cognitive models of confidence in judgments show that individuals who find a memory quickly will have greater confidence in their judgments. These ideas have important implications for leadership questionnaires that typically rely on a Likert scale (Strongly Disagree—Strongly Agree). Subordinates who relied on semantic processing had quicker response times and were more likely to use the extreme ends of the scale.

Contributions to Basic Research

This research examines an issue of long-standing concern to psychologists. The issue is how to reduce the impact of general impressions and liking on leadership measurement. A large body of basic and applied research suggests that behavioral ratings are not simply a function of the direct recall of actual behavior. Beyond actual behavior, research shows that liking is a significant source of variance in leadership judgments.

Our results to date offer three contributions to basic research. First, working adults are capable of identifying the memory basis for their leadership ratings. Second, leadership items that cue episodic memory can reduce the impact of liking on ratings. Third, the linguistic characteristic of items can reduce the impact of liking on ratings. Existing leadership scales use



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words that trigger both episodic and semantic memory. By understanding how subordinate response patterns, item linguistic characteristics, and questionnaire instructions work together, we can improve leadership measurement.

Our results to date offer several potential ways to trigger episodic memory. First, we can rewrite leadership items to be concrete and not reference the self. Items with these qualities should prompt episodic memory processing. Second, we can ask subordinates to rate items only if they have had the opportunity to observe the leader behaviors in question. Focusing subordinates on specific behaviors and events should increase the likelihood of episodic memory. Finally, we can train subordinates to distinguish the type of memory when rating leadership items.

Potential Army/Military Applications

It is essential in the 21st century environment that the Army continue to develop leaders. The Army designed its 360-degree assessment tool to enhance self-awareness and to identify Army leaders' strengths and weaknesses (McAninch, 2016). Our research has applications to improving 360-degree assessments and feedback tools used by the Army.

Leadership is a matter of both observable actions and perceptions by subordinates, peers, and superiors who interpret those actions. The primary way we measure leadership uses ratings by others. Thus, we cannot separate an understanding of leadership measurement from what we know about the factors that influence subordinate ratings. Assessment is critical for leadership development. It can increase the leader's engagement and motivation to develop and pinpoint the right areas for development. Expanding our view of what measurement means to include rater memory processes is relevant to the Army's 360-degree assessment tool in at least four ways.

First, designing leadership scales to cue specific behaviors and events should result in memories for behaviors that actually happened. It should increase acceptance of the feedback and motivation to act on the feedback. Second, improving the memory of actual behaviors should increase the level of agreement in leader ratings by subordinate, peer, and superior groups. Third, remembering specific behaviors and events could increase the agreement between self and other ratings, making the feedback easier to use. Finally, by including only items that cue episodic memory, we can shorten 360-degree assessments, making them less time consuming to complete.

Future Plans

Our final experiment will provide two critical pieces of information. First, test the incremental value of creating leadership scales with particular linguistic qualities. Second, examine whether the use of episodic memory processes results in more accurate leadership ratings. By that we mean, do subordinates remember leadership behaviors that actually happened?

Our final experiment will manipulate instructions designed to cue episodic memory processing and linguistic qualities of leadership items. We expect items that are more concrete and contain more emotion words will cue episodic memory. We will investigate effects of memory systems on the *accuracy* of leadership ratings. We will create two different leadership scales. One scale will consist of all concrete and leader-referent items. The second scale will consist of all abstract and self-referent items. We predict that matching the episodic memory strategy with concrete items will improve memory for leader behaviors. In contrast, matching the semantic memory strategy with abstract items will lead to lower behavioral accuracy due to increased false memories.

When asked to rate a leader, it is likely that subordinates who can access specific, vivid information about their leader can reconstruct actual events from memory. Because many outcomes of leadership pertain to specific events, accurate event retrieval should enhance both measures of leadership and measures of outcomes. The result should be accurate ratings of leader behavior and more ability to predict outcomes, such as trust in leader.

Associated Publications

Hansbrough, T., Lord, R. G., Schyns, B., Foti, R. J., Liden, R., & Acton, B. P. (2020). Do you remember? Rater memory systems and leadership measurement. *Leadership Quarterly*. <https://doi.org/10.1016/j.leaqua.2020.101455>

Foti, R. J., Acton, B. P., Hansbrough, T., Lord, R. G., Kim, E., & Elfeki, Y. (2020, April). *More than liking: The role of memory systems and language in leadership ratings* [Symposium]. 35th Annual Meeting of the Society for Industrial and Organizational Psychology, Virtual.



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- Acton, B. P., Foti, R. J., Hansbrough T. K., & Lord, R. G. (2021, August). An application and tutorial for creating within-person memory-sourced leadership scales. In T.K. Hansbrough (Chair), *Leadership measurement: Bridging the gap between theory and practice* [Symposium]. 81th Annual Meeting of the Academy of Management, Virtual.
- Hansbrough, T., Acton, B. P., Hanges, P., & Lord, R. G. (2021). *Rethinking leadership measurement: Incorporating memory into measurement theory to challenge assumptions and provide a way forward* [Manuscript under review for *The Leadership Quarterly 2023 Yearly Review*].
- Acton, B. P. & Koenig, N. (2022). *Automating is the future: Improving research scalability with predictive modeling* [Symposium under review]. Annual meeting of the Society for Industrial and Organizational Psychology, Seattle, WA.
- Acton, B. P., Hansbrough, T. K., Foti, R. J., Delice, F., Lord, R. G. (2022). Using predictive text analysis to identify the memory processing of leadership items. In B. P. Acton & N. Koenig (Chairs), *Automating is the future: Improving research scalability with predictive modeling* [Symposium under review]. Annual meeting of the Society for Industrial and Organizational Psychology, Seattle, WA.



Leadership as Event Management: Toward a Contextualized and Dynamic Theory of Leadership

Project #: W911NF-20-1-0205

Contract Dates: OCT 2020 – JUN 2023

PI: Frederick P. Morgeson

Institution: Michigan State University

Abstract

In this research I develop a new leadership theory called Leadership as Event Management (LdEM). In LdEM, leadership is defined as a process that is engaged to anticipate, react to, and create the dynamic events occurring in the organizational context. LdEM acknowledges that leadership exists at multiple levels simultaneously, ranging from dyads, to teams, to organizations. I seek to understand the flow of leadership and its dynamic nature over time as organizational members face significant events occurring in their operating contexts. To date I have developed a preliminary event taxonomy, conducted qualitative and quantitative analyses of over 700,000 news articles, and conducted qualitative coding of significant events. This research can be applied in Army/military settings via leadership simulations, training, and development initiatives.

Introduction

Organizations operate in increasingly dynamic, complex, unpredictable, and turbulent environments in which change is often the only constant. There are a host of forces that produce numerous events that impact the organizational environment and those working within it. These discrete events represent and create the dynamism present in organizational environments. These events also have an impact across space and time and challenge ongoing, stable routine functioning of individuals and collectives. Because of its importance and central position in the organizational hierarchy, leadership at all levels can play a key role in anticipating, reacting to, and creating events. Although we have long known that leaders often orient themselves around events (sometimes referred to as “fires” or “problems”), we know little about the potential proactive and reactive event management strategies that could be deployed in anticipation of and response to events.

Because of this, there is limited understanding of leadership processes in dynamic, event dense, contemporary organizational contexts. In other words, we currently know little about leadership in the very environments in which most leaders and teams typically find themselves operating in today. To address these gaps, I am developing and testing a novel leadership theory (called Leadership as Event Management or LdEM) that is explicitly contextualized, dynamic, and collective. LdEM goes beyond individualistic “great person” views of leadership, instead proposing leadership as a collective process that is deployed to manage the range of dynamic events that are occurring in the organizational context. LdEM is expressly integrative in that it can accommodate leader-centric (i.e., hierarchical or command and control) views of leadership as well as more distributed or collective forms of leadership. In addition, it is explicitly contextualized, both in terms of the events that comprise organizational contexts and the social units within which leadership is enacted. As such, LdEM acknowledges that leadership exists at multiple levels such that it encompasses dyads, teams, operating units, larger collectives, and organizations more broadly. Ultimately, I seek to understand the flow of leadership and its dynamic nature over time and across space as organizational members are faced with significant events that are occurring in their proximal and distal operating contexts.

Research Approach

My research approach uses a combination of qualitative and quantitative methodologies, drawing from multiple sources of data. These data include:

- Historical news articles. Over 700,000 New York Times articles published from 2000 to 2020.
- Archival leader event summaries. Nearly 400 descriptions of significant events across a diverse range of organizational contexts by leaders ranging from CEOs to front-line managers.
- Leader event interviews. 50-100 interviews with current leaders about events they have faced and leadership processes in relation to these events.



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- Original quantitative event surveys. Quantitative data on 200-300 leaders and their immediate supervisors corresponding to events and leadership processes.

My approach is intentionally broad as I seek to capture a wide range of event descriptions, leadership approaches, and organizational settings. Importantly, data reflect both past and contemporary accounts of events ensuring diversity and breadth in events and leadership actions.

Accomplishments

This past year's key findings revolve around the development of a preliminary event taxonomy that consists of three major elements: event source, event characteristics, and event outcomes. Event source concerns understanding what produced or led to the event (i.e., its origin). The source can be internal (arising inside the focal entity's context) or external (arising outside the focal entity's context). Source might also be meaningfully ascribed to specific entities (e.g., natural environment, organizations, teams, leaders, specific individuals) or forces (e.g., competitive pressures, regulatory changes). From a leadership standpoint, event source is important because it tells you where to look and what to pay attention to. Event characteristics are a distinguishing feature or essential quality of a given occurrence. Potentially important event characteristics are listed in Table 1 in alphabetical order.

Event outcomes reflect the consequences of an event for individuals, teams, and leaders. Potentially important outcomes include event favorability, event attention, breadth of impact, stakeholder behavior, and changes in individual and collective features.

Contributions to Basic Research

The leadership literature is extensive and influential. We know quite a bit about leaders, who they are, and what they do. Yet, this literature is narrow because it focuses on static features of leaders and typically ignores the dynamic context within which leaders and teams perform. This focus has led to a dearth of new theories of leadership, so much so that one might argue that there have been no genuinely new theories of leadership for quite some time. By adopting an event-oriented perspective and building from Event System Theory, this research will develop and test a fundamentally new and unique conceptualization of leadership.

The current research will systematically study and fill a key gap in the leadership literature and produce greater knowledge and understanding of the fundamental aspects of event-oriented leadership. In LdEM, leadership is fundamentally oriented around anticipating, reacting to, and creating events as needed. This process of anticipating, reacting, and creating events is manifested through different event management strategies performed by different members of a collective over time. These strategies comprise both "leadership" and "management" activities. In this way, leadership is a dynamic flow of activities over time within a collective where different "leaders" ascend and recede in response to events. The effectiveness of this leadership process is determined by the appropriate identification and deployment of knowledge, skill, ability, and other characteristics (KSAOs) within the collective.

LdEM will contribute to basic science by developing and testing a fundamentally new approach to leadership. This research will result in several products, including publications detailing the theory and empirical results and insight into potential leadership simulations, training program content, and leadership development initiatives.

Potential Army/Military Applications

This research has at least two key Army and military applications. First, the research will develop a new way of viewing leadership within the Army/military, particularly given the challenges associated with multi-domain operations (MDO). The MDO concept has been developed to address how the environment and adversaries have changed, and specific ways to both compete with and defeat those adversaries. To conduct MDO, "Army forces require resilient multi-domain formations with systems, leaders, and Soldiers that are durable, can persist in a difficult operational environment, cannot easily be isolated from the rest of the Joint Force or from partners, and able to conduct independent maneuver and employ cross-domain fires" (TRADOC, 2018, p. B-2).



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Table 1

Event Characteristics

Event Characteristic	Description
Clarity	Extent to which an event is clearly interpretable or unambiguous; extent to which meaning of event is immediately clear to entity.
Controllability	Extent to which an event can be controlled by the focal entity.
Criticality	Extent to which an event is important, essential, or a priority.
Disruptiveness	Extent to which an event blocks or transforms ongoing routines.
Duration	How long an event lasts.
Evolution	Extent to which the meaning or character of an event changes over time. Related to “event strength change” and the temporal evolution of event impact.
Frequency	The number of times the same or similar event has occurred.
Legality	Extent to which an event follows established laws, rules, and regulations present in the context in which an event is embedded.
Magnitude	The total size or “bigness” of an event. The scope and scale of an event.
Novelty	Extent to which an event is different or varies from current and past behaviors, features, and events.
Predictability	Extent to which an event is “anticipatable” or expected or unexpected.
Urgency	Extent to which an event requires an entity to respond immediately to the event.

LdEM will provide a new way of conceptualizing leadership within the MDO context. LdEM explicitly acknowledges the multiple demands and dynamic nature of the operational environment (characteristic of the MDO context) that is filled with events that are important for leader and team performance. In addition, LdEM can provide a useful leadership conceptualization that can account for the new, fundamentally dynamic organizational reality that depends on effective dynamic leadership processes. This includes a complex operational environment, a highly event dense context, the need for adaptive team performance, and a movement away from hierarchical command-and-control leaders to flexible collective leadership within and outside the team.

Second, the current research builds the foundation for the development of LdEM-based leadership and team assessments. This is possible because the current research will develop models and frameworks explaining the operating context and dynamic leadership processes occurring within the context. These tools include 1) the development of a situational judgment test and a structured interview to assess LdEM-centric KSAOs; 2) the development of team and leadership assessment instruments to determine leadership strengths and weaknesses; and 3) the development of an event environment assessment to diagnose the broader context within which leaders are performing.

Future Plans

Future research will involve further refining, developing, and qualitatively testing LdEM by interviewing a diverse set of leaders from all strata of organizational hierarchy and across a range of industries. I anticipate conducting 50 to 100 in-depth, semi-structured phone interviews. The final sample size will be determined based on the extent to which theoretical saturation is reached. In other words, data collection will be completed once no unique information is being collected from study participants. This strategy will mirror the broad, inclusive sampling approach adopted in previous research in an effort to



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provide as wide a scope as possible in the refinement and testing of LdEM but will differ in that it is not an archival data source and instead reflects contemporary organizational issues.

Major goals for this research include developing a final version of the taxonomy of events leaders are facing, developing an in-depth understanding of leadership ascension and recession processes, refining understanding of proactive and reactive event management strategies, identifying important event creation strategies, and understanding how KSAOs are identified, applied, and deactivated as leadership processes unfold during an event.



Switching Gears: Training Team Leaders and Members to Adapt Leadership Behaviors in Dynamic Conditions

Project #: W911NF-16-1-0545

Contract Dates: JAN 2016 – JUL 2023

PI: Gerardus (Sjir) Uitdewilligen

Institution: Maastricht University

Co-PIs/Subcontractors: Ramón Rico, Universidad Carlos III de Madrid; Mary J. Waller, Texas Christian University

Abstract

Despite agreement among scholars that the most effective leadership style depends on situational demands, little is known about how team leaders effectively transition between different leadership styles. Better understanding this leadership-style-transition process – known as adaptive leadership – is the aim of the current project. The current project aims to increase understanding of the underlying processes and requirements of how leaders shift between such styles, particularly as the leadership situation transitions from simple to complex. We build a research model depicting this adaptive leadership process and its contributing factors. We consider the style-transition process not as an isolated act of the team leader, but rather as an interdependent set of behaviors between leader and followers through which the team co-constructs the leadership transition process. We conduct eight studies, each of which focus on a particular aspect of this leadership transition process. The findings of our study provide insights that can be used in training and developing adaptive units and leaders.

Introduction

When operating in dynamic and unpredictable contexts, teams are often faced with a dual challenge. On one hand, in simple situations, they must optimally synchronize and coordinate members' actions in order to perform tasks as fast and as efficiently as possible; on the other hand, teams must maintain the flexibility and creativity that is required in situations for which there are no specific scripts or protocols. Yet, even though teams may be trained to perform both in simple and complex situations, their effectiveness in the long run may be as much a function of their capacity to sense when a switch is appropriate and to transition among different modes of action.

The team's leader plays an important role in sensing when this switch is necessary. Further, the team's leader is also often responsible for facilitating the transition from simple to complex action modes. Classic contingency theories of leadership argue that the most effective leadership style for any given situation depends on how well the style matches the situation's demands. When there is time pressure, in simple situations a hierarchical leadership style is often effective for optimizing performance. Conversely, a participative leadership style is likely more effective in complex situations. A participative leadership style is more effective in such situations because delegating authority to team members encourages collective information sharing. Information sharing facilitates team sense making processes that lead to the integration of divergent perspectives.

However, empirical research on how leaders successfully switch among appropriate leadership styles is lacking. Moreover, as can be seen in Figure 1, although the leader may be pivotal in the leadership transition process, the role of team members in enabling and facilitating is crucial and should not be understated. Recent theorizing on leadership suggests that the existing literature focuses predominantly on the one-way process of how leaders influence their followers. This view, however, neglects the dynamic and reciprocal process of leadership that emerges from the two-way interaction between leaders and followers. In other words, the prevailing theories of leadership do not accurately account for how the leader is influenced by followers. Thus, a transition in the style of the team leader will be effective only if it is matched with a commensurate transition in the behaviors of the team members; a successful switch in leadership style must be co-constructed by the leader and the team. Thus, the purpose of this research is to enhance our knowledge of the processes by which leaders and followers adapt their behaviors to the changing demands of the situation.

Research Approach

The research approach involves a series of controlled experiments in which four-person teams conduct computerized command and control tasks in dynamic situations. The teams perform a number of simple and complex scenarios. We experimentally manipulate leadership style (directive, participative, and flexible), followership's previous experience with

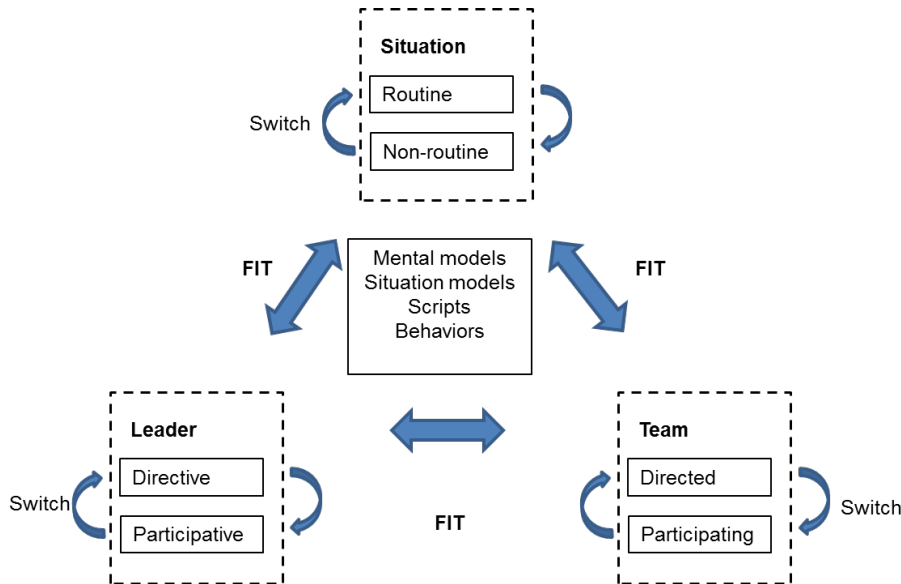


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Figure 1

Theoretical Model of Adaptive Leadership



adaptive leaders (a previous adaptive leader vs. a previous directive or participative leader), and the direction of the change (routine to complex vs. complex to routine). We measure team member and leader personality characteristics, team knowledge variables, and team communication. Our ultimate variable of interest is team adaptive performance, defined as the drop in performance and the subsequent increase in performance after a change in the team task. In a final study using a realistic medical environment, we test the effectiveness of the adaptive leadership training in a realistic context.

Accomplishments

The findings of study one suggest that teams with adaptive leaders (e.g., leaders who can transition from directive to participative styles) outperform teams with static directive and participative leaders. We looked at how team performance changes over time as teams transition between simple and complex scenarios. As can be seen in Figure 2, teams with adaptive leaders overall outperform teams with participative leaders in simple scenarios. Moreover, teams with adaptive leaders were better in switching from simple to complex situations. This is particularly obvious in contrast to teams with directive leaders. This is the first study to experimentally demonstrate the effectiveness of adaptive leadership for teams functioning in changing environments.

The findings of study two suggest that members of teams that have been previously working under an adaptive or participative leader develop a more proactive followership mind-set than team members who have been working under a directive leader. Under a subsequent adaptive leader, these teams were more adaptive than teams accustomed to working under directive leaders. Adaptation was defined here as the ability to engage in followership behaviors that fit the requirements of the task situation: more proactive behaviors in complex situations and less proactive behaviors in simple situations. Both a laboratory and a field study show that teams who had been previously working under an adaptive or participative leader switched more often to proactive followership behaviors when the situation became more complex, which was related to better performance.

The findings of study three show that teams face different challenges when switching from simple to complex situations than when switching from complex to simple situations. The findings of study four show that an adaptive followership training facilitates team adaptation, but only when the change is of a high magnitude. Moreover, we found that these effects occur via leader psychological safety—the extent to which the leader feels safe to express doubts and concerns within the team.

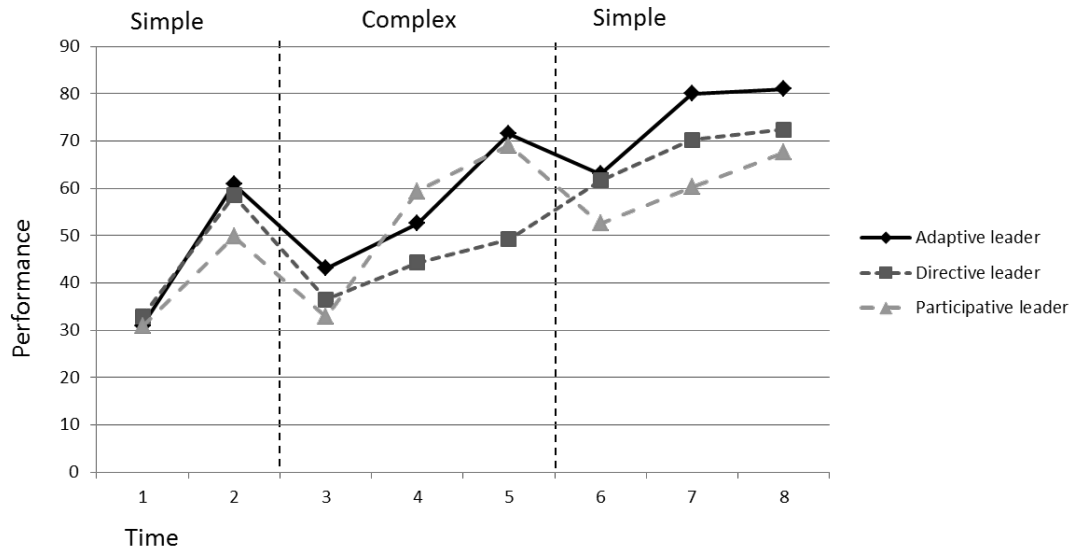


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Figure 2

Performance Over Time of Teams with Adaptive, Directive, and Participative Leaders



Contributions to Basic Research

This research project advances a reciprocally dynamic contingency theory wherein both the situation and leader behaviors dynamically change in response to the other. Thereby we move beyond contingency approaches to leadership, which consider that the most effective leadership style depends on situational demands. Instead, we conceptualize leadership not as a fixed style, but as a set of changeable behaviors. Given that situational demands dynamically change over time, an adaptive leadership process is required where leaders and followers dynamically adjust their behaviors to the demands of the situation. Thereby we recognize that a comprehensive understanding of the adaptive leadership process includes both leader and follower processes.

The products of this research are as follows. First, we provide a research paradigm for studying adaptive leadership in a controlled laboratory setting. Second, we develop a coding scheme for assessing leader and follower adaptive behaviors. Third, we develop interventions for advancing adaptive leadership and followership across a range of situations. Fourth, we identify which components contribute to the effectiveness of an adaptive leadership training.

The present research provides the foundation for several areas of future research. We identify behavioral mechanism and antecedents of adaptive leadership. Our research thereby creates new avenues for research on leader development. Future research could focus on how interventions and training programs can facilitate the development of the abilities underlying adaptive leadership in leaders in the field. For instance, studies may investigate how guided reflexivity—a structured form of reflection where leaders are encouraged to reflect on previous leadership situations and draw insights for future situations—might help to strengthen elements of adaptive leadership. We identified three critical adaptive leadership abilities and recommend that interventions are targeted towards these. First, interventions should focus on increasing leaders' ability to assess different task situations and select the optimal leadership style. Second, they should focus on the development of a wide repertoire of leadership behaviors. Third, switching between leadership behaviors may require leaders to overrule natural tendency or preferred leadership styles with situation-appropriate behaviors. Therefore, interventions should also aim to develop the self-regulatory capacity required to switch between leadership styles.

Moreover, our research emphasizes the dynamic interplay among leaders and followers. This provides an impetus for studies on leadership training that is not targeted at team leaders in isolation. Instead it should be focused on the dynamic interplay between leader and members. To take an example, video-recordings of actual team interactions could be used to code leader



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and follower behaviors. This could be used as feedback to the team in order to stimulate reflection on the effectiveness of specific behavior sequences.

Potential Army/Military Applications

With the present project, we aim to contribute to the Army's objective to improve its capability to train and develop adaptive units and leaders. The results of our studies suggest that some situations require directive leadership whereas in other situations participative leadership is beneficial; therefore leaders need to be able to flexibly alter their styles to the changing demands of the situation. In addition, we focus attention not only on the leader but also on the followers' role in this process. We find that it is crucial that team members respond to these leader switches with appropriate behaviors.

We do find that leaders receiving an adaptive leadership training are perceived to be more flexible by their followers than leaders receiving directive and participative leadership training. Moreover, their teams overall outperform those in the other conditions. These results clearly suggest that adaptive leadership is beneficial for team performance in dynamic environments and that adaptive leadership is trainable in a relatively short timeframe. Although we demonstrated these effects in a controlled laboratory setting, the training is based on theoretically derived components (e.g., building a repertoire of leadership behaviors, building the ability to recognize relevant cues) that can be translated to an applied setting. We aim to test the relative importance of these separate components in a study we are currently running. Thereby, the project not only aims to evaluate the effectiveness and underlying mechanisms of flexible leadership, but also to develop a blueprint for training that has the potential to be applied in practice.

Moreover, the results of our studies can be used as the basis for identifying crucial skills for adaptive leaders and teams. This has implications for personnel selection and the assignment of leaders and followers to tasks and missions. One of the goals of this project is to identify personality characteristics that facilitate adaptive leadership and followership behaviors. Thereby the present research facilitates the optimal assignment of personnel based on the dynamic characteristics of a mission. In particular, missions that are anticipated to be characterized by high levels of situational dynamism may benefit from a careful selection on characteristics that are related to adaptation.

Future Plans

The mission of this research project is to uncover the psychological and team processes through which changing leadership behaviors affect a team's response to changing situational demands. We are currently investigating which components contribute to the effectiveness of the adaptive leadership intervention developed in the first study.

In addition, our previous studies all assumed a formal leadership role and switches between directive and participative leader and follower behavior. In our previous studies we did however perceive that not only the behaviors of leaders and followers change over time depending on the situation, teams also change in who occupies the main leadership role. For instance, sometimes followers (temporarily) display leadership behaviors and leaders display follower behaviors. In the final laboratory study, we therefore test an adaptive shared leadership intervention.

The final step in the project is testing our adaptive leadership intervention in a realistic health care simulation environment.



Organizational Effectiveness Overview

Army Need

Military organizations reflect a complex structure based on both formal hierarchy and informal social structures, typically involving individuals working on teams within teams. Given this nested structure, it is critical to understand the multi-level and cross-level influences at the individual, small unit, and organization levels, and how these influences relate to organizational effectiveness. Moreover, military units frequently work within a Joint-Interagency context, creating an additional cross-organizational component that needs to be understood.

Combined and joint efforts by personnel from different services, agencies, and nations create numerous challenges, such as how understanding and assumptions of work processes will develop and be managed, and how goals are defined across organizations and levels. To achieve maximal effectiveness at all echelons, it is critical to understand how the processes, structures, and characteristics of these multi-echelon organizations impact performance and resiliency at the individual, small unit, and organization levels, and how these impacts unfold across time.

The two goals in the organizational effectiveness portfolio are to a) expand knowledge of the complex social, cognitive, and behavioral processes, structures, and characteristics of multi-echelon organizations and b) improve theories and methods for identifying, measuring, and modeling these factors to increase organizational performance and effectiveness. The key research objectives associated with each goal are explained below.

Key Research Objectives

Organizational Theories: Processes & Dynamics

The Basic Research Program strives to develop theories that can address cross-level causal influences in performance, communication, collaboration, and adaptability within and across organizations, especially from the perspective of organizations as dynamic systems. The program also seeks to develop, expand, and test theories that link individual characteristics – cognitive, affective, and motivational – to team-level processes and outcomes. ARI's Basic Research Program seeks to develop theories of team composition to optimize team performance for teams within complex, dynamic environments that require semi- to full autonomous functioning.

Multi-Level Methods & Models

ARI's Basic Research Program aims to develop new metrics, statistical models, and assessment techniques for defining and measuring complex, dynamic constructs at the group and organization levels (such as climate, knowledge, and norms), especially models and techniques that align with unobtrusive assessment in field-based environments. The program strives to develop new methods and models to better understand the effects of team aggregation and dis-aggregation at multiple levels of analyses. Team dynamics, leadership, and environmental characteristics are of particular interest.



Organizational Effectiveness Currently Funded Research

ARI's Basic Research Program is currently funding four extramural research projects. Brief descriptions of the projects are provided below, with detailed research summaries of each project provided on the subsequent pages.

Attribute Alignment Framework: A Novel Solution to Team Aggregation

(W911NF-19-1-0107; 2019-2023)

Dr. Kyle Emich (University of Delaware) and colleagues are developing a novel framework and method to better understand how individual team members' attributes combine to impact team processes and outcomes.

Beyond the Cultural Horizon: Mapping Relational Norms within Social Networks

(W911NF-16-1-0543; 2016-2021)

Dr. David Lazer (Northeastern University) and colleagues are utilizing massive online data collection and experimentation to support a fusion of research on relational scripts and the Blau space affiliational ecology model.

Building Better Teams

(W911NF-18-1-0233; 2018-2022)

Dr. Alexander Volfovsky (Duke University) and colleagues are developing new theory and methodology for understanding how networks of individuals change dynamically as a reaction to external and internal stimuli.

Optimizing Team Composition

(W911NF-19-1-0094; 2019-2022)

Dr. Scott Tannenbaum (The Group for Organizational Effectiveness, Inc.) and colleagues aim to: 1) outline different team staffing scenarios and their implications for member deployment decisions; 2) advance alternative composition models for predicting team effectiveness; and 3) develop and test optimization algorithms to deploy available members to teams and maximize overall effectiveness of the system.



Attribute Alignment Framework: A Novel Solution to Team Aggregation

Project #: W911NF-19-1-0107

Contract Dates: MAY 2019 – FEB 2023

PI: Kyle J. Emich

Institution: University of Delaware

Co-PIs/Subcontractors: Li Lu, West Chester University; Michael McCourt

Abstract

A major problem in current team research is that little, if any, attention is given to the multiple attributes team members have. For example, what happens when a team's smart members are also able to control their emotions versus when they are not? By thinking about teams as matrices made up of rows representing team members and columns representing their attributes, our framework allows us to answer such questions. We propose one lab and two field studies to test whether it matters if a team's smart members are also able to control their emotions, plan, and have the power to execute that plan. Our work can help organizations assemble teams made of individuals with a favorable mixture of talents and traits and inform more focused team interventions. It will also result in software allowing team researchers to use our alignment analysis technique.

Introduction

We propose a novel framework and method to better understand how individual team members' attributes combine to impact team processes and outcomes. Consider the two teams shown in Table 1 as an example. Two attributes are considered. The first one is *cognitive ability* (IQ), or the ability to reason, learn from experience and solve problems. The second one is *emotion regulation* (ER), the ability to manage or adjust one's emotions. Traditionally, when team researchers examine how IQ or ER affect team functioning, they look at distribution properties of these attributes, such as the mean, variance, and maximum of individual members' attributes within teams. However, by doing this, they ignore how group members' IQ or ER impact each other at the individual level. Our method answers questions regarding how *the level and distribution of IQ or ER in a team* affects team functioning. In other words, we believe it matters if, on a given team, the members who have high IQ are also capable of appropriately regulating their emotions. Team 1, where the smartest member does not know how to regulate her emotions, may run into problems compared to Team 2, where the smartest member does. Our proposal discusses how this framework can advance understanding of team members' attributes by accounting for the effects of such within-person attribute alignment. We aim to contribute to the *Organizational Effectiveness* research area, particularly concerning team composition and team aggregation.

Our attribute alignment framework also provides a new analytical tool to tackle team aggregation. Specifically, we view teams as matrices composed of individuals possessing multiple attributes. By applying normed vector spaces and electrostatic energy systems to team research, we map team members' multiple attributes to a multi-dimensional space and assess similarity between them through the use of vector norm distance and/or angle and the electrostatic potential energy of the vector system.

Research Approach

We are answering this question by observing interacting teams and surveying them on the focal variables we identified (IQ, emotional regulation ability, conscientiousness, and power). By surveying teams across military, academic, and entertainment settings, we hope to be able to understand how team members' IQ aligns with their other traits (i.e., EQ, conscientiousness, and power within team members) to impact team functioning. First, we surveyed 110 cadet teams completing their summer military training at the USMA at West Point. Second, we are in the process of observing 170 teams of undergraduate students completing a simulated climb of Mount Everest. Third, we will observe 170 teams completing an escape room with a James Bond or Star Wars theme.



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Table 1

Patterns of Cognitive Ability (IQ) and Emotion Regulation (ER) on Two Hypothetical Teams

Team 1			Team 2		
Members	IQ	ER	Members	IQ	ER
Alice	5	1	Danielle	5	4
Betsy	2	4	Eric	2	4
Chris	2	4	Francesca	2	1

Accomplishments

In 2021, we were unable to collect additional data due to the constraints of the COVID-19 pandemic. Because of this, we continued to analyze data from Studies 1 (involving 110 USMA teams) and 2 (involving 160 teams completing Harvard's Everest Simulation). In the first sample, we found that when cognitive ability (IQ) and emotion regulation ability (ER) align, teams perform better. Additionally, we found that when people in power have both high IQ and ER, the teams they are on perform better. This indicates that having smart people who are unable to regulate their emotions may harm military teams, especially if those people are put into positions of power. Similarly, having people who are very good at dealing with emotions, but without innate intelligence in positions of power will also harm military teams. Military leaders need both. In the second sample, we again found that it is important that IQ and ER are aligned within teams. However, interestingly, we found an opposite effect regarding leadership. In these teams, it was important that the high IQ-ER members were in positions of low power, as opposed to high power. We are planning to explore this discrepancy in Study 3, but our initial hypothesis is that in more hierarchically structured teams, such as those found in the military, it is more important to have stronger leaders. Alternatively, in flatter teams that rely more on expertise sharing from all members, it may be better to have members low in power who are able to comprehend the task and step up when necessary. It is also important to note that in addition to performance, in Study 2, we found that having IQ-ER alignment led to lower stress and negative conflict on teams, as well as increased planning and information elaboration. To that end, we are in the process of building an escape room to collect data for our third study at the University of Delaware. This was delayed due to COVID-19. We hope to be able to complete construction of the room and collect Study 3 data in spring 2022.

Despite our data collection delays, in 2021, we were actively writing papers. We had one paper accepted at *Organizational Research Methods* (Impact Factor: 9.39) and are planning to submit two more papers (one to *Organizational Research Methods* and one to *Academy of Management Discoveries*) in the next two months. Data has been collected and analyzed for both and they are being written now. Finally, we also currently have a manuscript under review at the *Academy of Management Journal*.

Contributions to Basic Research

Most often, team scholars use the sum or mean of individual members' attributes to describe a group property (e.g., cognitive ability). Less often, but increasingly, team scholars take a configural approach recognizing that team members vary in their attributes and that analyzing the patterns of within-team differences can lend important insight into team functioning. The diversity of these approaches highlights one fact about the current state of the team literature: team scholars are constantly searching for new frameworks and analytic techniques to explore how team member attributes, and more importantly, patterns of these attributes, influence team functioning. Another drawback of current teams research is that relationships among team member attributes are not accounted for before being aggregated to the group level. Think again about our opening example (Table 1). The level and spread of IQ and ER in Teams 1 and 2 is equal. Yet, it is plausible that these two teams behave differently since in Team 1 the smartest member has the worst emotional ability, while in Team 2 the smartest member also has the best emotional ability. This is an example of how aggregating individual attributes to the group level without first considering their relationship at the individual level costs researchers a valuable opportunity to explore their impact on group dynamics. Our framework proposes one way to realize this opportunity by slicing teams a different way.



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Our attribute alignment framework is an innovative way of considering teams. According to this framework, teams are viewed as matrices consisting of multiple team members with multiple attributes (as shown in Table 1). As stated, traditional approaches tend to aggregate individual traits to group level (across columns) without considering connections among traits within team members (across rows). Instead, we recognize the importance of alignment across individual attributes (across rows), in addition to exploring general team properties (across columns). Importantly, this framework allows team researchers to explore a different set of research questions that could not be answered before: does it matter *who possesses certain attributes* in teams? Going back to our opening example, assessing the alignment between intelligence and emotional regulation ability is really asking does it matter *who is intelligent*? In this case, specifically in terms of emotion regulation ability.

Being able to link team members' individual attributes and their patterns to team performance is important for two reasons. First, team members are the basic elements of teams. Team members' attributes interact and this interaction plays an important role in explaining not only their own attitudes, behaviors, and thoughts, but those of the team. After all, teams do not think, feel or act; team members do. Second, this connection has important implications for practical interventions such as team staffing and training. Essentially, we will be able to pinpoint what attributes are best possessed by which team members, which can help organizations including the Army adopt more focused team interventions. Thus, our framework can advance team research, and team aggregation in particular, by documenting the impact of the alignment, or lack thereof, of within-member attributes on team performance and other team processes and outcomes. As stated, the data we have collected so far indicates the importance of having intelligent team members who can also regulate their emotions. In practice, this means that it may be collectively beneficial to ignore intelligent people who are unable to effectively transfer that intelligence into collective solutions. After completing our final study, we should be able to tease apart additional mechanisms in this relationship, such as when it is important to promote these high IQ-ER individuals into positions of power, and why. At the end of this project, we will also have software programs developed (in Python, R, or both) that are able to measure attribute alignment in multiple ways across any number of attributes and be able to make practical training and staffing recommendations regarding how to train and align intelligence, emotional regulation ability, conscientiousness, power, and proactivity in military and other task-focused teams.

Potential Army/Military Applications

The goal of our research is to provide the Army with recommendations for team composition and training and software to measure the composition of current teams. These interventions are possible because the advantage of our framework lies in its ability to connect specific team member attributes with team outcomes. For example, team training normally targets either the team as a whole or important team members such as the leader. However, our approach would allow organizations and coaches to target training at specific team members with specific sets of attributes. For example, since our results indicate that a team's smart members also need to know how to regulate their emotions, team leaders could give those team members with high cognitive ability training on emotion management. It is also possible that our results will indicate that creating a sense of one of our focal variables across the team is more important than having it divided among team members. In this case, we would be able to recommend a holistic team training as opposed to this individually focused training.

In addition to active coaching, our approach will allow the people who make teams to consider multiple attributes of potential team members during team recruiting and assignment. Considering the same example in a recruiting context, organizational leaders could make sure to recruit members who are smart and able to regulate their emotions. In an assignment context, this would indicate that you would need a smart member who is emotionally able to pair with a smart member who is not, so that the smart person who is unable to control their emotions does not lead the team down a bad path. However, it is also important to mention that these studies are a first step. This framework can be applied to any set of attributes on any team.

To this point, another clear application of our work is team assessment. The tool we will create will allow team leaders to calculate and assess the alignment of any attributes of any military team. Some leaders are not interested in intelligence, emotional ability, planning ability, or power; instead, they may be interested in something else such as an openness to experience or expertise. Our tools would allow that leader to assess his or her team on any such attributes and then use appropriate training and assignment to improve the pattern of these attributes in teams.

Future Plans

In the next year, we will complete three major tasks. First, we will finish building our escape room and collect the data for Study 3. Second, we will analyze the data gleaned from this study to make recommendations regarding the alignment of cognitive ability, emotional regulation ability, conscientiousness, and power to the U.S. Army. Finally, we will work on three



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academic papers connected to this project's funding. First, we will submit a follow-up on our accepted two-attribute alignment method paper to *Organizational Research Methods*. This paper will explain how to calculate and interpret the alignment of more than two attributes. Second, we will submit three studies showing that conscientiousness-proactivity alignment improves team performance to *Academy of Management Discoveries*. Finally, we will wait to hear about our paper concerning metaknowledge-social sensitivity alignment, which is currently under review at the *Academy of Management Journal*, and revise and resubmit it as necessary.

Associated Publications

Emich, K. J. & Campbell, B. M. (2019). Eclipse or reflect? Why teams learn more when their star members are introverts [Symposium]. 14th Interdisciplinary Network for Group Research (INGRoup) Conference, Lisbon, Portugal.

Emich, K. J., Kim, Y. J., & Woolley, A. W. (2021). Enacting metaknowledge: Teams make better decisions when metaknowledge and social perceptiveness align [Symposium]. National Communication Association Annual Convention, Seattle, WA.

Emich, K. J., Lu, L., Ferguson, A. J., Peterson, R. S., & McCourt, M. (2019). Proactivity meets conscientiousness: Using an alignment approach to understand the effects of team composition on team performance [Symposium]. 14th Interdisciplinary Network for Group Research (INGRoup) Conference, Lisbon, Portugal.

Emich, K., Lu, L., Ferguson, A. J., Peterson, R. S., & McCourt, M. (2021). Team composition revisited: A team member attribute alignment approach. *Organizational Research Methods*. <https://doi.org/10.1177%2F10944281211042388>



Beyond the Cultural Horizon: Mapping Relational Norms within Social Networks

Project #: W911NF-16-1-0543

Contract Dates: SEP 2016 – SEP 2021

PI: David Lazer

Institution: Northeastern University

Co-PIs/Subcontractors: Matthew E. Brashears, University of South Carolina

Abstract

Most individuals can recognize and interact with cultural systems without necessarily being able to fully grasp what they are interacting with. While this may be sufficient for day-to-day life, it is inadequate in a modern world characterized by dense interactions between people from disparate cultural backgrounds. We propose to leverage advances in massive online data collection and experimentation to support a fusion of research on relational scripts and the Blau space affiliational ecology model (AEM). Relational scripts are the commonly understood behaviors and norms that guide, enable, and constrain the interactions between individuals (e.g., facing the doors rather than other passengers when standing in an elevator). Those who share scripts in common can interact more easily, while those who do not share scripts will find interaction to be more difficult and are more prone to perceive each other as outsiders. Blau space models are a way of representing social entities (e.g., organizations) in a k-dimensional sociodemographic space and modeling these entities as organisms competing for resources. We argue that relational scripts can also be modeled as competing for adherents in a dynamic Blau space and that particular cultures are recognizable as configurations of scripts (i.e., patterns of niche overlap) in this space. Online data collection allows us to measure the scripts in a variety of different cultures using virtually identical instruments and presentation, dramatically improving generalizability over previous efforts. To date this project has yielded multiple book chapters, articles under review or nearing submission, new analytic and data collection methods, and has contributed substantially to the training of students.

Introduction

Our approach is based on a combination of two streams of theory in social science. First, we propose to use the growing work on relational scripts. Relational scripts are behaviors and expectations that enable and constrain interactions between people (see Figure 1). As these scripts convey information, such that deviations from scripts can prove useful as signals of sub-group membership or intentions (see Humphreys 2009 [1970]: Ch. 4), they are largely non-discretionary. However, while all humans are effectively compelled to employ scripts, not all humans use the same scripts, and thus differences in script usage are key markers of culture (see Figure 2).

Second, we use the theory and methodology of Blau space affiliational ecology models (AEM) to compile scripts into interacting dynamical wholes that collectively provide signatures of individual cultures and subcultures. This provides a quantifiable depiction of culture rooted in the mechanics of how individuals interact, and thus is more predictive of actions than a view of culture rooted in overarching claims about values or ideals. While it may be the case that two cultures differ in their core ideals (e.g., liberty vs. piety), individuals in those cultures primarily recognize each other by the scripts that they use and the behaviors they exhibit rather than by comparing philosophical commitments. Moreover, Blau space provides validated predictive capability that should be extendible to relational scripts and culture.

We combine the social science theories outlined above with the unique and powerful capabilities afforded by online data collection. While questions have been raised about the quality of online data gathered from crowdsourcing outlets such as Amazon Mechanical Turk, research shows that the results of experiments performed with these services compare very well with probability-based sampling methods (Weinberg, Freese, & McElhatten, 2014). Given these positive results, there are many advantages of online data collection. For instance, it is possible to collect large amounts of data from extremely diverse populations in short periods of time while permitting the presentation of complex multi-media stimuli. We particularly exploit this multi-media capability in order to develop and evaluate our visual vignette approach to data collection, discussed below.

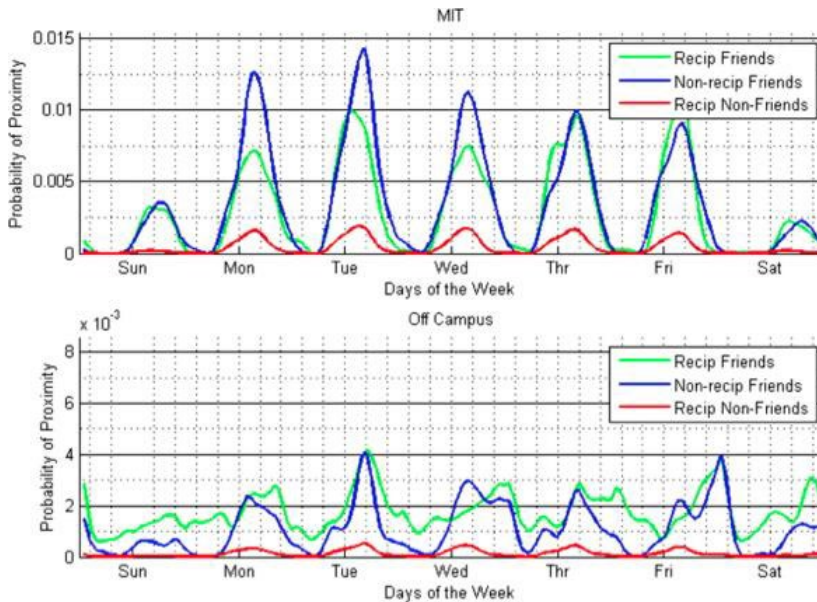


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Figure 1

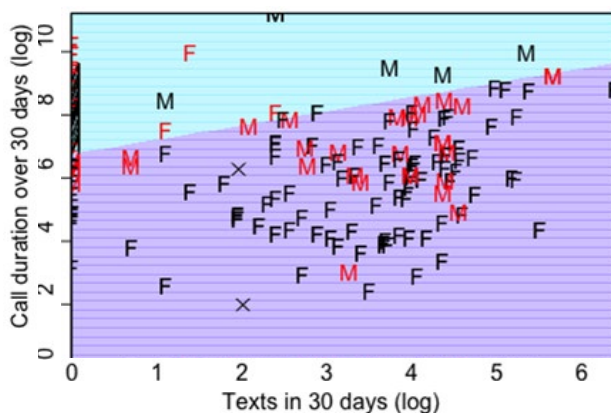
Behavioral Correlates of Friendship



Note. Proximity probabilities at work (top panel) and off campus (bottom panel) for symmetric friend, asymmetric friend, and non-friend dyads. Probability of proximity is calculated for each hour in the week and is generally much higher for friends than non-friends. However, because of the spread in the distribution and the very large number of non-friends, most pairs with high proximity are non-friends. The more powerful predictors are proximity off campus and off work hours, because non-friends are almost never proximate outside of the work spatio-temporal context.

Figure 2

Communication in Aftermath of Boston Marathon Bombing



Note. Using the 30 days of aggregated communication history available for most respondents we explored the feasibility of classifying the two most common relationship categories: mother and friend. While some variables do fairly well, basic classifiers only reach an out-of-sample AUC of .84, which remains below the base rate of friends (85.5%, $N=531$). Strong heterogeneity makes classifying social ties based on observed behavior a formidable challenge. What constitutes a friendship, and even a maternal tie, is a social construct that does not map cleanly onto measurable social actions. The figure shows an LDA classifier with apparent error 0.115, with correctly classified in black, and incorrect in red. Note neater sorting along the axes.



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Research Approach

We have used Volunteer Science (a science crowdsourcing solution) to execute three different types of studies in a developmental sequence: verbal vignette studies, visual vignette studies, and interactive experiments. The first two years of data will be used to build Blau space models of relational scripts, both at the national level (i.e., a separate model for each country), and at a cross-national level (i.e., a single model for all countries). The former of these model types will allow us to more accurately track over-time variation in scripts as well as to evaluate this technique's potential for uncovering sub-cultural variation. The latter of these model types will allow us to assess whether cultures commonly regarded as more or less qualitatively similar can be shown to be quantitatively similar or dissimilar in their patterns of script niche overlap. The data collected will be useful for validating the substantive meaningfulness of our Blau space modeling, particularly with respect to the impact of script profile dissimilarity on interactional compatibility.

Accomplishments

First, we have developed and deployed a series of textual vignettes intended to measure power and status differentials between characters in a reasonably familiar circumstance (e.g., employees sitting around a conference table). Participants evaluate characters who cut each other off during conversation, fail to pay attention, or otherwise engage in behaviors indicative of status displays. The characters are altered between conditions to produce new combinations of attributes (e.g., sex, age) so as to examine the interaction of both behavior and characteristics. While these textual vignettes are relatively weak instruments, we have nonetheless been able to identify consistent, and sometimes surprising, effects.

The interaction depicted here is easily transportable to other cultural contexts, where the meeting table can be replaced with some other culturally-appropriate meeting venue (e.g., a rug). Based on these experiments, we have fielded a new interactional inventory, meant to expose subjects to a series of small interactional scenarios and ask about both actions and gestures that the respondents believe individuals should or should not exhibit in response. The goal is to rapidly inventory distinctions in appropriate behavior between cultures in advance of developing more precise and expensive instruments to provide enhanced detail. Using primarily English literate populations in three countries (USA, India, and Nigeria) we have been able to identify significant differences in preferred, as well as disfavored, behavioral options and can use these in order to construct a profile of proper behaviors for each nation as well as identify points of most likely friction. A paper reporting on these results is currently under review.

Second, with the validation of the textual vignettes we have developed “visual vignettes” or stylized non-textual depictions of interaction. The social brain hypothesis (Byrne & Whiten, 2002; Humphrey, 1976) argues that human intelligence evolved to deal with social, rather than physical, problems. If this is so—and the social brain hypothesis has considerable empirical support (e.g., Brashears & Quintane, 2015; Lewis et al., 2011)—then human cognition should be more effective when presented with social problems (e.g., Janick & Larrick, 2005) and should be predisposed to interpret otherwise ambiguous stimuli in social terms. The latter tendency provides the explanation for the Heider-Simmel autism test (Heider & Simmel, 1944). In this test, individuals are presented with an animation depicting interactions between several geometric shapes. Neurologically-typical individuals commonly describe the interactions in social terms (e.g., “The circle and the square were playing. Then the triangle came and started being mean...”), while those with autism-spectrum disorder (ASD) are more likely to describe the interactions in purely non-social terms (e.g., “The circle and the square were bouncing back and forth near each other. Then a triangle came in and bumped up against the circle three times...”). Persons with ASD, which frequently includes significant social impairment, perceive what is literally occurring, while those who are neurologically-typical impose a social layer onto the animation that is not otherwise present. Subsequent research has confirmed the utility of the Heider-Simmel test for identifying individuals on the autism spectrum (e.g., Klin, 2000) and has more broadly shown that response patterns are influenced by whether the animated motion is random, goal directed, or interactive with implied intentions (e.g., Castelli et al., 2002). We see this test as an opportunity to improve data collection methods by charting a middle path between textual vignettes and video vignettes.

Textual vignettes rely on difficult-to-translate descriptions and unavoidably assume literacy, thus limiting their applicability to cross-national research or to research outside of developed nations. The existing alternative, video vignettes, relies on actual humans acting vignette actions out, but these approaches are expensive and introduce the risk of confounds. In other words, when using human actors these actors bring all of their attributes with them, rather than only those of interest to researchers. The same is true of realistic computer animations of humans as these animations are forced to “fill in” relevant details whether the researcher wants them or not (e.g., a computer generated human character must have a skin color, whereas in a textual vignette this information can be omitted without difficulty). But while modern computer animation makes it possible to present comparatively realistic avatars of human beings for research subjects to observe, human cognition makes this



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unnecessary as we are already disposed to see almost anything, including featureless geometric shapes, as social entities. We exploit this feature of human cognition to develop our new “visual vignettes” to present interactions to subjects for evaluation.

Much like the Heider-Simmel test, the visual vignettes we developed represent actors as minimally humanized geometric shapes and use their interactions to assess how respondents expect real humans to act (Figure 3). These visual vignettes allow us to collect interactional data of unprecedented quality. We have validated these methods using both American and international samples and have shown that they produce results equal to or stronger than traditional textual vignette approaches. A paper introducing these methods and demonstrating their effectiveness has appeared in the *International Journal of Social Research Methodology* and has been cited by subsequent research (e.g., Mittman et al., 2021).

Third, we have been working to improve the underlying Blau space methodology. While highly successful in a variety of contexts, Blau space has a number of limitations. In particular, calculation of the competition coefficients relies on uniform distribution assumptions that are obviously problematic, and we have reason to believe that there are unspecified scope conditions. We have been using the World-Values Survey data as a test bed for correcting these issues, with the intention of solving problems that will impact efforts to construct cross-national Blau space models. As a result of these efforts, we have encountered additional challenges in Blau space methods that have led us to question certain aspects of the model. In particular, we developed a new permutation-based approach to assessing whether a particular model represents a good fit to data. In brief, the model permutes the data in an affiliation matrix (i.e., matrix of memberships in which rows are individuals, columns are organizations or practices, and non-zero entries indicate membership) such that row and column marginals are unchanged but associations within the data are randomized. By permuting the raw data a sufficient number of times (e.g., 5,000 has typically been sufficient), and duplicating this process a sufficient number of times (e.g., 1,000 has typically been sufficient), we are able to build up a distribution of test statistics that should be obtained from the data if no ecological competition were present. We then compare the test statistic computed using the empirical data to our permuted null distribution and assess the significance of the statistic as equal to the fraction of permuted datasets with test statistics larger than the empirically observed value (Figure 4). The result of this test, when applied to classic data, is evidence that the test statistic values usually cited as evidence for the Blau space Affiliational Ecology Model are, in fact, quite typical values from our permuted null distribution. Based on additional work using empirically based and de novo simulations, we have concluded that while the theoretical foundation of the Blau space AEM is sound, the existing evidence supporting it is deeply misleading. While we did not anticipate pursuing this line of investigation at the outset of the grant, we believe that these results are critically important. We have presented these results several times to obtain feedback from colleagues at a variety of institutions. The manuscript was invited for submission for a special issue on Ecological Models at the journal *Social Networks*, but was ultimately rejected as not being sufficiently networks-focused. We are currently preparing the manuscript for submission to a new journal. Our new permutation test is currently being coded in a more systematic way for inclusion in our BlauNet package for R (<https://cran.r-project.org/web/packages/Blaunet/index.html>). We have also been working to develop a new competition coefficient metric that relies on measurement of actual resource exploitation, rather than volumetric overlap between niches. This approach will, we believe, help to circumvent the difficulties currently identified in Blau space methods and allow us to provide a firmer empirical basis for the theory.

Contributions to Basic Research

Some of our largest current contributions have been in developing Blau space modeling techniques. This technique has proven highly successful in predicting the recruitment of members into voluntary groups, the level of familiarity individuals have with different musical styles, and the spread of behaviors between organizations. However, much work remains to be done.

First, one of the major problems with existing Blau space techniques is the handling of categorical data. When modeling organizations, dimensions can be constructed using proportions of the members who fit into a given category (e.g., proportion female) thereby allowing organizations to be distinguished by their propensity to serve particular groups. Unfortunately, this approach prevents mapping individuals into the same space, as individuals occupy discrete locations on

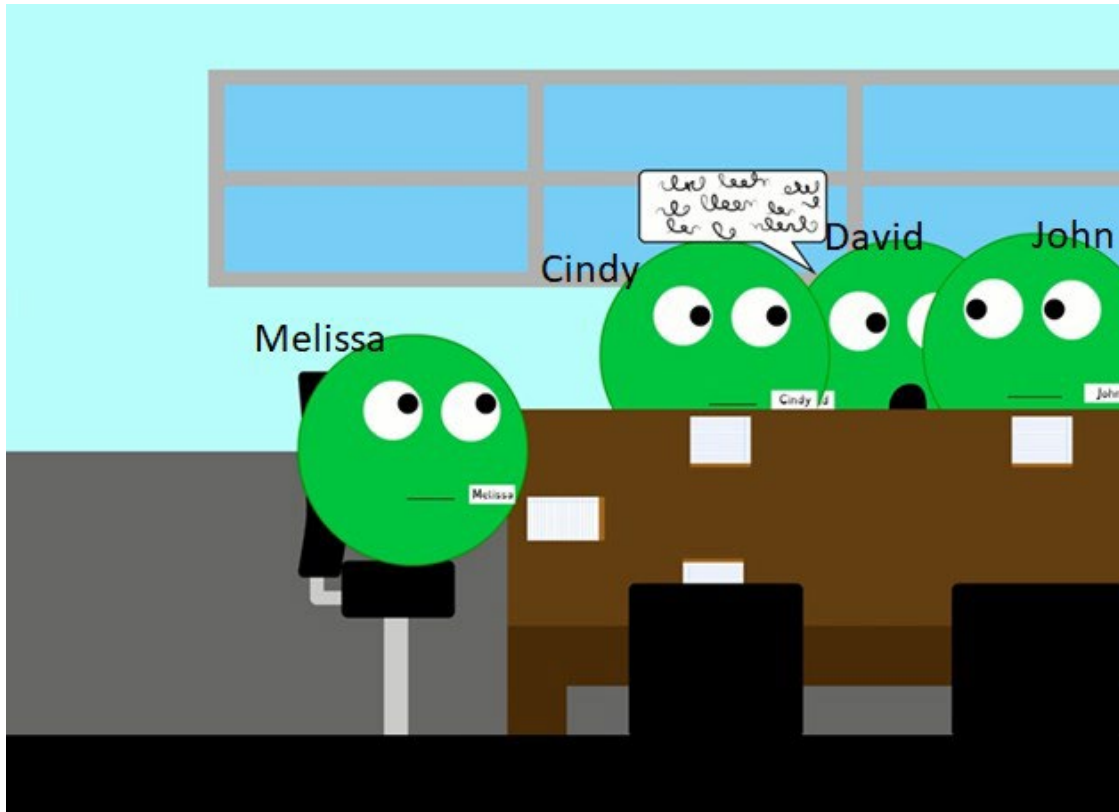


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Figure 3

Still Image from Visual Vignette Depicting Positive and Negative Interactions Between Four Characters

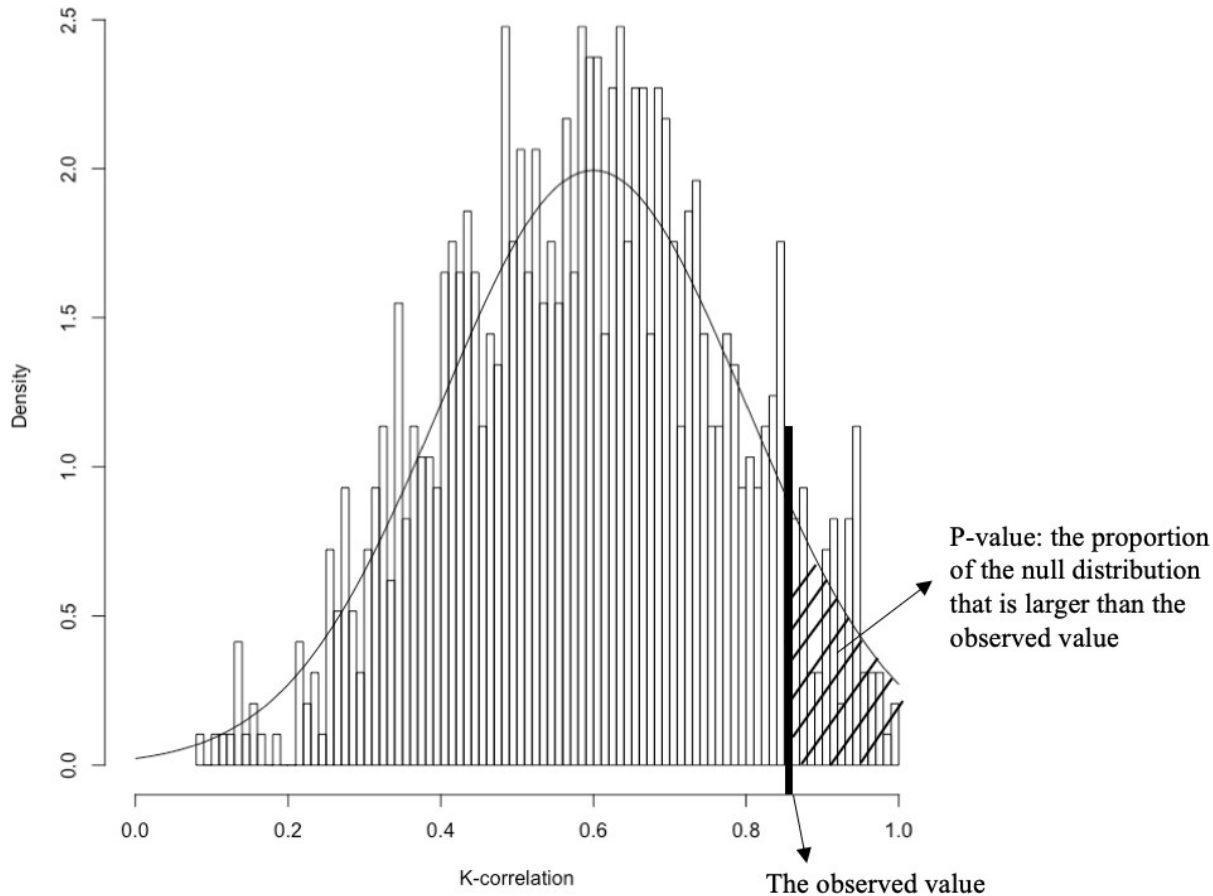


Note. Large names added for reader benefit. Speech is indicated using speech bubbles containing writing-like designs, and sounds that mimic the cadence of speech but do not belong to any language.



Figure 4

Test Statistic (e.g., k -correlation) Values Computed Using Permutation Test



Note. Significance of empirically observed test statistic is equal to the proportion of permuted values that are larger in size than the observed value.

these dimensions. Ongoing research has shown promise for resolving this difficulty by reimagining Blau space as a proximity space built using random walks in a multi-modal network, but much work remains to be done. We plan to continue advancing the models to smoothly incorporate larger varieties of data in a common framework. Effort on this problem carried out under a different program has yielded a new approach to Blau space that combines cellular automata from computer science with urn models from discrete statistics. We anticipate that this approach will eventually support modeling of relational scripts, many of which rely upon categorical group memberships. Several papers describing this new approach are already in print and a new paper applying it to General Social Survey data is in preparation for submission.

Second, the difficulties uncovered by our permutation test likely result from imprecision and inaccuracy in the metrics used to compute levels of competition between entities in Blau space. These competition coefficients make logical sense but impose heavily distributional assumptions on the underlying data (i.e., symmetric normality) and require that resources be distributed uniformly in the space. Unfortunately, these assumptions are frequently not borne out in empirical data. We are therefore developing a new competition coefficient metric that is based on estimated availability of resources in the space, as well as observed exploitation levels, rather than on simple niche overlap. The result should allow better measurement of competitive forces and, as a result, avoid the problems uncovered by our work to date.

Third, to support the above efforts we plan to continue to maintain and develop our BlauNet package for the R statistical environment. The most recent version of BlauNet (V2.0.1) contains numerous useful features, including a graphical user



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interface, the ability to render plots of three-dimensional Blau spaces with social network overlays (see Figure 5), computation of basic Blau statuses and network indices, and the ability to compute niches automatically. We have found it valuable to code new methods into developing versions of BlauNet as, in part, a repository of useful algorithms, and plan to continue to maintain BlauNet, as well as expand its function to incorporate the new methods developed in this project. As the paper introducing our new permutation test moves towards publication, we are in the process of adding this capability to BlauNet.

Finally, we are developing machine learning methods to infer relational scripts within particular contexts, using data collected from smartphones after the Boston Marathon Bombing. The data collection utilized an app, which evaluated the call and text logs of Boston residents for the hours after the bombing, and queried respondents regarding the nature of their relationship with particular, observed alters (friend, kin, coworker, etc.). The analysis highlights particular behavioral signatures related to specific relationship types (e.g., respondents—mostly in their 20s and 30s—tended to have long calls with their mothers, but many texts with friends).

Potential Army/Military Applications

The proposed research, while basic, has the potential to contribute to a number of Army-relevant competencies. First, Army forces have long been asked to serve overseas, often in areas with very different cultural backgrounds from the United States. With the increased importance of winning “hearts and minds,” as well as the Army’s increased involvement in counterinsurgency and peacekeeping operations that are categorically distinct from traditional warfighting, it is necessary for friendly forces to have improved knowledge of local cultures. Our research will, at a minimum, contribute improved knowledge of the relational scripts that govern interactions in different parts of the world. Since these scripts are the basic mechanisms used by individuals to interpret and coordinate interactions, training in these scripts can substantially reduce friction and improve operational capabilities. Critically, the same functionality could not be gained from working with area experts as they specialize in specific cultures, thereby sacrificing the ability to accurately measure the same scripts across a wide variety of cultures and sub-cultures. Put differently, such experts know what their specialty culture does, but are far less able to relate it to any other culture.

Second, by using Blau space methods to capture culture as an assemblage of relational scripts, we will have a robust, quantitative, and predictive approach for modeling culture. This approach should enable us to detect the presence of sub-cultures, understand their similarities and differences to dominant cultures, and quantify the degree of similarity or difference between different cultures. This will 1) benefit the ability to interact successfully with local residents, 2) prove useful for measuring and modeling functional and dysfunctional cultures among Army units, and 3) facilitate combined arms operations with other services that have their own unique cultural configurations. Third, it should be possible to assess the degree of script compatibility between individuals or within groups using these Blau space models. This would be tremendously beneficial to improving unit cohesion by allowing cultural disconnects to be identified more clearly and should greatly aid blue/green force interactions, which require tight coordination in stressful and often chaotic situations. Most intriguing, we may be able to identify the specific individuals in a unit who are most likely to be able to smoothly interface with allied forces based on their underlying script similarity, rather than by making guesses from more easily observable background characteristics. In short, these methods offer the chance to identify real similarities rather than just apparent similarities between individuals drawn from a wide international cross-section.

Third, Blau space models have previously been applied to the problem of identifying and penetrating the networks of sub-state actors planning CBRN attacks against the U.S. and her allies (HDTRA1-10-1-0043). This demonstrates the wide potential applicability of the modeling capabilities we are developing and we anticipate that the improved methods that emerge from this project will, in turn, provide the foundation for new capacities in the future.

Finally, development of visual vignettes has potentially far-reaching utility. While we envision these as primarily a research tool, they have the potential to be used as assessment tools applicable to both U.S. and non-U.S. personnel, regardless of linguistic competency. Such tools can help to measure the interpersonal skills/tendencies of personnel and can likely be adapted to facilitate training in these areas. Thus, we anticipate that these methods will contribute to Army assessment and training capabilities in the U.S. and overseas.

Future Plans

The last year of the project has unsurprisingly been significantly impacted by COVID-19. During the Spring semester of 2020 we were forced to shift to entirely virtual teaching/collaboration and associated difficulties derailed a planned data collection.

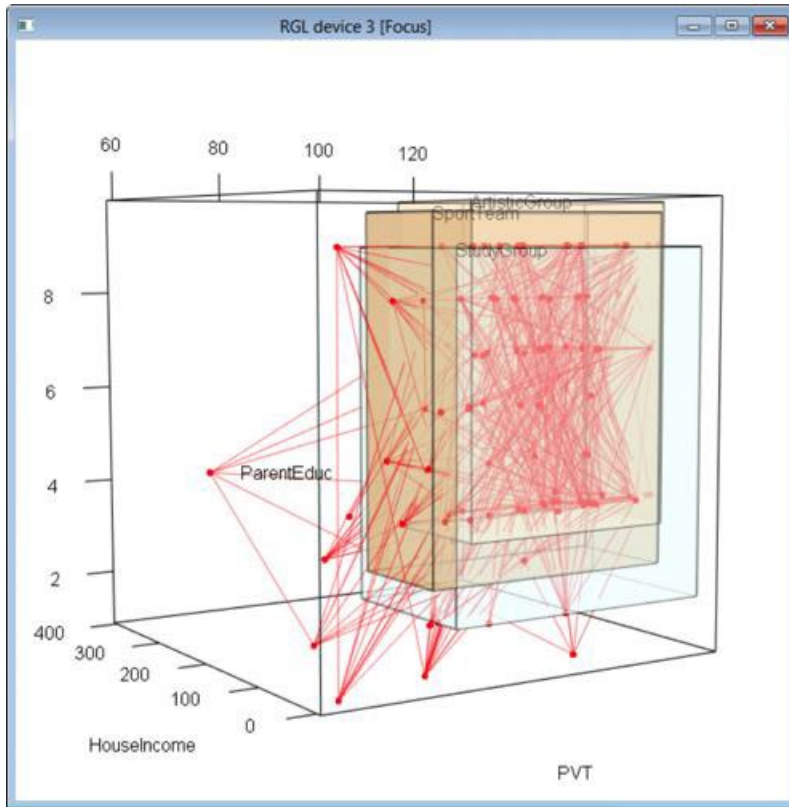


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Figure 5

Blau Space Model Using IQ (x), Parental Education (y), and Household Income (z) as Dimensions



Note. Various high school groups recruit members primarily from the shaded boxes, and overlaps between the boxes indicate competition. The red points are individual students in the same space and red edges are respondent-reported network ties linking these individuals. This reveals the presence of individuals not overlapped by any organizational niches who represent key network shortcuts between organizations who do not actually belong to any organizations. We would model relational scripts as competing in Blau space, predict script change using the AEM, and explore patterns of overlap with individuals and concrete network ties. Rendered using the BlauNet package (V2.0.1) for R.

Additionally, data collected during and following this period on other projects suggests that measures taken to deal with COVID-19 are inducing measurement changes in responses to data collection instruments, and so the long-term viability of data collected during the current time period is open to debate. In addition, the project was expected to end at the conclusion of Summer 2020 but has remaining funds because planned activities were prevented by COVID-19. We were issued a no-cost extension as part of the response plan to COVID-19 that would have allowed us to continue normal operations during Fall 2020, but we did not become aware of this until approximately November of 2020, and as such operated the project as a lower activity level. We anticipate receiving a no-cost extension to cover operations for the Spring 2021 semester, which will allow us to 1) complete work on our permutation test paper, 2) complete a paper introducing our new competition coefficient metric, 3) complete work on the new paper describing our rapid script inventory approach, and 4) execute an additional data collection to support project objectives, with the expectation of completing a paper draft by the end of the year.

Associated Publications

Brashears, M. E. (2017, March). *Dimensional analysis in Blau space models: Preliminary report* [Symposium]. Southeastern Sectional Meeting of the American Mathematical Society, Charleston, SC.



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- Facciani, M. & Brashears, M. E. *Survey methods for quantitative cross-cultural assessment of workplace interactions* [Manuscript under review].
- Facciani, M. J. & Brashears M. E. (2018). How culture influences our judgement of social scenarios [Symposium]. Group Processes Conference, Philadelphia, PA.
- Facciani, M. J. & Brashears M. E. (2019). Visual vignettes for cross-national research [Symposium]. Group Processes Conference, New York, NY.
- Facciani, M., Brashears, M. E., and Zhong, J. (2020). Visual vignettes for cross-national research. *International Journal of Social Research Methodology*, 1-15. <https://doi.org/10.1080/13645579.2020.1844897>
- Lazer, D. (2020). Networks and information: The second golden age. In B. Foucault Welles & S. Gonz  les-Bail  n (Eds.), *Handbook of communication in the networked age*. Oxford, UK: Oxford University Press.
- Facciani, M. (2020). *How self-sentiments and personal networks influence political polarization* [Doctoral Dissertation, University of South Carolina]
- Mattsson, C., Margolin, D., Wojcik, S., & Lazer, D. (2021). *Putting social ties in context: Insights from a pilot study during a sudden emergency* [Manuscript in preparation for submission to *Social Networks*].
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Building Better Teams: A Network Analysis Approach

Project #: W911NF-18-1-0233

Contract Dates: JUL 2018 – NOV 2022

PI: Alexander Volfovsky

Institution: Duke University

Co-PIs/Subcontractors: James Moody, Duke University; Raquel Asencio, Purdue University

Abstract

Social networks can be used to define and predict important kinds of interdependencies between people in a social group. The patterns of interdependence define how information and attitudes flow and evolve in groups and how coordinated action may develop. Dynamic network models are used to understand how these relationships develop and evolve over time and how these changes impact and are impacted by group-level behavior. The overarching goal of this project is to use statistical network analysis to improve understanding of team dynamics and performance.

Introduction

Team dynamics and team composition are naturally characterized by underlying networks of interactions and communications among team members. We propose to study these networks to better understand how teams achieve their goals, how each member contributes to the team's success or failure, and how to construct quality teams. In terms of inferential goals, we propose to study these networks to better understand how team behavior evolves, what each person contributes, how to differentiate between successful actions and those that fizzle away, and how to construct quality teams. To date, research on team dynamics has focused on individual traits as the key to quantifying leadership and group performance. Rather than continuing that focus, our approach is to take a holistic view of team development. The proposed statistical models will yield an understanding of how networks of individuals change dynamically as a reaction to external and internal stimuli as well as an embedding of team network information in a latent social space where it will be possible to identify and evaluate desirable leadership and successful team performance traits.

Research Approach

We have a two-pronged research approach: 1) developing statistical methods and tools for analyzing already available data on dynamic networks and 2) curating a novel dataset that can directly target the evolution of a team. On the first front, we have developed multiple different models (one to analyze small teams, two different approaches to analyze the evolution of a network that experiences influence from a stochastic process, such as a disease or some new information being spread, one to evaluate community structure in one or more networks, and one to employ this community structure in more general network and causal problems) and are in the process of extending these approaches to other realistic data scenarios (such as missing and corrupted data). We have further developed methods to analyze text data that appears in group and paired contexts, especially when the interactions are short. On the second front we have collected a large-scale dataset on four interacting teams. We are in the process of curating these data for use with our models to help us extract meaningful insights into team and leadership development.

Accomplishments

We have developed a more advanced model for individual-level stochastic processes that builds on our previous work on S(usceptible)-I(nfected)-R(ecovered) models (that was previously published in the Journal of the American Statistical Association and won a best student award). The extension, currently in pre-print (to be submitted to the Annals of Applied Statistics) allows for the analysis of stochastic processes on evolving networks when recovery *and* exposure times of events are missing – this can no longer be achieved in a simple data augmentation setting and requires the development of a stochastic Expectation-Maximization algorithm. We further developed tools for understanding causality in the presence of text data. Building on our approach to short-text modeling (under review), we designed a mechanism for assessing whether text mediates a causal effect. This type of sensitivity analysis is needed when non-intervention arms do not collect text data (e.g., some people are randomized to a leadership academy where they have conversations with their peers while others are randomized to have no intervention – the question is whether the leadership academy experience is different for individuals with different peer-conversations and whether the total causal effect of “leadership academy” on leadership quality can be decomposed into direct and indirect (conversation-based) effects).



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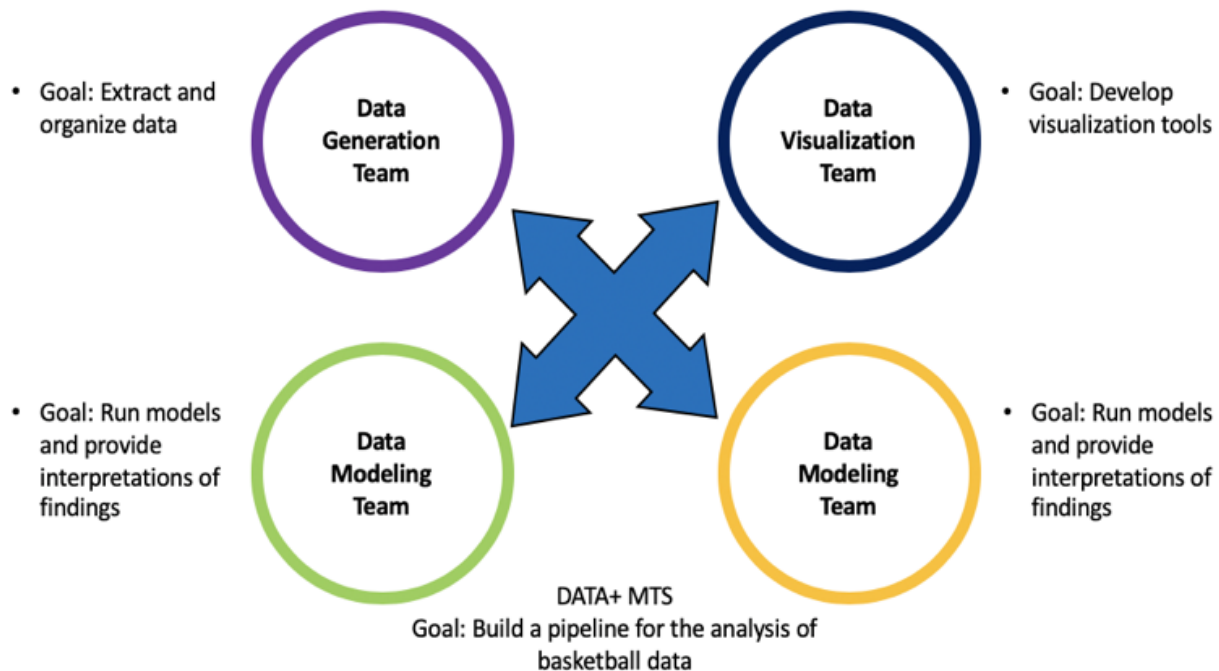
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We have had several developments in modeling of multiple dependent networks. For example, we can combine information from different types of communication networks to better understand the individual behavior.

Since the previous report we have also made progress on curating the data from our large scale study. For this study, we focused on a single multi-team system (MTS) comprising 10 students enrolled in DATA+, a 10-week summer program at Duke University. The DATA+ program assembles undergraduate students into teams led by graduate students and faculty for a summer research project. We had the opportunity to observe four of the DATA+ teams. Figure 1 illustrates the component teams and associated goals/functions. Preliminary analysis was presented at the Dissecting the Dynamics of Team, Multiteam, and Organizational Systems panel at SIOP. We are in the process of extracting gesture and additional mobility data from the videos – Figure 2 presents the way these data are coded and showcases the type of information that can be extracted.

Figure 1

Illustration of the DATA+ MTS Component Teams and Associated Functions



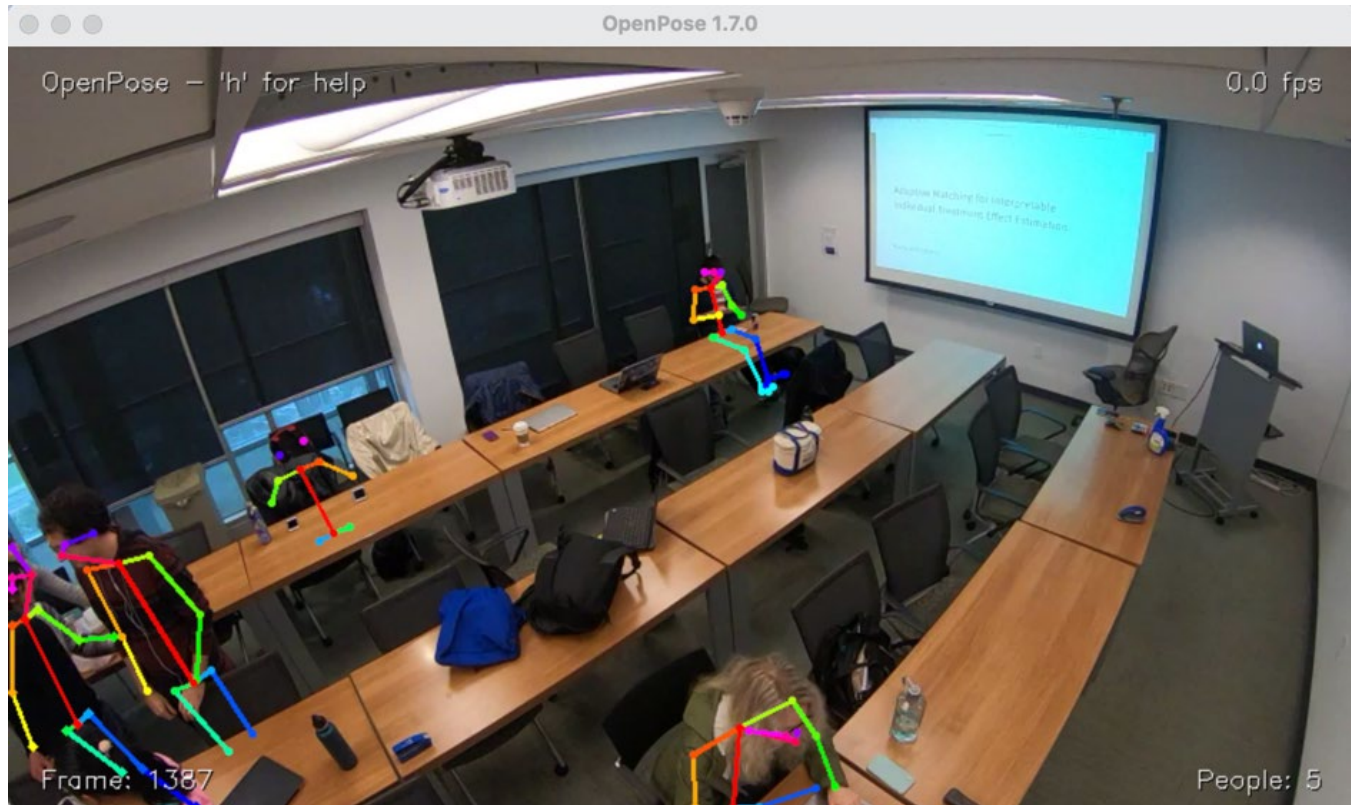


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Figure 2

Example Output from OpenPose of Gestures in a Room



Note. Videos of the gestures can be analyzed for “poses” (such as “pointing to the board,” “speaking to,” “listening to,” “arm-crossing while talking”) as well as for general mobility. Once all the data are extracted they can be analyzed anonymously, since they do not need to be overlaid with the actual video. We will connect these gestures with other observed characteristics and survey responses.

Contributions to Basic Research

We have collected the first natural-experiment dataset on a multi-team system that includes video of nearly all interactions among the participants of the different teams over a 10-week period. We also collected their work products, online communications, and weekly survey responses. Following our analysis, we will work to make this dataset (as well as the procedure by which it was collected) publicly available for other researchers to study and replicate.

We have also contributed to basic research in statistical theory and methodology:

1. Published in First Workshop on Causal Inference & NLP:
 - a. Developed a sensitivity analysis for the mediating effect of text in a randomized experiment under partially observed text data.
2. Published in American Journal of Epidemiology:
 - a. A simulation-based approach for understanding the effect of homophily (similarity among people who are connected by a network) on the effectiveness of network interventions.



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3. Forthcoming in Clinical Therapeutics:
 - a. A review of reinforcement learning for graph processes. This is preliminary work for improving graph data collection and deployment of sequential experiments (such as understanding how to manipulate team composition over time to increase overall output).
4. Pre-print on individual-level likelihood epidemics with missing observation times:
 - a. Provided a computationally tractable inference procedure when incomplete data are available for recovery and exposure times of individuals in a stochastic process.
5. Pre-print on clustering and topic modeling of short text:
 - a. Problem: Classical algorithms for studying text data rely on the text in question being extremely long, but conversations among individuals rarely include long soliloquies.
 - b. We developed a tool for studying short text which allows speakers to cluster together – this allows us to identify overall individual patterns of text within larger communities.

We will use these methodological and theoretical tools to analyze the data we are curating.

Potential Army/Military Applications

Almost all DOD activities are characterized by complex interdependent teams at multiple levels, and the tools developed here could be built into the simulation and training regimes already in place. For example, squad organization could be assessed by training a model like the one developed here during repeated exercises. Combined with remote sensing tools already in place to track combatants, one could train a model for how best to organize activity in near real time. Furthermore, much of the data that DOD collects includes the flow of information through dynamically changing networks/channels which can change as a reaction to the information that they receive. One can leverage the tools we propose to evaluate how quickly the channels will react or how wide the information will spread.

We anticipate that the data collected from our study of small research teams working towards a common goal will shed light on what type of leadership qualities are needed (or emerge) in such multi-team systems.

Future Plans

We are working on incorporating additional structure into the models of networks interacting with stochastic processes. This will allow for more flexible modeling of information passing over a network. We are particularly excited about developing new tools for identifying relevant network features and deploying novel interventions on partially observed networks.

We continue to extract more from the video data we collected from our experiment. We are starting to analyze the detected gestures towards developing a taxonomy of visual leadership behavior.

We are developing an agent-based modeling approach to small-group dynamics – this will allow us to capture how different decision making techniques affect group success. We will apply these models to the data extracted from our experiment.

Associated Publications

- Bu, F., Aiello, A. E., Xu, J., & Volfovsky, A. (2020). Likelihood-based inference for partially observed epidemics on dynamic networks. *Journal of the American Statistical Association*, 117(537), 510-526.
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- Mathews, H., Mayya, V., Volfovsky, A., & Reeves, G. (2019,). Gaussian mixture models for stochastic block models with non-vanishing noise. *2019 IEEE 8th International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP), Guadeloupe*, 699-703. <https://doi.org/10.1109/CAMSAP45676.2019.9022612>
- Tierney, G., & Volfovsky, A. (2021). Sensitivity analysis for causal mediation through text: An application to political polarization. *Proceedings of the First Workshop on Causal Inference and Natural Language Processing*, 61-73. <https://doi.org/10.18653/v1/2021.cinlp-1.5>
- Weltz, J., Volfovsky, A., & Laber, E. B. (2022). Reinforcement learning methods in public health. *Clinical Therapeutics*, *44*(1), 139-154. <https://doi.org/10.1016/j.clinthera.2021.11.002>
- Zivich, P. N., Volfovsky, A., Moody, J., & Aiello, A. E. (2021). Assortativity and bias in epidemiologic studies of contagious outcomes: A simulated example in the context of vaccination. *American Journal of Epidemiology*, *190*(11), 2442-2452. <https://doi.org/10.1093/aje/kwab167>



Optimizing Team Composition

Project #: W911NF-19-1-0094

Contract Dates: MAR 2019 – MAR 2022

PI: Scott I. Tannenbaum

Institution: The Group for Organizational Effectiveness, Inc. (gOE)

Co-PIs/Subcontractors: John Mathieu, University of Connecticut

Abstract

Teams are a basic building block of modern organizations and research shows that who is on a team greatly influences its effectiveness. Achieving the “best combination” of members is intuitively appealing but difficult to implement in practice. Several related needs must be met before the research can be used to form teams across the Army. First, there is a need for a more integrated theory of team composition and a need to build more advanced predictive models (e.g., neural networks, machine learning). Second, there is a need for more sophisticated optimization routines (e.g., decision diagram-based algorithms) to overcome computer limitations (the “optimization challenge”). Third, there is the need to apply the theory, models, and routines to more complex team staffing decisions. This program of research addresses these needs.

Introduction

Research has revealed a great deal about team effectiveness, including how team membership can influence its success. However, several related needs must be addressed before the Army can widely apply that research to practical team composition challenges. To advance the science and apply it in the Army and beyond, there is a need to: 1) enhance and extend existing team composition theory to consider the role of time and to address different types of team staffing decisions (e.g., forming a new team; replacing a single team member; assigning a pool of Soldiers to form several qualified teams); 2) refine existing and explore alternative predictive models, such as neural network techniques; and 3) establish sophisticated optimization techniques so the research and models can be used to provide timely, practical information to leaders who need to form teams.

The goal of this program of research is to address those needs, and in particular, to develop suitable optimization techniques. There are an enormous number of possible solutions to any complex team staffing decision, such as assigning 200 Soldiers to create 20 similarly qualified teams. Computers have been unable to process all possible alternatives in a reasonable amount of time, and this limitation is a primary obstacle to the development of usable decision aids. However, this obstacle could be overcome through the development and application of optimization algorithms that work with composition models that predict team effectiveness for a variety of team staffing decisions. Meeting this goal will enable the advancement and application of future team effectiveness research and will allow for the subsequent development of practical Army decision aids.

In sum, the goals of this research are to: 1) outline a variety of different team staffing scenarios and their implications for member deployment decisions; 2) advance and apply alternative composition models for predicting team effectiveness; and 3) develop and test different optimization algorithms to best deploy available members to teams so as to maximize the overall effectiveness of the system.

Research Approach

During this effort, we review and extend existing theories and models of team composition to ensure that they apply to Army team staffing decisions. We refine and develop alternative predictive models for relevant scenarios, and we explore and develop optimization routines that can be used with the predictive models to assign individuals to teams under different conditions. Using existing and new laboratory and field data sets, we will test and refine the techniques. We also conduct an experiment using students competing in a business simulation to test the predictive validity of our techniques.

Accomplishments

We reviewed existing information on staffing decisions to confirm the types of staffing decisions to be addressed in this effort, identifying both simple and more complex types of team staffing needs. We have been refining and extending theoretical models by drawing from the strategic human resource management (SHRM) literature, in particular considering how strategic intent can influence the decision process (see Gallagher, Mathieu, & Reilly, under review).



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We have been examining three predictive model approaches: 1) SME derived weights; 2) ordinary least squares solutions (OLS); and 3) neural network (NN) solutions. Based on the solutions we identified previously, we conducted a multi-semester experiment where student teams participating in a strategic business simulation were randomly assigned to three conditions: 1) control (31 teams); 2) OLS optimized (35 teams); or 3) NN optimized (30 teams). We are testing the impact of composing teams in the different manners. Preliminary results suggest that OLS optimized teams perform slightly better than NN optimized teams, with both performing better than control teams.

We are also examining our approach using archival data from trainees preparing to deploy as Army Transition Teams (see Donsbach, et al., 2011). Using self-report measures of individuals' knowledge, skills, abilities, and other (KSAOs) characteristics from 863 participants, we are modeling the potential of different team configurations. We are employing a SME weighting scheme to represent the predictive model, then leveraging a dual heuristic optimization model and solving for different team staffing configurations. For instance, in one application the goal is to form 10 teams in a way that maximizes the average performance of those teams. In another application, we set the goal to form three elite teams while simultaneously maximizing the performance of the seven remaining teams.

We also continue to examine optimization algorithms. We applied five different algorithms that differed primarily on whether all potential member combinations are considered. We extended that work and adopted heuristic optimization algorithms that provide a more flexible and scalable option than exact algorithms. As seen in Figures 1 and 2, early results suggest that "genetic algorithms" show promise. Figure 1 illustrates how such an algorithm can be adjusted to maximize different desired outcomes (e.g., maximize average performance across teams), while Figure 2 compares predicted performance in optimized vs. non-optimized teams.

Contributions to Basic Research

The methods, algorithms, and routines developed as part of this effort can assist future basic research efforts. Researchers will be able to use them to test research assumptions and hypotheses about the impact of various team composition decisions. In addition, they will make it easier to transition future basic research results into applied policies and tools.

In terms of concrete contributions, we are clarifying the types of models that may be most appropriate for different staffing scenarios. That type of basic understanding is essential for being able to conduct targeted research in the future. Second, we are building out the general models outlined by Mathieu et al. (2014) using different predictive models, such as subject matter expert's subjective weightings, Linear Regression models, and Neural Networks. These models will provide a foundation for future research that moves beyond simple means, variances, or extreme scores of members' characteristics. In other words, it will allow researchers to examine more complex models that are more likely to predict future team performance. Third, to date, even relatively simple decisions, such as assembling a single team from a pool of applicants, have proven to be challenging and it has not been feasible to consider all potential member combinations for moderate to complex applications. This is a key obstacle that needs to be resolved. Our work is designed to overcome this obstacle and to provide a useable approach for examining team composition decisions under different staffing scenarios.

When forming teams, there is often more than one desired outcome. For example, the goal may be to boost production levels, while simultaneously maintaining high safety levels. In such an instance, you would not want to assemble a team made up of individuals who are all high risk takers. In another setting, you might want to assign people to teams in a way that maximizes the teams' performance while also allowing room for developmental growth and learning for the team members. Historically, most of the basic research on teams has focused on a single outcome at a time. For instance, Wolfson and Mathieu (in press) illustrated how composing teams of different member combinations (from a pool of available members) in terms of their competencies and previous work experience with one another yielded greater overall long-term performance in different situations. Figure 1 illustrated the maximization of different outcomes separately; we are now examining multiple outcomes simultaneously. In addition, most existing models are static and do not consider the impact of time. Our approach can be extended to consider how needs, goals, and requirements may change over time. For instance, some teams must be ready to perform at a high level when first deployed, while others have time to develop. These require different staffing solutions. Our methodology can be adapted to address time-based factors.

Potential Army/Military Applications

The ultimate goal of research on team composition is to enable the development of tools and decision aids that can inform and allow Army decision makers to address a range of team staffing challenges effectively and efficiently. The proposed



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research is a necessary step toward that goal. Clever models that cannot be implemented in a timely fashion are of little value for research or applied purposes. Currently, due to computer processing limitations, tool developers are unable to employ the most sophisticated staffing models or develop useful tools to tackle complex team composition challenges. The innovative routines we are developing and testing should help overcome those limitations. If successful, they will allow developers to build deployable decision aids, enable policy makers to test assumptions, and equip leaders to make better informed team composition decisions. In other words, the models, algorithms, and routines developed as part of this effort could serve as an invisible engine inside future team composition tools and decision aids.

The ability to compose teams effectively, and to quickly examine the impact of potential reconfigurations, has obvious operational benefits. Assigning the right mix of people to teams creates a strategic competitive advantage. Unfortunately, the cognitive processing required to make complex team composition decisions exceeds a human's mental capacity. Decision aids are needed. This program of research should remove several key obstacles to the development of those tools. In addition to aiding operational decisions, composition tools based on our algorithms could also be used to assist during training. They could help answer questions such as, how do you assign a large group of trainees to teams in a way that increases their opportunities to learn? That is an example of another question that a human cannot answer effectively unaided. The assignment of trainees could be made more effectively using products based on this research.

Another application of this research is at the strategic or policy level. It helps to be able to anticipate the implications of a potential staffing policy or directive. For example, what is the impact of a proposed staffing requirement? What will happen to the remaining teams when the top candidates are all assigned to one team? Being able to model how a proposed policy, strategic focus, or potential decision can reveal whether it is likely to yield the desired results as well as surface possible unintended consequences. Tools can be developed based on our models that would allow decision makers to examine various alternatives. In that sense, the current program of basic research could serve as a bridge connecting team composition research with force deployment strategies.

Future Plans

We plan to continue to develop and document different team staffing scenarios based on the SHRM literature and Army staffing needs. For instance, these scenarios may range from identifying the best replacement from a pool of candidates, to distributing a large number of candidates to numerous teams.

We will continue to develop alternative predictive models for different staffing scenarios, team types, and weighting schemes. For example, following Mathieu et al. (2014), the effectiveness of some teams is more contingent on the members' position-related competencies, while in other teams, teamwork-related competencies may be a stronger predictor. These two examples would yield models, which may have implications for the optimization algorithms.

We are continuing to explore additional neural network predictive models and heuristic optimization algorithms and will consider dynamic temporal composition factors. We will further explore and refine our application based on the archival transition team data.

In the future, it would be beneficial to translate the findings from this program of research into tools that can be used for research and practical purposes, with the algorithms serving as an engine within a decision aid or tool.



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Figure 1

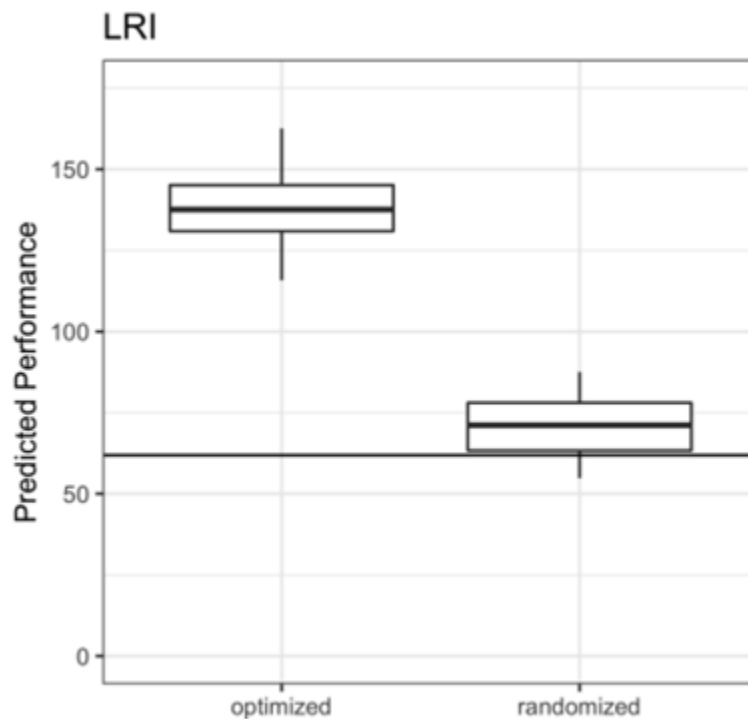
Example Results Using Genetic Heuristic Optimization

Objective	Mean	Max	Min	Var	3rd best	3rd worst
Maximize mean	123.041	191.637	53.1183	1795.94	89.6568	159.631
Minimize var	60.901	65.7567	56.0526	7.21118	59.7737	62.4124
Maximize min	75.2732	89.8466	63.6532	41.5853	71.8774	78.0716
Maximize $0.9 \cdot \text{mean} - 0.1 \cdot \text{var}$	90.0931	95.5006	64.4181	75.7204	90.9733	93.7149
Maximize 3rd best and average of rest	117.996	192.636	17.9341	2549.3	87.3546	157.848

Note. 40 students assigned to 10 teams to maximize different objectives.

Figure 2

Predicted Team Performance: Randomized vs. Optimized Assignment



Note. 40 students assigned to 10 teams: Performance predicted by Linear Regression (LRI)

Associated Publications

Gallagher, P. T., Mathieu, J. E. & Reilly, G. (2021). *Managing unit human capital resource deployments* [Manuscript in preparation, received R&R from *Journal of Management*].

Gallagher, P., Wolfson, M., Reilly, G. & Mathieu, J. *Managing unit human capital resources: Integrating insights from human resource management and team literatures* [Manuscript in preparation, received R&R from *Journal of Applied Psychology*].



Learning in Formal and Informal Environments Overview

Army Need

The U.S. Army's current and recent operational tempo continues to necessitate a rigorous training schedule and institutional education opportunities. In addition, the operational landscape has evolved to include irregular warfare, stability operations, and other forms of military operations. The Army seeks to understand how to maximize all opportunities for learning across a diverse range of operations (e.g., combat, peacekeeping missions).

To meet these modern operational goals, Soldiers will be responsible for developing a broader array of skills and acquiring higher levels of proficiency earlier in their careers. In some instances, Soldiers may be required to retool existing knowledge and skills within their current or new occupational specialties in highly dynamic environments. This need will require a sustained focus on maximizing learning from formal and informal learning environments while reducing the length of time to achieve skill mastery. Uncertainty about future operational environments will also require all Army personnel and units to identify critical operational areas in need of development and to learn quickly from informal learning experiences, including their battlefield experiences, mentoring, shared experiences of others, and self-development.

The overarching research goal in the learning in formal and informal environments portfolio is to develop novel, multidisciplinary theories conceptualizing learning as a dynamic, multi-level, multiscale process spanning spatial, social, and temporal contexts. Through such theories, a secondary goal is to understand the dynamic processes of how individuals and collectives develop, refine, and maintain the technical and tactical skill configurations necessary to navigate complex and uncertain environments. The key research objectives associated with these goals are explained below.

Key Research Objectives

Choice and the Individual Learner

ARI's Basic Research Program seeks to develop and evaluate formal (e.g., mathematical, computational) theories of learner choice behaviors spanning situational complexity and temporal scope (e.g., from highly structured, formal basic training to more unstructured, informal advanced individual training). The program also aims to develop and demonstrate novel construct validation methods focused on behavioral, high-dimensional, and longitudinal data for inferring learner psychological states across diverse levels of theoretical granularity (e.g., from low-level behaviors to high-level self-concepts).

Skill Development in Context

The Basic Research Program strives to model the complex, nonlinear, and evolving nature of skills (e.g., dynamic skill networks, skill ecologies) across a wide range of spatial, social, and temporal contexts (e.g., within- and between-individual, within- and between-task, within- and between-collectives). The program aims to identify the fundamental properties common to a wide range of skills (e.g., spatial skills, leadership skills, complex problem-solving skills) and identify/ model the key contextual factors within which such properties are more and less likely to emerge (e.g., strong vs. weak situations, open vs. closed loop tasks, feedback vs. feedforward systems).

Multiscale Learning Theory and Methods

The Basic Research Program aims to develop dynamic and longitudinal learning theories that integrate traits (e.g., personality), states (e.g., fear), and situations (e.g., new assignment) incorporating both top-down (i.e., general-to-specific, such as from personality traits down to psychological states) and bottom-up processes (i.e., specific-to-general, such as from individual learning experiences up to personality traits). In a similar vein, it seeks to develop and evaluate formal (e.g., mathematical, computational) learning theories spanning both conceptual levels (e.g., individual, collective, organization) and temporal scales (e.g., episodic, developmental period, career) with an emphasis on cross-level and cross-scale dynamics (e.g., short term individual learning influencing long-term organizational skill profiles through mid-term collective knowledge and skill transfer).



Learning in Formal and Informal Environments Currently Funded Research

ARI's Basic Research Program is currently funding five extramural research projects. Brief descriptions of the projects are provided below, with detailed research summaries of each project provided on the subsequent pages.

Affective Forecasting Errors: Implications for Individual Learning and Performance

(W911NF-16-1-0513; 2016-2021)

Dr. Seth Kaplan (George Mason University) and colleagues are using experience sampling methodology and are conducting laboratory investigations to identify when affective forecasts about work-related tasks and events are more or less accurate and the implications of these (in)accuracies on task performance.

Examining the Role of the Curiosity Drive as a Facilitator of Formal and Informal Learning and Adaptability during Newcomer Socialization

(W911NF-20-1-0311; 2020 – 2023)

Dr. Jay Hardy (Oregon State University) is studying curiosity as a universal drive to produce a novel theory of curiosity that will support interventions designed to enhance learning and adaptability in newcomers.

Motivation, Learning, and Performance: Developing a Detailed and Comprehensive Computational Theory

(W911NF-17-1-0236; 2017-2022)

Dr. Ron Sun (Rensselaer Polytechnic Institute) and colleagues are developing a comprehensive theory and detailed computational model of how motivation affects learning and performance based on empirical data.

Promoting Informal Self-Regulated Learning: A Multi-Level Approach

(W911NF-19-1-0142; 2019-2022)

Dr. Jason Randall (University at Albany, State University of New York) are examining the mechanism behind how informal learning occurs in team settings to help the Army and other organizations to promote informal learning on the job.

Variability in Repeated Adaptive Performance (VARI)

(W911NF-19-1-0453; 2019-2023)

Dr. Mindy Shoss (University of Central Florida) investigates how individuals differ in their ability to adapt with a specific focus on whether these differences are linked to personality traits.



Affective Forecasting Errors: Implications for Individual Learning and Performance

Project #: W911NF-16-1-0513

Institution: George Mason University

Contract Dates: SEP 2016 – JUN 2021

PI: Seth Kaplan

Co-PIs/Subcontractors: Jill Bradley-Geist, University of Colorado, Colorado Springs

Abstract

When thinking about deployments, the battlefield, or training exercises, Soldiers have expectations about how they will react. Those anticipated reactions may take the form of excitement or concerns about how one will respond when in-the-moment. The current research investigates how such anticipated reactions (or “affective forecasts”) impact task performance once in the scenario. Two studies showed that positive predictions about the upcoming event were associated with better performance. Also, experiencing the task as more positive than anticipated was associated with further performance gains. These findings imply that training should induce positive, but not overly positive, expectations about upcoming scenarios. Two other studies – one of runners and one of equestrians – showed that both groups predicted their upcoming events to be more unpleasant than they later turned out to be. These findings suggest a tendency to overestimate negative reactions to challenging tasks.

Introduction

Intuition suggests that current thoughts and reactions drive behavior. However, decisions and behavior often reflect not only current circumstances, but also considerations about the *future*. For instance, individuals who are “not in the mood” to exercise still may choose to do so because they recognize the long-term health benefits of exercise. Indeed, the capacity to overcome short-term barriers to achieve long-term gains is one of the fundamental aspects of human motivation. A considerable amount of research examines the factors that influence people’s ability and willingness to overcome this challenge (Halpern & Arnold, 2008).

In choosing whether or not to exercise, though, there is another potential consideration beyond the outcomes (e.g., health benefits, weight loss, etc.) one obtains from such exercise. This other consideration is the relative enjoyment of the activity (i.e., the exercise) itself. Whereas people easily may be able to cite the outcomes of engaging in a given task or activity, they may fail to recognize how they will react during the task itself. That is, irrespective of other outcomes, one may like the experience of the activity more or less than predicted. Thus, one fundamental issue we address in this research is whether – and when – anticipated reactions to performance tasks/activities are more or less accurate.

Beyond this question of accuracy, we explore the implications of such accuracy or inaccuracy for performance during the focal task. When one enjoys exercising more than anticipated, for example, does that positive reaction create a positive spiral in which individuals exercise more intensely (e.g., run faster) than they would have had they predicted enjoying the exercise? This is the second main topic we address here – the performance implications of anticipated reactions for later performance.

The answers to these questions have both theoretical and practical significance. Theoretically, they extend literature on the concept of affective forecasting. This literature shows a general tendency to overestimate reactions to negative life events (Wilson & Gilbert, 2005). But, it has not examined the accuracy or implications of forecasts about task-related performance. Practically, these findings can inform training programs and also leader communication (e.g., before deployments) so that leaders can “strike the appropriate chord” in modulating Soldiers’ anticipated reactions.

Research Approach

We are studying these topics in real-world performance contexts. Although there are trade-offs between field versus laboratory research, the research team decided that priority should be placed on studying individuals engaged in consequential tasks. The basic research design is as follows: First, individuals are asked a series of questions including their anticipated reactions during the upcoming performance task/activity (e.g., “how will you feel when completing “X” work task or when running the upcoming race?”). Then, immediately after completing the task/activity, individuals report their reactions while they engaged in that task/activity. This allows for examining the consistency between anticipated and experienced reactions.



We also collect performance data. In some cases, this is self-reported performance, and in others it is objective performance data (e.g., race time). Having these data allows us to examine how anticipated reactions relate to actual performance and how consistency between anticipated and experienced reactions relates to performance.

Accomplishments

We separately examined more mundane, “everyday” performance contexts and more intense and demanding performance contexts. Findings show that, in the more common contexts (i.e., individuals completing their job duties and students studying for an upcoming exam), there was not a systematic tendency to anticipate the task as being more or less enjoyable than it later turned out to be. Some tasks were more pleasant (or less aversive) than anticipated and others were less pleasant than anticipated. But, there was not a systematic pattern.

In contrast, the results from the more extreme environments (e.g., a running race and an equestrian event) reveal a systematic tendency to over predict how negatively one would react. This latter result is consistent with the affective forecasting literature showing that people often tend to overestimate the intensity of negative reactions (Wilson & Gilbert, 2005).

The difference between the two sets of findings seems to be due to the context. Anticipated negative reactions were higher in the running and equestrian contexts than in the work and studying contexts. These results suggest that, in at least some demanding performance-related tasks, there is indeed a consistent pattern of overestimating negative reactions about engaging in that task.

We also have examined the second topic noted above – that of how anticipated reactions (and the difference between the anticipated and actual reactions) relate to performance. The findings from both the sample of employees reporting about their work tasks and the students reporting about studying were similar. Anticipating more positive reactions was associated with better performance. In contrast, anticipating more negative reactions (e.g., worry, frustration) was associated with poorer performance. Of note, these anticipated reactions predicted performance beyond (i.e., after statistically accounting for) reactions during the performance episode. These findings help rule out the possibility that the reason positive anticipated reactions relate to better performance is because they foster better reactions during performance. Rather, the discrepancy itself may have motivational value. We also have found that reacting more positively than anticipated was related to especially favorable performance. This finding implies that there are limits to how favorable anticipations should be about upcoming task performance. A moderate level of anticipated positivity seems to be ideal. We display illustrative results from these analyses in Figure 1.

However, there was no relationship between discrepancies and objective or subjective performance in the more demanding performance scenarios of running or an equestrian competition. So, whereas competitors in these contexts were broadly inaccurate in predicting their emotional reactions, those inaccuracies were not reflected in their performance. We suggest that this null relationship may reflect the ability-driven, intense nature of performance in these contexts. Thus, in general, the overall findings of this research paint a more complicated picture of forecasting biases and inaccuracies, and they moreover emphasize the relevance of the performance task and context.

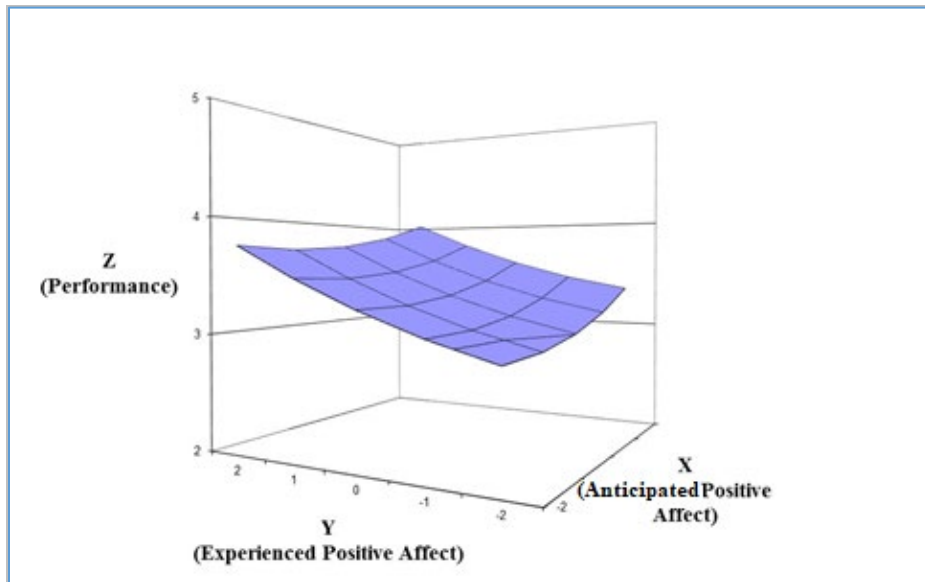
Contributions to Basic Research

These results can inform several areas of basic research. First, they extend the literature on affective forecasting. Research on this topic generally explores anticipated emotional reactions when people consider and experience discrete (and sometimes uncontrollable) events (e.g., receiving a diagnosis of a disease) or when people make choices and decisions (e.g., about social relationships or health-related matters; Halpern, & Arnold, 2008). In none of these cases are individuals considering their reactions while behaving in activities that will require sustained effort to accomplish a task. Here, we separated the reactions resulting from choices and outcomes from reactions one anticipates about *engaging in the effortful behaviors*. The results to date suggest that the existing affective forecasting findings generalize to more extreme performance contexts – in that individuals systematically over-predicted their negative reactions. However, for more commonplace and less intense activities (e.g., work tasks and studying), predictions about future reactions were somewhat accurate and not systematically too negative. This finding adds to the affective forecasting literature and to our understanding of anticipations about normal and more extreme events. We may spend much time worrying about performance during the latter – largely unnecessarily so.



Figure 1

Response Surface Area From Study of Employees Reporting About Upcoming Job Tasks/ Activities



Note. Performance is predicted by anticipated affect (reactions), experienced affect (reactions), and their discrepancy.

The performance results also add to the literature on affect (i.e., moods and emotions) and task performance. Although common sense suggests that emotions have strong impacts on job behavior and performance, results generally show only modest effects (Kaplan, Bradley, Luchman, & Haynes, 2009). The current findings suggest that anticipations about how we will feel during upcoming performance also are an important piece to understanding the role of affect in task performance. Intuitively, this too makes sense. We engage in certain behaviors because of the outcomes they will provide. What the current findings, suggest, though, is that reactions about how we will feel *during that task engagement* also matter. However, other tasks and contexts that are more physically demanding, drawing more so on a person's ability than their psychological state, may elicit inaccurate expectations that do *not* factor into overall performance. Overall, the importance of emotions and their anticipation may depend in large part on the context of the task at hand.

Practically, the findings have implications for the development of training programs, perhaps especially for leaders, and for the design of pre-mission briefings. The results imply that the tenor of training materials and of leader communications should be tailored to the nature of the upcoming event. Although obviously not conclusive, the current findings recommend that Soldiers may overestimate the negative reactions of some task activities (e.g., training exercises) but not other, more mundane ones. Also, the results imply that training and leader messages should aim to foster moderately positive reactions to maximize Soldier performance.

Potential Army/Military Applications

This research has several applications for the Army/military. First, with respect to training, it suggests that there may be value in crafting anticipated reactions to more commonplace/mundane activities. Furthermore, it suggests that, for more intense performance exercises (e.g., intense training assignments), there could be a tendency to predict the activity/task as being more aversive than it later turns out to be. While we have not yet established that inconsistency in predictions is linked to performance in these more extreme contexts, preliminary analyses suggest that there is at least no loss of performance from mitigating some of the unpleasantness that otherwise may accompany future scenarios. Obviously, this depends on the context. In general, though, these findings do not imply a value in training programs fostering Soldiers' beliefs that they will react more negatively than reality suggests.

The findings also have practical implications for leaders. Perhaps surprisingly, the results to date suggest that anticipated reactions – and the discrepancy between anticipated and experienced reactions – are most important for performance in more



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commonplace and less intense scenarios. These are the tasks with which Soldiers likely are most familiar and that may fill up much of their days. As such, leaders may be less prone to think about how the Soldiers' think about these upcoming activities and the implications of those anticipations on performance. However, the current findings suggest that these are the activities/tasks for which leaders may be able to adjust reactions to most impact performance. In more intense and ability-driven activities, Soldiers' emotions may matter less for performance itself but may matter for other outcomes (e.g., psychological well-being), especially because discrepancies do seem to emerge more strongly in these contexts.

The results also suggest value in training for specific administrative tasks. For instance, delivering negative/critical feedback often may be less onerous than leaders infer it to be. Similarly, speaking with Soldiers about their personal challenges may be less daunting than leaders often reason it to be. In these cases, the performance benefits may manifest in the leaders simply performing these activities more often (rather than performing them better per se).

Future Plans

This research program was/is aimed at exploring “affective forecasts” (i.e., individuals' predications about how they will feel about/in future events/situations) within the context of job/task performance. Prior research had determined common errors/inaccuracies in people's affective forecasts about major life events/circumstances, including the tendency to overestimate the intensity and duration of one's emotional reaction. However, little/no research prior to the current program had examined the extent to which affective forecasting is accurate/inaccurate for task/work activities. Findings indicate that people may unduly “dread” upcoming tasks, especially when those tasks/activities are especially intense ones. In reality, their later emotions/experiences of such tasks are not as aversive as they had anticipated. Knowledge of this effect/inaccuracy may be incorporated into employee training/mentoring/coaching as a way to enhance self-efficacy and reduce counterproductive tendencies including procrastination and avoidance of a work task. Findings also demonstrated that anticipating the upcoming task to be more favorable was associated with better performance on it. There appears to be a limit, though, to how positive these anticipations should be. Expecting to feel too positively while engaging in the task may not benefit performance.

Going forward, our next step is to determine whether the relationship between affective forecasts and performance also holds in the more intense performance scenarios. If it does not, we will attempt to discern why that is the case. We also are in the process of writing multiple manuscripts – consistent with our original plan to complete data collection and then work on writing papers for journal submission.

Associated Publications

Aitken, J. A., Kaplan, S. A., Pagan, O., Wong, C. M., Sikorski, E., & Helton, W. (2021). Affective forecasts for the experience itself: An investigation of the impact bias during an affective experience. *Current Psychology*, 1-7.

<https://doi.org/10.1007/s12144-021-02337-8>

Aitken, J., Kaplan, S., Wong, C., Pagan, O., Sikorski, E., Helton, W., Bradley-Geist, J., Craig, L., & Bayley, B. (2020, August). *Leaning into discomfort: Accuracy of affective forecasts does not correlate with performance* [Poster]. 128th Annual Meeting of the American Psychological Association, Washington, D.C.

Biskup, M.J., Lei, X., Kaplan, S., Bradley-Geist, J., Wong, C.M., Craig, L., Pomeranz, K. & Ruark, G.A. (2018, April). Affective forecasting of work events: Effects of accuracy on performance. In S. Kaplan & J. Bradley-Geist (Chairs), *More than a feeling: Advancing the study of emotions and performance* [Symposium]. 33rd Annual Meeting of the Society for Industrial and Organizational Psychology, Chicago, IL.

Hughes, L., Pagan, O., Lei, X., Craig, L., Wong, C., Bradley-Geist, J., & Kaplan, S. (2019, May). *On the accuracy of job-related affective forecasts: A text-based analysis* [Poster]. 31st Association for Psychological Science Annual Convention, Washington, D.C.

Kaplan, S., Winslow, C., Craig, L., Lei, X., Wong, C., Bradley-Geist, J., ... & Ruark, G. (2020). “Worse than I anticipated” or “This isn't so bad”? The impact of affective forecasting accuracy on self-reported task performance. *PLOS ONE*, 15(7), e0235973. <https://doi.org/10.1371/journal.pone.0235973>

Winslow, C. (2017). *The role of affective forecasting in task behavior: How – and for whom – does (in)accuracy in emotional predictions impact task performance?* [Doctoral dissertation, George Mason University].



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Wong, C., Craig, L., Bradley-Geist, J., & Kaplan, S., (2019, April). *Emotional intelligence, affective forecasting, and police recruit performance* [Poster]. 34th Annual Meeting of the Society for Industrial and Organizational Psychology, National Harbor, MD.



Examining the Role of the Curiosity Drive as a Facilitator of Formal and Informal Learning and Adaptability during Newcomer Socialization

Project #: W911NF-2-01-0311

Contract Dates: AUG 2020 – FEB 2023

PI: Jay H. Hardy

Institution: Oregon State University

Abstract

The objective of this Early Career Grant is to jumpstart a new era of curiosity research. Specifically, I advocate for studying curiosity as a universal drive (like hunger and thirst) rather than a personality trait. Along the way, I hope to gain unique insights into how, when, and why new employees learn and adapt using this framework. In this vein, I plan to conduct a 30-month program of research using an interview-based, theory-building technique called grounded theory. The result will be a novel theory of curiosity in the workplace. If successful, this research will support interventions designed to enhance learning and adaptability in newcomers, which can aid the Army in developing interventions to better leverage the curiosity of its recruits.

Introduction

The traditional approach to curiosity research frames it as something that only some people have while others do not. However, this line of thinking has led researchers to overlook curiosity's central role in human adaptability and learning. I believe all people can be curious. They simply need to be presented with the right information in the right context. Unfortunately, enthusiasm for the trait-based view of curiosity overlooks its more central role in the human experience. As such, there is a need for better theories that speak directly to factors shaping curiosity's causes and effects.

Through this grant, I plan to start working toward correcting this issue by researching the form and function of curiosity. Specifically, I plan to study curiosity as a drive that shapes the day-to-day experiences of real-world newcomers. Although my exact questions continue to evolve as I analyze the data, I begin this investigation with two key goals in mind.

First, I am exploring the extent to which a newcomer's curiosity at work is consistent with the characteristics of a universal human drive similar to hunger or thirst. Along the way, I am also open to the possibility that the alternative perspective (i.e., that curiosity is a trait held by some but not all) is correct.

Second, I am exploring the key factors driving the curiosity response. Toward this end, I propose a set of research questions drawing on Loewenstein's information gap theory (Loewenstein, 1994), examining "levers" that contribute to newcomer curiosity.

Research Approach

I have been using Murphy et al.'s (2017) grounded approach to theory development to accomplish these goals. Figure 1 summarizes the general research steps and stages. To summarize, I start by conducting structured interviews with organizational newcomers working in video game development companies. Specifically, we will collect this information during their first few weeks on the job. My questions for the video game developers draw upon existing research on curiosity and socialization. My goal here is to capture the essence of how curiosity processes unfold within real work contexts. Unexpected insights learned during these interviews inform future directions of the project. Once the first round of interviews is complete, I analyze the interview responses and adjust my research questions accordingly. This back-and-forth approach enables my new theory to expand to capture any new or interesting information learned. Additional rounds of interviews and analyses follow. The work is only complete once I have sufficiently narrowed in on aspects of a comprehensive theory of curiosity at work.

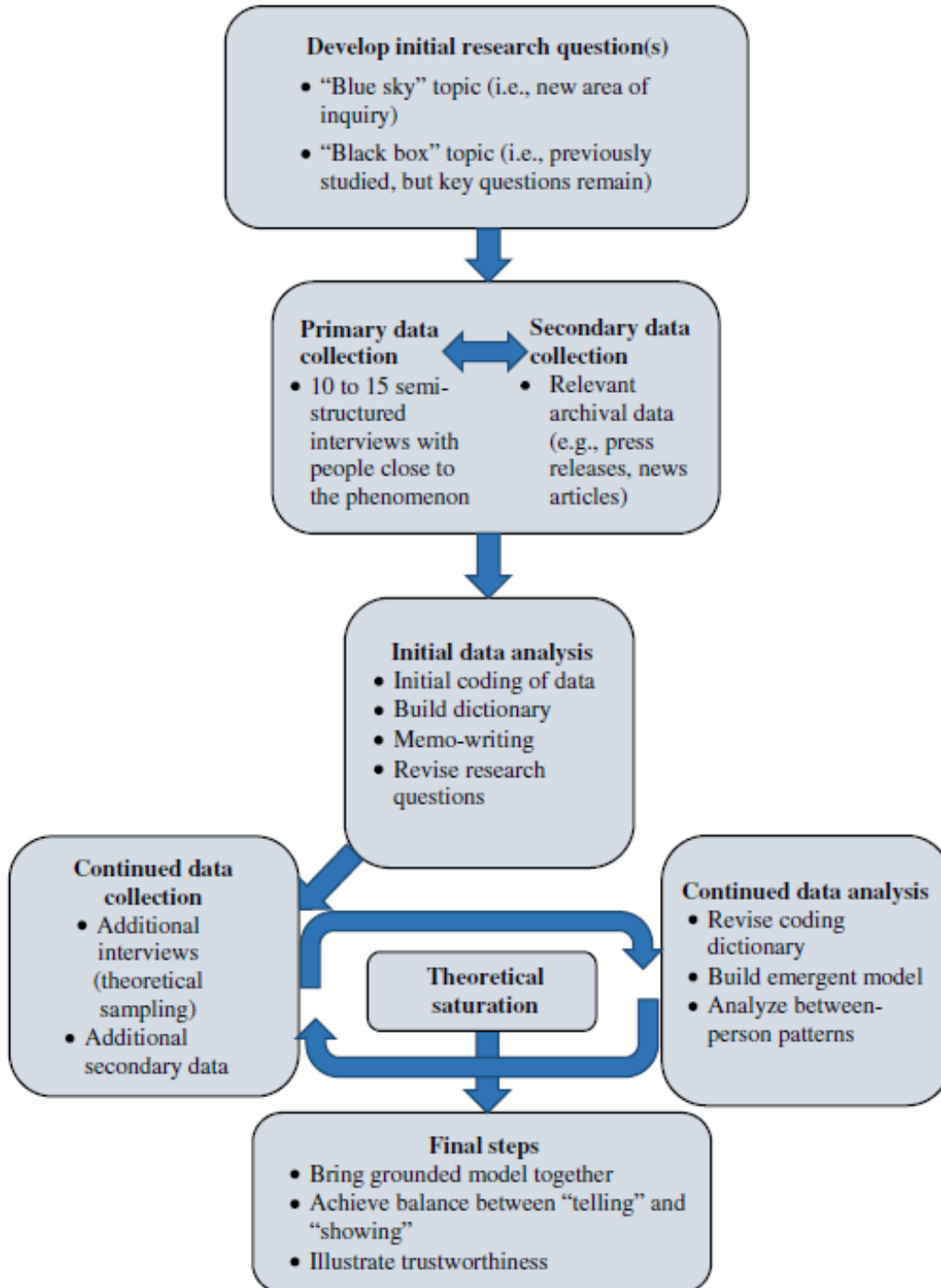
Accomplishments

In the last year, I conducted an extensive review of the literature, got ethics board approval for my study designs, and started the data collection process. As of the writing of this report, I am still in the early stages of conducting the initial interviews. However, several interesting insights have begun to emerge.



Figure 1

Grounded Theory Approach



Note. Reproduced with permission from Murphy, C., Klotz, A. C., & Kreiner, G. E. (2017). Blue skies and black boxes: The promise (and practice) of grounded theory in human resource management research. *Human Resource Management Review*, 27(2), 291-305. <https://doi.org/10.1016/j.hrmr.2016.08.006>



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First, as expected, participants describe the first weeks in a new job as an incredibly overwhelming time. They are expected to “drink from a firehose” of information as they get up to speed on their new position. To deal with these intense demands, every interviewee I have spoken to has described their curiosity as an invaluable tool they leverage to make sense of their job context, suggesting that curiosity is a universal experience and a central part of learning.

However, a few concepts have emerged from these conversations that I have not yet fully considered. For instance, one theme that keeps emerging from the interviews is the close relationship between fear and curiosity. On one hand, participants have described ways they leverage their curiosity to overcome fear associated with uncertainty in their jobs. On the other hand, fear and uncertainty can constrain future curiosity as newcomers who feel they are “just hanging on” don’t always feel free to express their curiosity. This idea of curiosity as a “luxury” is a concept I plan to continue exploring as I collect and analyze the interview data.

Another interesting theme emerging from the initial round of interviews is the impact of formal, company-wide curiosity initiatives (e.g., free time to explore ideas potentially unrelated to the current projects at hand) on newcomers’ willingness to utilize their curiosity. All participants I have spoken to have thus far discussed the positive impact of these policies on their work-related behavior and company commitment. The context clearly matters when dealing with curiosity. Exploring how companies intentionally (and unintentionally) impact employee curiosity will be a theme I continue to explore as the project unfolds.

Contributions to Basic Research

Curiosity is a universally felt experience. This is no accident, as the basic human desire to seek new information has allowed our species to adapt to an uncertain world. We all have an innate hunger to learn and grow. This hunger likely reveals itself in different ways for different people. However, early curiosity research suggests that many of the underlying mechanisms driving this process are universal. That is to say, everyone experiences curiosity in the same way, even if different things trigger it. The trick is finding ways to present information to increase rather than decrease an employee’s natural curiosity. Managing curiosity is particularly important for organizational newcomers who must adapt quickly while often overwhelmed with novel information. Unfortunately, many modern organizations implement policies that are inadvertently suppressing the curiosity drive in their employees.

By studying curiosity through a process-based rather than trait-based lens, I hope to develop a broader, more practical theory of curiosity in the workplace. This theory is derived from the lived experiences of real-world newcomers collected through one-on-one interviews. Insights from newcomer responses are integrated with existing research on curiosity to build a stronger theoretical foundation. My long-term hope is that we can move away from the “you have it, or you don’t” understanding of curiosity and toward a more inclusive, functional perspective. As a result, I anticipate that this research will help move us down a path toward uncovering practical “levers” organizations can use to access their workforce’s untapped potential.

This theoretical foundation will help create socialization initiatives that accomplish three goals. First, process-based curiosity interventions can expedite the learning process for newcomers. Human beings are natural learners. By embracing these tendencies, organizations can design more efficient and effective learning interventions. Second, process-based curiosity interventions will allow organizations to embrace the unique characteristics of new employees. The efforts will help us create a more creative workforce with a greater diversity of thought. Third, process-based curiosity interventions will give new employees tools to adapt to changes within the modern workplace.

Potential Army/Military Applications

In the mid-2000s, a few years after the start of the global war on terrorism, Marines in a special task force under the command of Lt. Col Rob McClary faced a seemingly insurmountable problem. McClary’s orders dictated that a local nation’s coalition force must play a meaningful role in the planning and executing of their mission. However, McClary’s assessments of the coalition partner’s fighting capabilities were not good. They indicated that all but the most minimal involvement of the partner coalition would put the mission (and thus the lives of McClary’s Marines) in danger. In an attempt to work around these constraints, McClary’s team drew up a plan that involved the coalition partner. However, he kept their role in the plan’s execution highly marginalized. Yet, when McClary presented this plan to his commanding General, he was told to throw it out and try again. The General explained that the mission’s political credibility was a central goal. He demanded that the coalition partner not be seen as a tag-along in the effort but instead as a major, cooperating partner.



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Frustrated, McClary returned to his team of Marines to brainstorm possible solutions. During one of these meetings, a team member pointed out one novel route forward they had not yet considered. At the time, one of the unsolved challenges of the mission was figuring out how best to get large, bulky artillery units ashore. Then, they needed to get that bulky equipment across difficult terrain to where it would be most needed. The Marine pointed out that he had recently learned the coalition partner had access to lightweight artillery units. These units could be used to help solve some of the mission's lingering mobility challenges. Leveraging the partner nation's expertise and experience with this equipment, McClary and his team drew up a new mission plan. This new plan greatly increased the likelihood of mission success while actively involving the coalition partner in a meaningful and politically visible way. Impressed with the elegance and effectiveness of this solution, McClary later asked his Marine where he learned this incredibly valuable information. The Marine explained that he had recently returned from a vacation to the coalition partner's nation with his wife. While there, he became curious. He understood that he would be spending time with individuals from the partner nation soon and decided to learn more about how they did things. His curiosity led him to spend part of his valuable vacation time visiting one of their military bases. While there, he learned about their unique expertise with lightweight artillery.

This story is one of many like it that demonstrates that the benefits of curiosity extend beyond the individual to the organization. A well-developed theory of curiosity's emergence and expression is directly connected to the Army's mission of developing capable and adaptable Soldiers. In particular, Soldiers who can leverage their curiosity will be better equipped to meet the challenges they face across a wide range of combat and peacekeeping missions. My research promises to provide a practical theory of curiosity that can reshape Soldier socialization to meet these goals.

Future Plans

In the next year, I plan to complete phase one of the interview data collection and to begin analysis in earnest. Following the initial examination of the data, I will reevaluate my research questions, make adjustments to the interview questions as necessary, and begin the second round of interviews. This is an exciting time in the grant, as new discoveries that emerge during this phase of the research process will have massive implications for the structure and content of the theoretical model I plan to develop once data collection is complete.

Associated Publications

Shoss, M., Jundt, D., Howardson, G., Rudolph, C. Flynn, P., Hardy, J. H., III, (2021, April). *Tackling big issues in understanding adaptation: A discussion across research domains* [Panel]. Society for Industrial & Organizational Psychology's 36th Annual Conference, Virtual.

Jundt, D., Su, Shiyang, Shoss, M. Flynn, P., Howardson, G., Hardy, J. H. III, Rudolph, C. (2022, April). *Methodological and statistical approaches to studying adaptation and change* [Panel]. Society for Industrial & Organizational Psychology's 37th Annual Conference, Seattle, WA

Hardy, J. H., III (2022, April). *Curiosity and adaptation in videogame developers: Lessons learned and opportunities presented* [Poster under review]. Society for Industrial & Organizational Psychology's 37th Annual Conference, Seattle, WA



Motivation, Learning, and Performance: Developing a Detailed and Comprehensive Computational Theory

Project #: W911NF-17-1-0236

Contract Dates: MAY 2017 – SEP 2022

PI: Ron Sun

Institution: Rensselaer Polytechnic Institute

Co-PIs/Subcontractors: David Dai; University of Albany, State University of New York

Abstract

This project aims to develop a comprehensive theory and a detailed computational model of how motivation affects learning and performance. It investigates relevant issues through exploring a variety of human data and through the development and use of a generic computational model, that is, a cognitive architecture, for modeling and simulating the data. The goal is to achieve a better understanding and a synthesis of empirical findings through a more precise, mechanistic theory on the basis of the cognitive architecture. Such a theory can lead to practical applications in a wide range of circumstances in the future.

Introduction

This project aims to develop a comprehensive, unified theory and a detailed computational model of how motivation affects learning and performance. The overarching goal of the project is to produce comprehensive, yet detailed, understanding of the relationship between motivation and learning/performance in a wide variety of circumstances. Such understanding can lead to practical applications in many circumstances, including enhancing learning, training, and performance by individuals, teams, and organizations.

This work investigates the relevant issues through exploring a variety of human data, including data generated from new human experiments that we conduct, and through the development and the use of a generic computational psychological model, that is, a cognitive architecture (named Clarion), for modeling and simulation of the data (Sun, 2002; 2016). To achieve a better understanding and a synthesis of empirical findings, this work explores human data (new and old) on the basis of the Clarion cognitive architecture and aims for a more precise mechanistic theory (which in turn enriches and substantiates the cognitive architecture). Modeling and simulation based on the cognitive architecture, as well as detailed comparisons between human and model data, help to shed light on mechanisms and processes of motivation-cognition interaction in a precise and detailed way, leading to a unified theory that synthesizes a large variety of empirical data and phenomena concerning motivation and performance.

The major contributions of this work include a comprehensive, precise, and detailed (mechanistic, process-based) theory/model that explains a wide range of human data concerning the motivation-cognition interaction and the motivation-performance relationship in a unified way. The theory/model that emerges through this work will be both more in-depth and more comprehensive than previous work. New human experiments generate new data that also shed new light on relevant issues, providing further clarification and integration.

Research Approach

The project investigates the motivation-performance relationship through a generic, comprehensive computational model and on the basis of empirical data. The human motivational system, its dynamics, and its interactions with other systems are investigated and computationally modeled using the generic computational model, namely, the computational cognitive architecture Clarion (Sun, 2002; 2016). Within this cognitive architecture, motivations are either explicit or implicit, either approach- or avoidance-oriented, and centered on a number of clearly identified basic motives (such as *achievement*, *autonomy*, *affiliation*, and so on).

On that basis, the relationship between motivation and learning/performance is explored, in part through detailed computational simulation of a large variety of empirical data, as well as through new integrative human experiments (e.g., using Raven's matrices). In turn, simulations and experiments lead to further development of models.

The project utilizes methods of machine learning (including neural networks, deep learning, and reinforcement learning), but also includes symbolic computational mechanisms and processes (e.g., involving symbolic rules), in computational modeling.



Accomplishments

An integrative, unified, and generic model of motivation and performance has been developed that centers on basic human motives as well as cost-benefit calculation on the basis of these motives. Extensive simulations have been carried out, covering empirical data from twelve separate human experiments, addressing external goal setting, external goal priming, intrinsic motivation, extrinsic rewards, cultural differences, and so on. We are able to account for empirical data from these human experiments (and beyond), explaining these facets in a unified model. We have also been working on new learning methods that alleviate the problem of hand picking/setting of values of model parameters and we have been using the learning model to explore generalization (that is, training the model on a subset of the human data and using the resulting model to predict human performance on the rest of the human data). Recently, we are working on an integrated model of the effects of self-efficacy on effort expenditure and/or performance. The preliminary work shows that the model is able to account for the various effects of self-efficacy, including the apparent discontinuity, the positive effect, the negative effect, the effect of deadlines, and the effect of feedback ambiguity, both at a within-person level and at a between-person level. A journal paper on one of these models described above has been completed and is in press now. Another is under way.

Fine-grained, specific models of human performance on the Sandia Matrices (an automatically generated variation of RPMs, Raven's Progressive Matrices), which are the basis of the human experiments of this project, have been under development. Computationally, in the current model, deep learning (convolutional) neural networks are used for dealing with visual inputs from matrices (which are in a raw pixel form). These networks learn to detect relevant basic visual features and then, on that basis, extract relations (that is, changes in figures across rows or columns), which are then used for selecting the right answer out of the eight candidates based on similarity measures. We have explored various computational possibilities. We are currently focusing on how the model can be implemented in the Clarion cognitive architecture, which has the right mechanisms and processes to carry out the task and facilitates computational modeling of psychological phenomena. We have been working on how various psychological phenomena (both cognitive and motivational) related to human performance on these matrices can be captured within the model. A total of three conference papers have been published on models of RPMs.

For the human experiment part of the project, we have worked on two manuscripts based on our collected experimental data, one on the Bandura-Vancouver debate, with an attempt to address the debate with the human data we collected so far for this project, and the other on comparing Rasch model, IRT model, and a multivariate model of human cognitive performance incorporating both ability and effort parameters. Both are close to the final stage of preparation and scheduled to be submitted for publication by the end of November 2021. We are currently starting to develop a third manuscript synthesizing what we have done, with a focus on connecting concepts of intelligence, motivation, and learning in a coherent manner, aiming toward a theory of human learning and cognitive performance. Human experiments were shut down by the university due to COVID-19.

Contributions to Basic Research

This project develops a comprehensive and unified theory and a detailed computational model of how motivation actually affects learning and performance. Its goal is to achieve a comprehensive, integrative, detailed, and precise understanding of the relationship between motivation and performance in a wide variety of circumstances.

The computational theory/model of the relationship between motivation and learning/performance that emerges from this work, on the basis of empirical data, is both more in-depth and more comprehensive than previous work. It includes, for instance, implicit and explicit motivational processes (and other dual processes), approach versus avoidance orientation, the set of basic, essential motives (that are largely innate), and so on. In particular, the computational theory/model addresses how motivation affects learning/performance in a mechanistic, process-based way (and in turn how learning and performance affect motivation eventually).

The computational theory/model leads to detailed specifications of hypotheses, predictions, and explanations regarding the relationship between motivation and learning/performance. It covers a variety of circumstances, including the relationships between goal setting and performance, between goal priming and performance, between self-efficacy and performance, between intrinsic motivation and extrinsic influences, between motivation and anxiety/stress, between anxiety/stress and learning/performance, and so on.



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While many incompatible theories and studies currently exist, this work aims to show that many of them can actually be synthesized and unified within the framework of a computational cognitive architecture (Sun, 2002; 2016) and thus clarified. As a result, a better, clearer, more general, more integrated, and more mechanistic understanding can be achieved.

Potential Army/Military Applications

Although this project constitutes basic research, it is highly relevant to the Army's missions. The results of the project support applied research that is directly relevant and meaningful to the Army.

The most relevant domains/areas that are of interest to the Army include a) Learning in Formal and Informal Environments and b) Personnel Testing and Performance. For example, the topic area of Learning in Formal and Informal Environments includes the following question: What learning methods and theory can be leveraged or developed to maximize individual and collective processes and outcomes under various conditions (e.g., high or low difficulty level, high or low goal setting, high or low stress, high or low work group cohesion, etc.)? Relatedly, the topic area also covers the effort to understand change in an individual's knowledge/skills, retention, and transfer over time and the underlying processes (e.g., motivation, engagement, self-regulation, and affect) within and across a variety of formal and informal environments. On the other hand, the topic area of Personnel Testing and Performance includes the objective to advance understanding of motivational, psychological, organizational, and societal factors that influence personnel enlistment, retention, and productivity. This work can provide some of the underlying understanding for better addressing these questions.

In particular, the theoretical understanding achieved through this work may be applied for the purposes of enhancing learning/training and performance, especially when dealing with novel and demanding problems. Based on the theory (as well as the computational model and the cognitive architecture) developed in this work, one may propose ways of improving learning/training and performance of individuals or groups. This work, for instance, should have significant relevance to improving training methods and their outcomes in terms of motivation, incentive, stress, and self-regulation, and should also have significant relevance to maintaining or enhancing performance and morale over a longer period of time.

The need for better models of human behavior for military applications, especially in the form of cognitive architecture, has long been underscored by the National Research Council (see, e.g., Pew & Mavor, 1998). This project contributes to a new generation of tools for behavioral representation and modeling for military applications: Various psychological processes may be more accurately captured by the cognitive architecture developed herein because of its better theoretical underpinnings and its considerations of a wider range of empirical data.

Future Plans

This project develops a comprehensive and unified theory and a detailed computational model of how motivation actually affects learning and performance in a mechanistic and process sense. Its long-term goal is to achieve a comprehensive, detailed, and precise understanding of the relationship between motivation and learning/performance in a wide variety of circumstances.

For the human experiment part of the project, we plan to conduct a large new experimental study as part of the extension of the grant to address the causality of self-efficacy and metacognition (performance calibration) with respect to effort expenditure and performance outcomes. This is a follow-up study on the Bandura-Vancouver debate mentioned earlier. A secondary goal of this new study is to use alternative test conditions to corroborate what we have found with the use of Raven's progressive matrices.

For the computational modeling part of the project, we will work on the integrative model of effects of self-efficacy, within the context of our unified model of motivation-performance phenomena. Detailed analysis will be done on these effects. Extensive simulations will be carried out in order to validate the model and to shed new light on empirical phenomena. We will also tackle other aspects of the unified model of motivation-performance phenomena. In the coming year, we will finish more journal papers on the unified model of motivation and performance.

We will also finish developing the computational model of the RPMs, in order to capture human performance in this task, taking into account various motivational and cognitive phenomena. More publications will be forthcoming (in addition to those already published).



Associated Publications

- Sun, R., Allen, J. & Werbin, E. (in press). Modeling emotion contagion within a computational cognitive architecture. *Journal of Cognition and Culture*.
- Sun, R., Bugrov, S., & Dai, D. (2022). A unified framework for interpreting a range of motivation-performance phenomena. *Cognitive Systems Research*, 71, 24-40. <https://doi.org/10.1016/j.cogsys.2021.09.003>
- Wilson, N. & Sun, R. (2021). A mechanistic account of stress-induced performance degradation. *Cognitive Computation*, 13(1), 207-227. <https://dx.doi.org/10.1007/s12559-020-09725-5>
- Xiang, S., Qi, S., Li, Y., Wang, L., Dai, D. Y., & Hu, W. (2021). Trait anxiety moderates the effects of tDCS over the dorsolateral prefrontal cortex (DLPFC) on creativity. *Personality and Individual Differences*, 177, 110804. <https://doi.org/10.1016/j.paid.2021.110804>



Promoting Informal Self-Regulated Learning: A Multi-Level Approach

Project #: W911NF-1-91-0142

Contract Dates: JUL 2019 – JUL 2022

PI: Jason G. Randall

Institution: University at Albany, State University of New York

Co-PI/Subcontractors: Stephanie A. Zajac, University of Texas MD Anderson Cancer Center

Abstract

Informal learning is important for Army personnel to meet the challenges of an ever-changing environment. Despite its importance, relatively little is known about informal learning, particularly as a team process. Therefore, we propose a new theoretical perspective: the Multi-Level Model of Self-Regulated Informal Learning. We develop and test the model's ideas through three main tasks. Task 1 includes reviewing existing assessments of informal learning and interviewing working adults to better understand the informal learning process and how it should be defined and measured. Results from Task 1 provide general support for this new perspective by identifying the critical intentions, strategies, actions, and feedback that characterize informal learning and how these processes overlap for individual and team learning. New insights also highlight the importance of underexplored thoughts (e.g., planning, reflecting) and affective states or feelings (e.g., frustration, excitement, anxiety, hope) to the informal learning process. Future large-scale surveys (Tasks 2 and 3) will evaluate the proposed model and the predictors and outcomes of individual and team informal learning. This will advance scientific understanding of informal learning and help the Army and other organizations to promote informal learning on the job.

Introduction

Following decades of research, much is known about the science of designing and delivering formal training programs that facilitate the learning process. Comparatively, research provides relatively little guidance on how the informal learning (IL) process unfolds over time or how to support IL for employees (Cerasoli et al., 2018). Initial evidence suggests that self-regulation may be more important for IL than formal training because IL is initiated by the employee, self-guided, and often unplanned or unstructured (e.g., Tannenbaum et al., 2010). Of particular importance, Boekaerts and Minnaert (1999) argue that features of the learning environment (presence of others, assessment, structure) may affect the awareness and choice of self-regulatory processes (e.g., goal setting, monitoring) differently in informal versus formal environments. However, self-regulation models have not been incorporated into informal learning outside of educational domains. Further, self-regulation models have given little attention to multi-level settings where individuals are nested within teams.

Self-regulation represents the mechanics of motivated learning and includes five components: 1) Intent to learn (Goal), 2) Reflection (Comparison), 3) Output (Strategy), 4) Action (Behavior), and 5) Input (Feedback). These five components are considered a reciprocal loop, where setting a learning goal contributes to strategy formation, then action to achieve the goal, seeking feedback to assess progress, and finally comparing performance to the goal standard to know if one should stop or repeat the process. Importantly, since IL is inherently social in nature, these reciprocal self-regulation processes co-occur at the individual and team levels, which facilitates their integration into IL for individuals and teams.

The purpose of this effort is to help address challenges for training Army personnel and the workforce at large by clarifying the attitudes, behaviors, and cognitions that characterize the IL process for individual and teams. Our research goals address several gaps in the literature, including: 1) what attitudes, behaviors, and cognitions are involved in the informal learning process, 2) how we can accurately and reliably assess the informal learning process, 3) how an individual's team affects how they learn on the job (including in virtual or hybrid work environments), and 4) how the IL process unfolds over time.

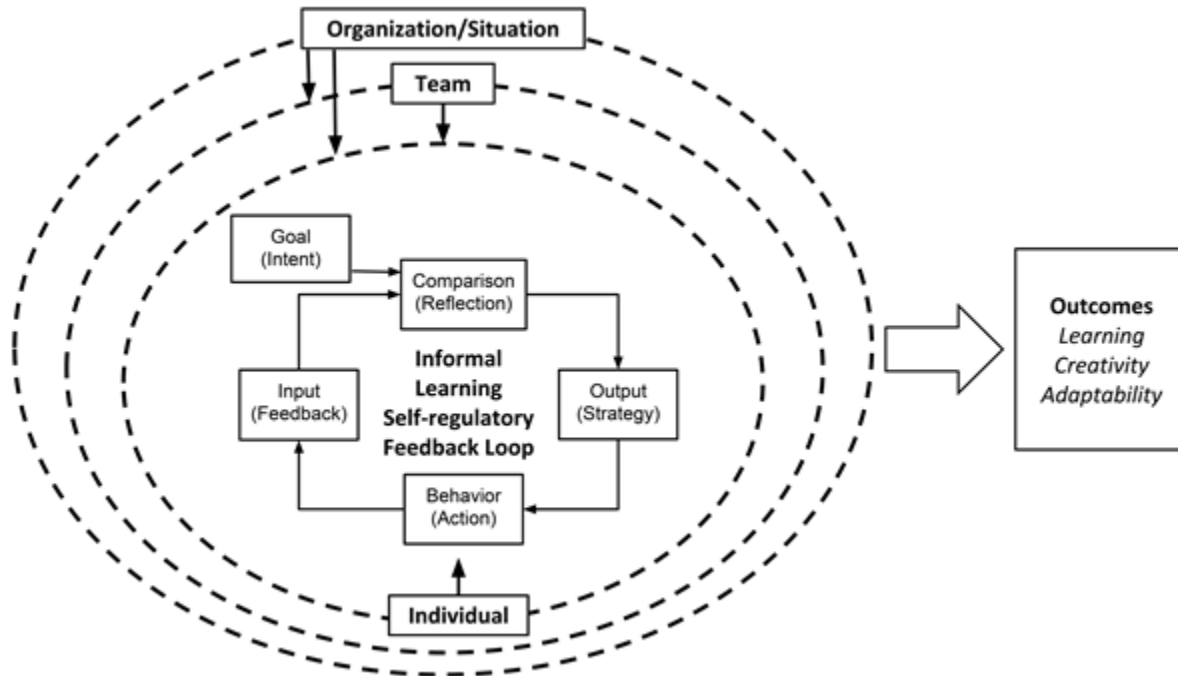
Research Approach

Using existing IL models as a starting point, we proposed a unique Multi-Level Model of Self-Regulated Informal Learning (see Figure 1) that incorporates self-regulation and addresses the identified gaps in the literature. To validate this model and uncover specific IL processes, we first conducted a literature review of informal learning measures. Second, we interviewed individuals who work in teams to gather information about how they learn informally in order to address processes that may be missing from the proposed model and to ground it in real world contexts. An initial version of a comprehensive IL Process tool is being drafted based on the results of these data. The tool will be used to assess multi-level influences on IL across a



Figure 1

Multi-level Self-regulated Informal Learning



variety of settings (i.e., the tool is not context specific) and in separate samples of working adults to collect validity evidence and test key model assumptions.

Accomplishments

To uncover the attitudes, behaviors, and cognitions that underlie the informal learning process, we began with a systematic review of the literature on existing IL tools. This review was comprehensive (more than 4,000 primary articles), including studies that utilized quantitative scales of IL as well as qualitative or mixed methods (e.g., interviews, focus groups, observations). The PI and Co-PI extracted individual and team IL processes from the articles and categorized them into the components of the proposed theoretical model (see Figure 1), remaining open to adaptation as needed. This review highlighted inconsistencies in the definitions and assessments of IL and revealed that most research focuses on the action (behavior) and input (feedback) steps in the self-regulatory IL process, with less emphasis on comparison (reflection) and output (strategy), and very little on goal (intent). There was also an almost complete neglect of theory and assessment of IL as a team phenomenon, despite acknowledgment of its social sources. We present a select list of findings in Table 1, that demonstrates a) what specific behaviors, thoughts, or attitudes are reported in the literature as constituting IL, b) the extent to which these various processes match our predetermined, theoretical expectations, and where updates were needed, and c) whether these processes are represented at the individual and/or team level. The implications from these findings are covered in more detail in the Contributions section below.

This past year we also conducted interviews with 16 adults working in teams (across fields and management levels) to directly assess the types of thoughts, feelings, and actions people report when describing their experiences with informal learning in the workplace. We developed a semi-structured interview protocol that asked interviewees to report on three IL experiences: 1) a successful individual experience, 2) an un-successful individual experience, and 3) a successful or unsuccessful team-based experience. Review and analysis of transcripts from these interviews to extract the IL processes identified reinforced the information found in the literature review, but also uncovered new insights in areas where the literature was lacking. For example, interviewees had more to say concerning the goal setting process that prompts IL (goal/intent), the strategies they relied on (output/strategy), and how they reflected on their progress (comparison/reflection). Asking about emotional states throughout this process and prompting interviewees



to share successes and failures, also yielded valuable and novel information about how to promote effective IL. These conclusions are highlighted in Table 2. We are also conducting some follow-up text sentiment analysis to identify what emotions people feel throughout the IL process and preliminary results suggest that people feel a mix of positive and negative emotions (e.g., joy, anticipation, fear) during IL and that these emotions may be felt more strongly when IL occurs in teams as opposed to individually. We are also exploring the effect of emotions on one's willingness to engage and put effort toward IL in the future.

Our research on this grant also contributed to a paper that is in press for publication in a special issue on "Business and Society in the Age of COVID-19" at the journal *Business and Society Review*. In this paper, we argue that organizations have an obligation to support informal learning for employees who may be working remotely, as increases in virtual work have become more commonplace during COVID-19. Therefore, we highlighted research-based strategies to promote IL for a virtual/hybrid workforce and present these recommendations in Table 3.

Contributions to Basic Research

Our guiding research questions - what informal learning is and how to adequately assess it - are urgent because they address a number of unanswered basic science questions concerning informal learning. Specifically, current research and theory on informal learning tends to be limited in four primary ways:

1. The informal learning process is not clearly understood. What are the thoughts, attitudes, and behaviors that characterize informal learning, and how do these operate over time to create meaningful learning outcomes?
2. There is no complete and broadly useful assessment used to measure the informal learning process.
3. Past research has largely ignored the possible effects of team influence on the informal learning process.
4. There is a lack of well-designed, longitudinal studies of informal learning to determine causal relationships and dynamic effects over time.

Our research contributes to basic science by addressing these shortcomings of past research on informal learning. Based on what has been completed thus far, we have at least two primary conclusions: First, our approach to incorporate self-regulation theories of motivation to identify the steps involved in the IL process has proven useful. A large component of the IL literature captures processes in the Behavior/Action and Input/Feedback components of self-regulation, with fewer manifestations of the Comparison/Reflection and Output/Strategy components, and very few processes specific to Goal/Intent. Thus, a major emphasis of describing and assessing IL is on performing actions and obtaining feedback, while reflecting, devising strategies, and setting goals are less frequently addressed. This suggests that more is known about what people do (i.e., the behaviors performed) when learning informally as opposed to what they think and feel, which are also an integral part of the process. This encouraged us to uncover more of these underrepresented processes during interviews, with interview data shaping the redesign of our theoretical model, including the sentiment analysis that helps identify the importance of emotions and moods to the pursuit and success of IL.

Second, our results also demonstrate the social, multi-level nature of informal learning. Despite an over-reliance on measuring IL at the individual level, many of the processes assessed are social in nature, representing group- and organization-level influences such as seeking advice from a leader, observing an expert, experimentation with a colleague, or debriefing with a team. Thus, our findings and continuing research tasks will acknowledge that IL is not just supported by teams and other organizational members, but that teams and others are fundamental to this process. For example, individuals in the interviews point to experiences where colleagues navigated the IL process together, yielding better outcomes than if they had attempted to learn on their own. Consequently, there seems to be considerable value in conceptualizing IL at the team level and in capturing this in our assessment tool and theoretical model to encourage future research to adopt this shift in focus from individual to teams.

The expected products of our research are a theoretical model that others may draw on to understand the IL process. Additionally, we will produce and validate a measurement tool that other researchers may use to assess the cognitive, attitudinal, and behavioral elements that make up informal learning. This shared understanding and common assessment will help advance the field by allowing researchers to gather evidence regarding the nature and consequences of IL.



Table 1

Select Literature Review Findings for Informal Learning Processes

Goal/Intent	Identifying learning needs and goals (I/T) Generating new ideas (I/T)
Comparison/Reflection	Reflective journaling of learning experiences (I) Reflecting on past performance (I/T) Assessment of strengths/capabilities/weaknesses (I/T) Reflecting on peer feedback (I) Assessing past mistakes (I/T) Reviewing exemplars (I/T)
Output/Strategy	Discussing plans for learning goals (I) Personal development plans (I) Metacognitive planning (I) Seeking new assignments/situations/tasks (I/T) Seeking mentoring or coaching (I)
Behavior/Action	Observing peers perform/demonstrate a task (I) Having peers observe one's own performance (I) Individual information seeking (online, literature) (I) Consulting an Expert (I) Asking questions of peers, network, or online community (I) Collaboration or co-production of work products/services (I) Experimentation with new tasks and methods (I/T) Trial-and-error (I/T) Professional development (I/T)
Feedback	Others sharing experiences (I) Receiving coaching through a task (I) Observing the effects of other's actions (I) Actively seeking feedback/advice from others (I/T)

Note. Individual processes are noted by (I), Team-level processes are noted by (T).



Table 2

Differentiating the Conditions for Informal Learning (IL) Successes and Failures

Conditions for Successful IL		Conditions for Unsuccessful IL	
What is to be learned is:	• Necessary for effective job performance • Not too difficult given the learner's ability and background	What is to be learned is:	• Unclear or ambiguous • Too far outside the learner's expertise or ability level
The learner is motivated, including:	• A strong desire for progress • Getting an "early win" to encourage persistence • Autonomy to self-set pace and activities	The learner lacks motivation or emotions interfere when learners feel:	• Intimidated, afraid of confirming adequacy • Uncomfortable acknowledging deficits • Not personally responsible for workplace learning
Others support IL by:	• Providing encouragement • Giving security around mistakes and experimentation • Being a source of knowledge who can effectively share their experience • Learning together • Being available (physical space and time)	Others fail to support IL by:	• Providing unhelpful or overly critical feedback • Not delegating tasks to stretch capabilities • Not providing the necessary time and tools • Failing to provide a backup plan or, alternatively, allowing one to revert to old practices



Table 3

Five Tips to Promote Informal Learning in a Virtual World (with Example Applications)

Tip	Examples
1. Create opportunities for spontaneous connection	• Leaders can hold open “Zoom hours” for questions or feedback • Host virtual lunch or coffee breaks without a formal agenda • Integrate and promote use of virtual communication tools and ensure adequate training • Document and share important changes that happen offline with virtual employees • Call on all employees (in-person and virtual) by name to provide the opportunity to speak up
2. Support virtual mentoring and knowledge sharing	• Host virtual mentoring sessions and events • Create a searchable mentor database • Supplement mentoring with virtual communities of topical interest • Share videos or blogs on timely topics through asynchronous, organizationally-sponsored platforms
3. Expand accessibility of development opportunities	• Increase opportunities for observation in the virtual environment • Encourage employees to create and share micro-learnings (e.g., videos, articles)
4. Capture lessons learned from rapid changes and new or expanded employee roles	• Individually reflect on work processes; identify important questions, choose a process that fits you, start small, and ask for help if needed • Engage teams in regular debriefs or after-action reviews; use validation and normalization, team with a co-facilitator, and use inclusive pronouns • Build psychological safety and social presence in virtual teams by breeding familiarity and inclusion, limiting group size, and designing collaborative learning activities • Hold daily or weekly virtual briefings on the state of the organization
5. Create a culture of lifelong learning	• Leaders can be examples by highlighting their own ongoing learning and development activities through a variety of communication vehicles (e.g., emails, podcasts, social media) • Create pathways for all employees with flexible scheduling and on demand training; use a mix of in-person and virtual environments • Create online mentoring circles for particular groups of employees to support their specific needs



Potential Army/Military Applications

U.S. Army personnel work in fast-paced, complex environments. It is essential for the Army to develop and maintain a culture of continuous learning in order to remain competitive and successful. However, given such complex, dynamic work environments that require adaptive and continuous learning, it is not reasonable to expect that all of the training needs of Army personnel will be addressed through formal training programs and structured curricula. Formal training is both expensive and time-consuming, while also pulling personnel away from their regular work responsibilities. Learning opportunities, therefore, must include informal efforts in addition to traditional formal training.

Yet, while most organizational learning occurs in the field or on-the-job, research provides relatively little guidance on the antecedents, process, and outcomes that are associated with informal learning (Cerasoli et al., 2018; Tannenbaum et al., 2010). In other words, informal learning is both very common and very important for organizations like the U.S. Army, and yet we know very little about what informal learning is, how to measure it, and how to promote it. This may be of increased importance with a shift toward a more remote workforce and hybrid teams and the challenges this may present to the intrinsically social process of IL.

Our research will help the Army better meet the demands of a complex, dynamic workforce by assisting in the definition and measurement of the informal learning process. Our theoretical model (see Figure 1) identifies the steps of the informal learning process in the form of a feedback loop where individuals identify areas of needed improvement, set a subsequent informal learning goal, devise strategies to correct these deficiencies, engage in informal learning behaviors, obtain feedback, and assess progress to see if the goal has been met. Identifying these steps in the informal learning process will help the Army know what informal learning “looks like” and will allow individuals and supervisors the opportunity to refine this process or create interventions to better promote informal learning if the process is broken down. Our theoretical model also acknowledges the role of teams, so such efforts in facilitating the informal learning process (e.g., setting goals, devising strategies, providing feedback) may also be accomplished among teams. In the process, such teams create and reinforce a culture of continuous, informal learning. These team dynamics are key as we believe that informal learning is an inherently social process that is best accomplished when individuals and teams understand and promote exploration, ask questions, and engage in other active, self-guided informal learning behaviors. Table 2 provides useful information to help Army personnel promote effective IL and avoid ineffective IL. Table 3 also provides practical recommendations for virtual or hybrid teams, since COVID-19 has increased the prevalence of this work arrangement. Therefore, Army teams that do not want increased virtual work to compromise their socially-supported informal learning may follow these guidelines.

In addition to better understanding the process of informal learning and how to promote it, the Army and other organizations will have access to our research tool that assesses the informal learning process. This assessment could be used in a diagnostic manner to help individuals and teams evaluate how well they are engaging in the different steps of the informal learning process to identify areas for needed improvement. Assessment results could be used in conjunction with the team- and organization-level predictors identified to promote effective informal learning processes. This should help individuals and teams gain a wider variety of skills and expertise to reap the benefits of informal learning—including adaptability, innovation, and creativity—compared to those who rely on formal learning opportunities alone.

Future Plans

Although we have made progress in Task 1, including the literature review (Task 1.1) and interviews (Task 1.2), we were delayed by a larger-than-expected amount of literature to code and COVID-19-related impacts on university and HRPO ethics board review processes. However, we have laid out and begun working on the steps needed to complete our proposed project. First, we are in the process of finalizing our first deliverable: an initial draft of the Informal Learning Process assessment tool. We will then need to obtain IRB approval for an amendment to incorporate this new scale and any other new data we would like to gather based on our findings so far. The next step is to move to Tasks 2 and 3 to collect survey data online from adults working in teams who we are in the process of recruiting from employment settings. The survey will measure a) individual and team variables that are expected to predict informal learning, b) informal learning using the new assessment from Task 1, and c) individual and team outcomes that we would expect informal learning to predict. The results from these large data collection efforts will allow us to evaluate the statistical properties of our new assessment tool, to test key antecedents and outcomes of informal learning, and to examine whether informal learning can be accurately measured at the team level. We have already completed a lot of leg work to recruit participants and build the online survey. We will be able to begin data collection shortly pending IRB and HRPO amendment approval. We anticipate completing this project by the end of the no-cost extension year (July 2022).



Associated Publications

Zajac, S. A., Randall, J. G., & Holladay, C. L. (In Press). Promoting virtual, informal learning now to thrive in a post-pandemic world. *Business and Society Review*.



Variability in Repeated Adaptive Performance (VARI): Examining Personality Predictors

Project #: W911NF-19-1-0453

Contract Dates: AUG 2019 – FEB 2023

PI: Mindy Shoss

Institution: University of Central Florida

Co-PIs/Subcontractors: Dustin K. Jundt, Saint Louis University; Shiyang Su, University of Central Florida

Abstract

Mission success often requires adaptation to uncertain, changing, and novel work environments. However, some people may adapt more quickly or successfully than others, especially when facing repeated changes. Our research investigates how people differ in their ability to adapt. First, we are interested in how quickly and successfully people adapt to work-task related change. Second, we are interested in whether these differences are linked to personality traits. Personality traits may explain differences in adaptation because they capture the different ways that individuals think about, react to, and are motivated by situations. Third, we look at whether adaptation can be learned. For example, some people may get better at adapting as they face repeated opportunities to adapt. Our research seeks to provide insight into noncognitive individual difference characteristics that are cost effective to measure and influence Soldiers' abilities to leverage and adapt existing knowledge and skills while operating in dynamic environments.

Introduction

Army personnel routinely face complex, uncertain, and changing operational objectives. For example, deployment locations and roles may change with short notice. Likewise, personnel may need to quickly and adeptly respond to technologies, weather, and unexpected enemy activities that threaten mission success. For this reason, the Army needs to select and train Soldiers who can exhibit adaptive performance, which is defined as the extent to which individuals are able to alter their behavior when faced with new task demands or changes in their work or mission context.

The overall goal of our research is to examine the ways people differ in how they adapt to change. For example, some individuals might alter their behavior immediately upon noticing relevant task changes, and thus adapt more quickly than others. Others might alter their behavior more slowly, but ultimately select more useful strategies or behaviors and perform better in the long run. Furthermore, some individuals may try to deal with all changes in a similar manner, while others may be more flexible in tailoring their behavior to the specific nature of a given change. To help illustrate this, Figure 1 provides two people's simplified patterns of adaptive performance over time in response to a change. These patterns reflect how quickly and successfully an individual is adapting. If one compares these two people's average performance across the time period, it would appear that these people are the same. However, when comparing performance at the end of the time period it appears that person 1 has adapted better; when comparing performance at the beginning of the time period (i.e., shortly after the change) it appears that person 2 has adapted better. Figure 2 extends this example to show potential different patterns in how people adapt to repeated change.

We expect that people will show different patterns of adaptation and that these differences will be predicted in part by personality. Successfully adapting requires managing stress, paying attention, and being motivated. Personality traits capture person to person differences in ability to deal with stress, motivation, and how attention is targeted. Therefore, personality traits may help identify people who will be most successful at adapting. Our study looks at traits that have not been studied in other research on adapting, such as trait risk-taking and optimism.

Research Approach

To address these questions, we are currently inviting undergraduate students at two universities to participate in a research study. Participants answer questions about their personality and complete several versions of an air traffic control simulation. Participants first learn how the simulation works through several basic examples, which will serve as a measure of their baseline performance. Then, we introduce a variety of changes to the simulation, including variable changes in aircraft altitude, slower update rates on the monitoring system, and greater density of aircraft. Using novel statistical techniques that we developed for this project, we will analyze patterns in how quickly and successfully people adapt. Then, we will see whether participants' personality traits can explain these patterns.



Figure 1

Example Individual Differences in Adaptive Performance Over Time in Response to a Single Change

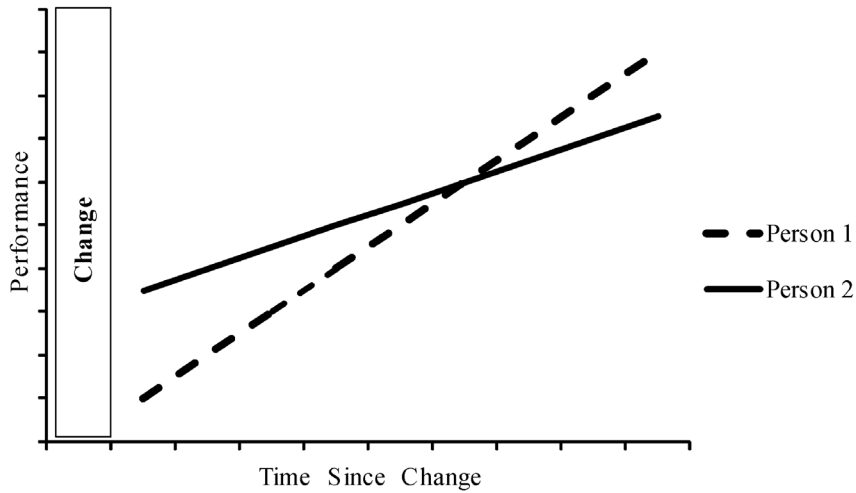
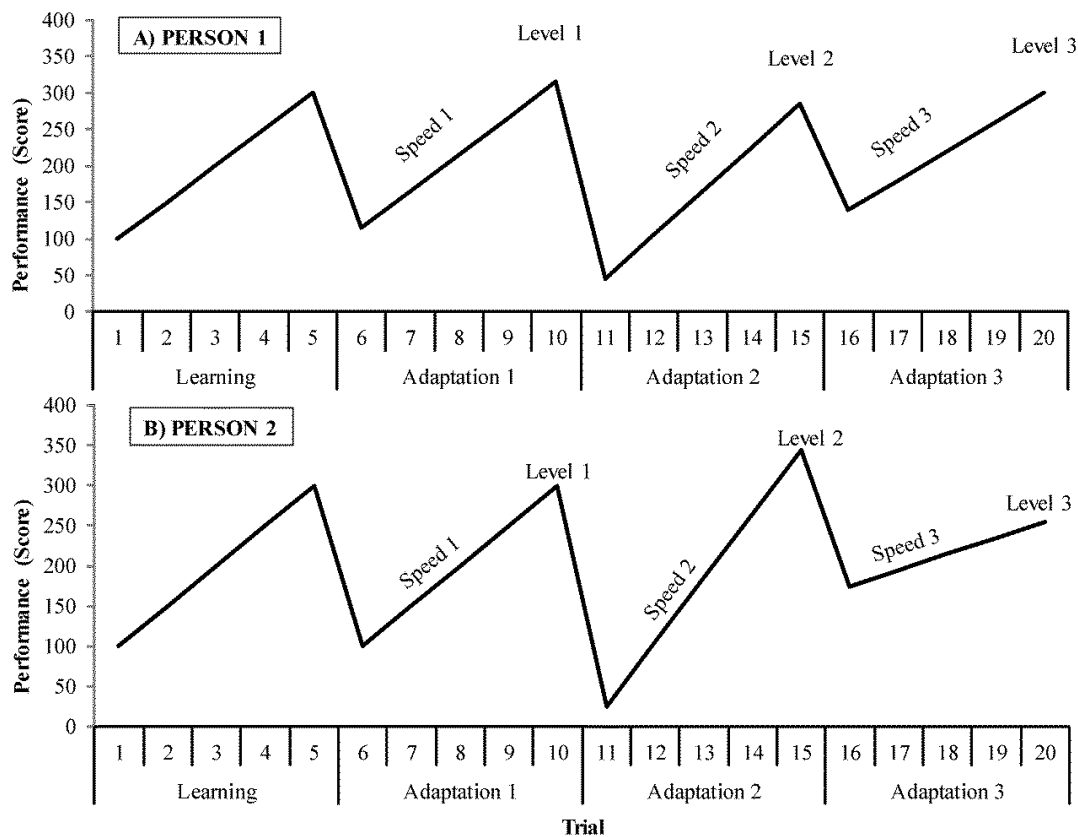


Figure 2

Example Individual Differences in Patterns of Adaptive Performance During Repeated Change





Accomplishments

Guided by demands identified in the air-traffic controller literature and extant taxonomies of task components and change, we conducted three sets of pilot studies to determine the change scenarios that would be used in the study. Pilot 1 tested our software and examined the task training and learning scenarios to ensure they enabled adequate learning of the task. Pilot 2 examined candidate change scenarios individually to ensure each change scenario required adaptation from the initial learning scenarios, as indicated by immediate post-change performance score drops (e.g., Lang & Bliese, 2009), and to ensure change scenarios were approximately equal in difficulty. Pilot 3 examined the entire set of scenarios separated over two sessions, as planned for the main study. This helped to ensure that there are no systematic ordering effects of change scenario presentation and supported the viability of offering two sessions one-day apart. Piloting also allowed us to resolve technological challenges associated with pandemic-necessitated online study administration.

Given the need for virtual research due to the COVID-19 pandemic, we transferred our previously planned in-person lab study to online administration utilizing the AWS virtual environment. This included creating an online infrastructure to randomly present change tasks and to securely record and store data. We have developed a technical report to help future researchers create a virtual research lab. We have also developed code for the different statistical paradigms, such as the latent change score model, that we will use for data analysis.

Contributions to Basic Research

Our project has multiple contributions to basic research. First, it impacts how the field thinks about, defines, and measures adaptive performance. Previous studies have frequently measured people's performance on a task before and after a change was introduced, focusing on average or "general" levels of post-change task performance. Alternatively, studies examined performance at a single time point after the change. However, our study points out that this misses important patterns in how people adapt, and it explicitly defines and measures these different indicators of adaptation. In doing so, we show how these different indicators may lead to different conclusions and provide a theoretical framework that research can use to think about how we should think about what it means for someone to have adapted.

Second, we will study personality traits as predictors of patterns of adaptive performance over time. The traits we will focus on are optimism, resilience, ambiguity tolerance, self-control, and temporal focus. These personality traits have not been previously studied in other research on adaptive performance. These traits are linked to differences in how individuals think about, react to, and are motivated by changing situations. Therefore, we predict that these traits will help to explain why some people are better at adapting than others.

Third, our study looks at whether some people can learn to adapt. In other words, we see if some people get better at adapting when they have had more opportunities to adapt. Because past research has not looked at how people adapt to repeated change, it is unable to answer this question.

Finally, along with new ways of defining and measuring adaptive performance, we explore two new statistical techniques for studying adaptive performance. One is based on a technique called discontinuous growth modeling and the other is based on a technique called latent change score model. These statistical techniques, especially the latent change score technique, will allow us to analyze patterns of adaptive performance in greater detail than in previous research. We will explore what each approach can tell us about patterns of adaptive performance.

We expect several products from our research. First, we will produce a dataset that captures how individuals with different personality traits adapt to repeated change situations. Second, we will document our new analytical approaches. Third, we will write one or more journal articles that describe our results.

Potential Army/Military Applications

This research can benefit the Army's efforts to acquire the right people for the right jobs by using time and cost-effective measures that provides the Army with more re-investable resources (e.g., time and money) for other areas of concern. Our potential findings will be easy to implement to recruit or select when Soldiers are working in situations that may change over time. Demands on the military are ever-changing, uncertain, and complex. Additionally, personnel are increasingly being deployed on non-war missions (e.g., peacekeeping, medical outbreak crisis response) which may include similarly unpredictable or changing settings. As a result, the ability for personnel to adjust rapidly and to be able to demonstrate resilience when faced with repeated change is paramount to the Army's success.



LEARNING IN FORMAL AND INFORMAL ENVIRONMENTS

BASIC RESEARCH PROGRAM

Second, our research will identify different patterns of adaptive performance. Some missions or operations may be time sensitive and therefore require immediate adaptation. Others may involve more long-term strategic changes where overall levels of adaptive performance take precedent over initial adaptation speed. Our findings will help the Army distinguish these scenarios and determine which individuals may be more successful in each environment.

Finally, our study will help answer questions about whether people can learn from opportunities to adapt. That is, we will see if some people get better at adapting across the three scenarios in our study. This will help the Army to decide how to best achieve an adaptable core. These findings may be helpful for the Army in determining placement and training assignments in a manner to maximize fit between personnel capabilities and assignment demands.

Future Plans

Over the next year, we will continue to recruit participants and conduct our data collection at two universities, University of Central Florida and Saint Louis University. After completing data collection, we will go through a systematic process of data cleaning and data analysis using several different and novel statistical approaches. We plan to submit conference presentations and publications based on our results. We are also in the process of writing a theoretical manuscript that provides a model for sources of failures to adapt. This manuscript complements our study by suggesting where in the adaptation process inter- and intra-individual in adaptation might occur.

Associated Publications

- Donnelly, S., Naranjo, A., Jundt, D., Su, S., Shoss, M. *Tutorial for integrating and hosting experimental lab tasks online using AWS* [Symposium under review]. 37th Annual Meeting of the Society for Industrial and Organizational Psychology, Seattle, WA, United States.
- Naranjo, A. & Shoss, M. K. *Using sports data to drive organizational theory and practice* [Panel under review]. 37th Annual Meeting of the Society of Industrial and Organizational Annual Conference, Seattle, WA, United States.
- Shoss, M. K., & Jundt, D. K. (2021). *Tackling big issues in understanding adaptation: A discussion across research domains* [Panel]. 36th Annual Meeting of the Society of Industrial and Organizational Psychology, Virtual.
- Su, S., Jundt, D. K., & Shoss, M. K. *Applying novel methodological and statistical paradigms to the study of adaptation* [Symposium under review]. 37th Annual Meeting of the Society for Industrial and Organizational Psychology, Seattle, WA, United States.
- Su, S., Shoss, M. K., Jundt, D. K., & Tavoosi, S. The COVID-19 pandemic and repeated adaptation: Evidence for different trajectories [Symposium under review]. In Su, S., Jundt, D. K., & Shoss, M. K. (Chairs), *Applying novel methodological and statistical paradigms to the study of adaptation*. 37th Annual Meeting of the Society for Industrial and Organizational Psychology, Seattle, WA, United States.



Culture Overview

Army Need

Army Soldiers and leaders are expected to plan and operate in ways that require them to interact with and support individuals within their unit as well as those from other units, military services, organizations (civilian and military), nations, and ethnic/cultural backgrounds. Understanding how differences in culture affect interpersonal interactions, social influence, leadership, and other social phenomena both within and across groups is critical to the operational effectiveness of the Army. Further, understanding how culture develops and changes may provide key insights into the broader context for these interpersonal interactions. The future success of operations (both sole agency and Joint/Interagency operations) is likely to be affected by cultural differences, how those differences affect cognition and behavior, and the ability of individuals and organizations to recognize, plan for, and deal with these differences. In addition to the operational importance of both organizational- and cross-cultural capability, the Army is interested in understanding and influencing the development and change of culture, both within Army units and organizations and across social contexts. The Army's ability to assess and influence the organizational culture of units within the Army may be a significant factor in the Army's adaptability and effectiveness in a dynamic geopolitical context. In FY21, the culture portfolio was integrated into the other portfolios, in particular the organizational effectiveness portfolio, to reflect the role of culture in the different aspects of psychological science. For continuity with prior Foundational Research in Behavioral & Social Sciences summary reports and because research that was designated within the culture portfolio prior to FY21 is still ongoing, the culture portfolio remains a separate section here.

The overall goal of the culture portfolio is to develop theories and models of culture that can be used to improve understanding and prediction of individual perceptions, cognition, and behavior, and to develop improved processes for assessing culture and culture-related behavior and cognition. The key research objectives are explained below.

Key Research Objectives

Defining and Refining the Meaning of Culture

ARI's Basic Research Program strives to develop broader theories of culture that are not limited only to nationality, ethnicity, race, or geographic location. The program aims to expand models of culture and identity to fully incorporate perspectives offered by multiple disciplines (e.g., psychology, sociology, anthropology, behavioral economics, linguistics) to examine intra- and inter-cultural variability across a wider range of overlapping contexts, including geographic, organizational, social, and familial. The program also seeks to identify specific dimensions of culture which can be meaningfully applied to improve our understanding of individual and small group norms, behavior, and cognition.

Understanding Cultural Differences

ARI's Basic Research Program aims to develop an improved understanding of the antecedents of culturally-relevant cognition, such as cultural awareness and identity, as well as an improved understanding of psychological and behavioral reactions to violations of cultural norms, including cultural and individual differences that moderate such reactions. The program aims to develop theories to explain how or why differences in culture (e.g., organizational, ethnic, religious) are associated with differences in relevant outcomes such as attitudes, cohesion, or performance.

Assessing Culture and Understanding Cultural Change

The Basic Research Program seeks to develop improved, multidisciplinary methods for assessing culture. The program aims to identify the sources of culture construction, maintenance, and change, including subcultures within broader cultures, across different levels and time scales and improve understanding of how culture is learned and transmitted. Another top priority is to improve understanding and assessment of the dynamic interplay between individuals and cultures, including how culture impacts one's self-identity and how individuals construct and create cultures.



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Culture Currently Funded Research

ARI's Basic Research Program is currently funding one extramural research project. A brief description of the project is provided below, with a detailed research summary provided on the subsequent pages.

Broadening Our View of Culture

(W911NF-17-1-0175; 2017-2024)

Dr. Adam Cohen (Arizona State University) is working with a multi-disciplinary team of colleagues to broaden the current understanding of culture by conducting focus groups, quantitative surveys, and a longitudinal study using ecological momentary assessment techniques.



Broadening Our View of Culture

Project #: W911NF-17-1-0175

Contract Dates: MAY 2017 – MAY 2024

PI: Adam B. Cohen

Institution: Arizona State University

Co-PIs/Subcontractors: Leah D. Doane, Arizona State University; Gene A. Brewer, Arizona State University; Kevin Grimm, Arizona State University; Carolyn M. Warner, University of Nevada-Reno

Abstract

Culture in psychology is virtually synonymous with ethnicity and nationality. The field needs an expanded cultural focus, including social class, region of origin, religion, profession, gender, political culture, and others. We are broadening our view of culture via focus groups, memory experiments, quantitative surveys, and a longitudinal study in which we will predict successful adaptation. Our statistical methods are capable of accounting for within-person processes over time and we will ensure that the psychological meanings of the measurements do not change over time or differ across groups. Our interdisciplinary team represents cultural, developmental, cognitive, and quantitative psychology, and political science. U.S. military and strategic interest require a full understanding of what culture is, how cultures affect goals and behaviors, how cultural identities change over time, why cultural identities vary in importance over time, and how such variation predicts adaptation to stress and change.

Introduction

A military that has members from many cultural backgrounds and operates in multicultural environments needs to know about cultural variation. Nonetheless, the study of culture in cultural psychology, cross-cultural psychology, organizational psychology, and other subfields, has largely taken culture to be synonymous with ethnicity or nationality. Our work will broaden our view to a wider array of cultures. Examples of cultures we will focus on include military culture, social class, religion, region of origin, sex and gender identity, and others. The key questions we wish to address in our research are: 1) What cultures are important to individuals? 2) What do individuals see as important and defining about those cultures? 3) How stable are various cultural identities? 4) What factors predict variation in cultural identities over time? 5) How do individuals' varying cultural identities, and the stability or variation of such identities, predict adjustment?

Research Approach

First, we conducted focus groups centered on how people identify with different cultures. Second, we conducted a large survey (1055 people) designed to document the importance of various cultural identities to people. Finally, we are conducting a longitudinal study. This is to investigate the stability and change of cultural identities. Predictors of stability/change include: initial and changing feelings of connection to others in the cultural group; changes in socio-cultural ecologies (e.g., transitioning to college); importance of the identity; person-culture fit (actual or perceived compatibility of values with others in the group); personality; region of origin; and how much people have moved in their lifetime. Outcomes will include adaptation to the college environment, including: emotional resilience and coping; GPA; engagement in extracurricular activities and campus life; and leadership roles. We also have the opportunity to see how people of varying cultural identities adapt to COVID-19.

Accomplishments

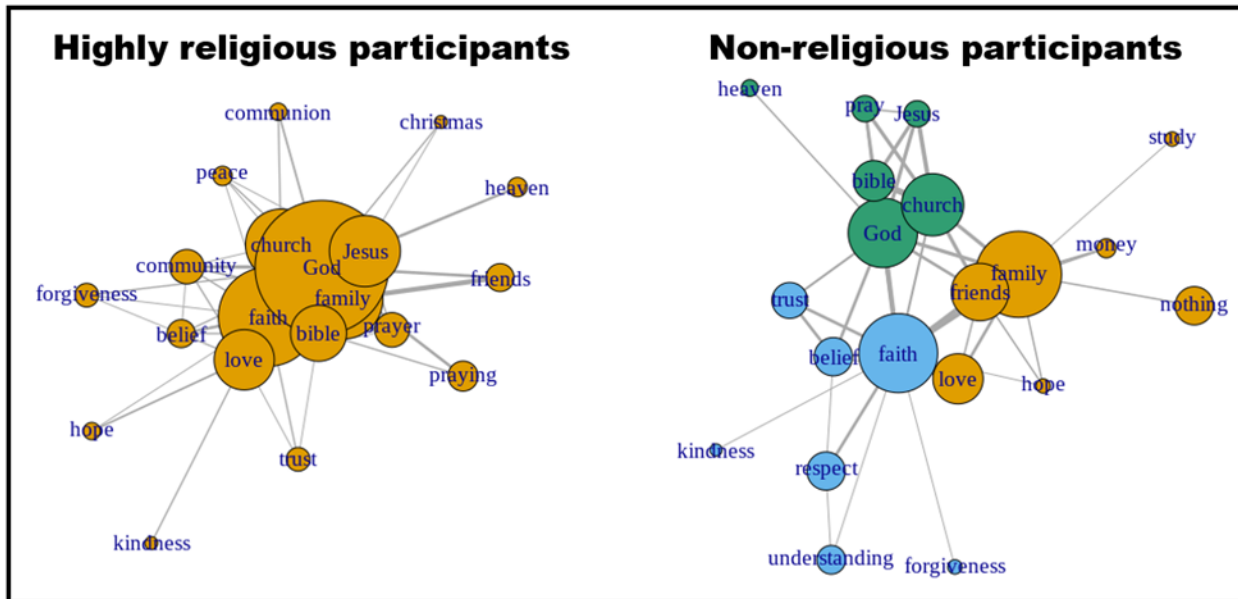
Through focus groups, we discovered that religious identification is qualitatively different from ethnic and vocational identification. The locus of moral authority, and the comprehensiveness of the identity, vary across identities.

People in several kinds of majority cultural identities value their cultural identities less than do minorities. For example, Whites value their cultural identity less than non-Whites. We further found that the reasons for minority valuing or majority devaluing are category-specific. For example, for nationality, the effect seems to be Americans downplaying their identity because of not wishing to have unfair advantages over others. For gender, however, the effect is explained by women feeling more of a sense of connection to other important women in their lives.



Figure 1

Illustration of Cluster Analysis of Semantic Fluency Data



In a memory task, individuals who highly endorsed one cultural identity generated more “important things” (in less time) than individuals who did not identify with the culture. Second, the specific exemplars recalled grouped more tightly for individuals who highly endorsed a culture (Figure 1).

In our large quantitative survey, we found that the widely used moral foundations scale is not scored appropriately. The model needs to account for the difference between “judgment” items and “relevance” items. Doing so not only greatly improved the fit of the statistical model, but enabled much stronger prediction of political attitudes.

In our survey, we found that there is a group of people who generally endorse all or most identities, and ones who endorse the various identities at a much lower rate. We have since discovered that demographic variables (such as whether one is male or female, White or an ethnic minority, etc.) do not predict membership in these classes. In other words, one’s psychological construction of their cultural identity cannot be accounted for by their demographic characteristics alone.

We found that women rate their gender identities as containing “tighter” social norms than men do. This gender difference appears related to perceptions of greater threats associated with gender.

Finally, our longitudinal study examined transitioning to the online learning environment due to COVID-19 (e.g., better sleep quality and longer sleep duration after the initial transition to online). At the online transition, females reported greater stress, whereas individuals identifying as non-White/non-Hispanic reported lower stress counts. Females also experienced worse sleep quality, but individuals reporting higher socioeconomic status reported better sleep quality. Living on one’s own/in an apartment/on campus was positively correlated with sleep duration. These findings have been accepted for publication at the journal SLEEP (Gusman et al., in press).

Contributions to Basic Research

Culture is often seen as one’s ethnicity or nationality. This is reflected in definitions of culture offered by senior scholars in psychology and other disciplines. However, culture can be seen much more broadly. This broader view opens up the idea that culture 1) takes many forms, 2) can be related to many different variables, and 3) might mean different things to different people.



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The purpose of our work is to broaden our view to a wider array of cultures. We aim to identify 1) what important kinds of cultures there are, 2) how important these cultures are to individuals, 3) what these cultures are made of, 4) how identification with these cultures changes over time within and across individuals, and 5) how such variations relate to adaptation such as stress and coping in changing environments.

Given the novelty of many of these questions, and the rigorous and multi-method ways we will investigate them, we believe that our results will be an impetus for a sea change in the various fields of psychology that study culture. We believe our theorizing and results will be published in the very best journals in the variety of fields represented by our highly multidisciplinary team.

Our team consists of leading experts in: cognitive psychology and memory (Dr. Brewer); developmental psychology and ecological momentary assessment (Dr. Doane); quantitative psychology and hierarchical linear modeling (Dr. Grimm); and religion and socio-political choices (Dr. Warner). We expect that this line of work will have an impact in psychology, but also in other fields that study culture, like political science.

Across the social sciences, cultures are understood to be actively and socially constructed and not just passively received. We allow for the fact that people may not make explicit, rational choices about their cultural identities. Affiliation with varying cultural identities may change for a variety of structural or nonstructural reasons (such as individual difference variables). We seek to document this variation in cultural identities within and across individuals over time. We are also interested in how cultural identities change, less because of macro-level factors (like institutional discrimination), but because of the salience of situations on identities. Finally, we also seek to show how such variation between and within individuals in cultural identities predicts successful adjustment to university life, a novel and challenging environment.

Potential Army/Military Applications

Our military has members from many cultural backgrounds and has U.S. personnel operating in multicultural environments. Therefore, it needs to understand culture. Developing trust and interpersonal cohesion can be particularly challenging in such contexts. This challenge can be especially hard given that we don't even know which cultural identities are important to people, what is important about them, and how stable or varying they are over time. Gaining a greater appreciation of such issues can also help predict adaptation, such as ability to deal with stress, engagement in extracurricular activities, and adopting leadership roles. Of course, adaptation is of high military relevance. We can understand culture in a better way if we study more kinds of cultures. This could include enriching 1) how we define culture, 2) how we think about universality and cultural specificity, 3) our views of multiculturalism and how we do research on culture, and 4) what dimensions of culture we study.

This project stands to identify the cultural identities that people do and do not consider to be influential in their lives. It will also demonstrate what features of these cultures people emphasize. Further, it will document what predicts stability and change in people's cultural identities over time, and show how such changes predict changes in adaptation like stress and coping, college GPA, and leadership. It moves beyond traditional survey research methods and studies of intergroup conflict to track multiple facets of culture. Many of these goals would be difficult to address if culture just meant ethnicity or nationality and were studied statically.

Documenting different cultural identities addresses key research aims to the Army. This includes developing broader theories of culture that are not constrained by nationality, ethnicity, race, geographic location, etc. Identifying the factors that are important in different cultural identities addresses the Army goal of identifying specific dimensions of culture which can improve our understanding of individual and small group norms, behavior, and cognition. And, identifying predictors of stability and change addresses the Army need to identify the sources of culture construction, maintenance, and change across different levels and time scales. This can include subcultures within organizations (like the Infantry within the Army).

Our focus on adaptation is also important from a military perspective. Our approach to adaptation includes a focus on academic achievement, campus, and community engagement. It also includes leadership roles relevant to the military implications of our work.

Future Plans

We have conducted all of our focus groups. We have developed an a priori and emergent themes coding scheme. The focus groups transcripts have been coded. We are presenting work on religious identity, including at the Society of Experimental



Social Psychology (October 2020) and preparing a manuscript, to be submitted shortly, on religion as a special cultural identity (also the topic of a paper submitted for publication reviewing the existing literature).

We are currently conducting follow-up studies to see why people seemingly have a propensity, or do not, to identify with cultural groups. We continue to analyze data using latent class analysis to see what can predict these latent class memberships.

Our paper on why women rate their gender identities as “tighter” than men do has been given a “Revise and resubmit” decision so we are revising for resubmission.

We are awaiting a large moral foundations data set to replicate our revised factor structure and associate the moral foundations, and judgment and relevance, with outcome variables. Then we will submit for publication.

From the large questionnaire, we are also examining cultural risk and resilience across different kinds of cultural identities, using measurement invariance techniques.

In our longitudinal data, we are linking cultural identification trajectories to outcomes related to stress and adaptation, leadership, and GPA.

Associated Publications

Barbour, J. E. (2019). *Intrapersonal culture clash: The effect of cultural identity (in)congruence on decision making* (UMI No. 13811933) [Doctoral dissertation]. ProQuest Dissertations and Theses A&I database.

Barbour, J. E., Scott, M. J., Park, H., Grimm, K. J., & Cohen, A. B. (2019, February). *Why do minority members value their cultural identities higher than majority members?* [Poster]. 20th annual meeting of the Society for Personality and Social Psychology, Portland, OR.

Barbour, J. E., Scott, M., Park, H. J., Cohen, A. B., & Grimm, K. J. (2019). *Why do minorities value their cultural identities higher than majority members?* [Manuscript submitted for publication].

Blais, C., Brewer, G. A., & Cohen, A. B. (2020). *Semantic memory provides a basis for cultural identity* [Manuscript submitted for publication].

Blais, C., Cohen, A.B., & Brewer, G. A. (2019). *Semantic memory provides a basis for cultural identity* [Poster]. 60th annual meeting of the Psychonomic Society, Montreal, Canada. Cohen, A. B. (2021). You can learn a lot about religion from food. *Current Opinion in Psychology*, 40, 1-5. <https://doi.org/10.1016/j.copsyc.2020.07.032>

Cohen, A. B., Moon, J. W., & Warner, C. M. (2021, October). Is there anything special about religious morality? In M. E. McCullough (Chair), *Religion in the moral realm: How religion influences moral judgment, moral behavior, and morally desirable societal outcomes* [Symposium]. Society of Experimental Social Psychology Conference, Santa Barbara, CA.

Cohen, A. B., Scott, M. J., & Grimm, K. J. (2020, February). Broadening cultural identification. In R. C. Brooks (Chair), *Family, politics, and culture* [Symposium]. Behavioural Economics Society and Technology (BEST) Conference, Brisbane, Queensland, Australia.

Cohen, A. B., Scott, M. J., Wormley, A. S., Choy, B., & Li, N. (2021, May). *Gender and cultural tightness: A new form of variation in cultural norms* [Symposium]. Association for Psychological Science conference, Virtual.

Cohen, A. B., Wormley, A. S., Graham, J., Scott, M. J., & Grimm, K. J. (2021). *Moral measurement and moral relevance* [Manuscript in preparation].

Elliott, B. L., & Brewer, G. A. (2019). Divided attention selectively impairs value-directed encoding. *Collabra: Psychology*, 5(1). <https://doi.org/10.1525/collabra.156>



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- Elliott, B. L., Blais, C., McClure, S. M., & Brewer, G. A. (2020). Neural correlates underlying the effect of reward value on recognition memory. *Neuroimage*, 206, 116296. <https://doi.org/10.1016/j.neuroimage.2019.116296>
- Elliott, B. L., McClure, S. M., & Brewer, G. (2020). Individual differences in value-directed remembering. *Cognition*, 201, 104275. <https://doi.org/10.1016/j.cognition.2020.104275>
- Gusman, M. S., Grimm, K. J., Doane, L. D., Sasser, J., Park, H. J., Cohen, A. B. (2020). *Cultural risk & resilience: Contributions to psychopathology by gender, race, and socioeconomic status* [Manuscript in preparation].
- Gusman, M., Grimm, K. J., Cohen, A. B., Doane, L. D. (In press). Stress and sleep across the onset of the COVID-19 pandemic: Impact of distance learning on U.S. college students' health trajectories. *SLEEP*. <https://doi.org/10.1093/sleep/zsab193>
- Levin, A. (2019). *Cultural differences in memory output*. [Barrett Honors Thesis, Arizona State University:].
- Moon, J. W., Laurin, K., MacKinnon, D. P., & Cohen, A. B. (2021). *Is religion special?* [Manuscript submitted for publication].
- Scott, M. J., Grimm, K. J., & Cohen, A. B. (2020). *A new way of conceptualizing cultural identification* [Manuscript in preparation].
- Stefanidi, A., Ellis, D. M., & Brewer, G. A. (2018). Free recall dynamics in value-directed remembering. *Journal of Memory and Language*, 100, 18-31. <https://doi.org/10.1016/j.jml.2017.11.004>
- Weldon, H., Gusman, M., Doane, L.D., Grimm, K.J., & Cohen, A.B. (2021, April). *COVID-19 related PTSD symptoms and adolescent internalizing symptoms: Moderation by prior discrimination and socioeconomic status* [Poster]. Society for Research in Child Development Biennial Meeting, Virtual.
- Wormley, A. S., Scott, M. J., Choy, B., Li, N., & Cohen, A. B. (2021). *Loosening culture: Gender and cultural tightness* [Manuscript submitted for publication].

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