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14. ABSTRACT Introduction The CERP project aims to create a systems-based model for describing and evaluating resilience, with the expert input of a diverse group of scientists who help to identify metrics and create a testable model of resilience such that it can be applied to the evaluation of resilience, health and fitness in military populations. The specific aims of CERP are to: 1) Review and identify key domains for systems-based assessment of health and fitness with particular relevance to military populations; 2) Convene a network of experts (termed the HARNESS group) to review the state of the science and identify metrics to be used in a systems-based model of resilience; 3) Use the HARNESS group to identify or create standard analytical processes (criteria and procedures) for implementing resilience and fitness program tracking (i.e., the Health and Fitness Space Map), in part by identifying avenues for testing the created analytical model; and 4) Publish, communicate and disseminate information about this systems framework, its evaluation standards and translational processes widely so that they become available for use in the Department of Defense (DoD), Veterans Affairs (VA) and other systems.					
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Yearly Report

AWARD NUMBER: W81XWH-11-2-0173

REPORT DATE: 14 October 2014

REPORT PERIOD: 1 September 2013- 1September 2014

PI: Wayne Jonas, MD, President/CEO

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AWARD ORG: Samueli Institute

PROJECT TITLE: Central Evaluation of Resilience Programs (CERP)

I. Introduction

The CERP project aims to create a systems-based model for describing and evaluating resilience, with the expert input of a diverse group of scientists who help to identify metrics and create a testable model of resilience such that it can be applied to the evaluation of resilience, health and fitness in military populations. The specific aims of CERP are to:

- 1) Review and identify key domains for systems-based assessment of health and fitness with particular relevance to military populations;
- 2) Convene a network of experts (termed the HARNESS group) to review the state of the science and identify metrics to be used in a systems-based model of resilience;
- 3) Use the HARNESS group to identify or create standard analytical processes (criteria and procedures) for implementing resilience and fitness program tracking (i.e., the Health and Fitness Space Map), in part by identifying avenues for testing the created analytical model; and
- 4) Publish, communicate and disseminate information about this systems framework, its evaluation standards and translational processes widely so that they become available for use in the Department of Defense (DoD), Veterans Affairs (VA) and other systems.

II. Administrative and Logistical Matters

The percent effort and expenditures to date sections reflect figures from September 1, 2013 to September 1, 2014. Additionally, we were granted a No Cost Extension request for one year. This will enable us to develop and finish a model depicting key variables that can predict successful reintegration following deployment.

Additionally, Shamini Jain has left Samueli Institute and will no longer be acting as a co-PI.

III. Body (Research Progress)

The project was awarded on September 15, 2011 and is a two-year funded project that has been extended to four years. This report thus reflects progress for the first quarter of the third year of this project.

During the last year, Dr. Jonas, Dr. Ives, Ms. Sprengel and Ms. Crawford have engaged in several activities to forward CERP's goals. These are described below:

1. Concept Analysis

In order to receive feedback on the concept analysis performed on reintegration we held an expert panel that included the following experts:

Expert Panel-

Rachel Yehuda, PhD- The Mount Sinai Hospital

Col (ret) Arthur Corbett- MCCDC/CD&I, G-3 Navel Concepts

COL Carroll Diebold, MD- Tripler Army Medical Center, HI

COL (ret) Karl Friedl, PhD- Fellow, Oak Ridge Institute for Research and Education (ORISE)

COL (ret) David Orman, MD- Fort Sam Houston

LTC Christopher Ivany, MD- Office of the Army Surgeon General

LTG (ret) Eric Schoomaker, MD- USUHS

Diana Purvis, PhD, PMP- USUHS

Sarah Medows, PhD- RAND

Herman van Wietmarschen, PhD- Nederlandse Organisatie voor Toegepast

Natuurwetenschappelijk Onderzoek/Dutch Organization for Applied Scientific Research (TNO)

Albert Graaf, PhD- (TNO)

Samueli Institute Participants

Wayne Jonas, MD- Co-Principle Investigator, CERP

Shamini Jain, PhD- Co-Principle Investigator, CERP¹

Meredith Sprengel, MS- Program Manager, CERP

Cindy Crawford- Concept Analysis & Literature Review Expert, CERP

Lynn Tao- Concept Analysis & Literature Review Consultant, CERP

Rachel Draper- Concept Analysis & Literature Review Coordinator, CERP

After holding the expert panel meeting in which the panel provided us with their input and criticism on the results of the concept analysis, we integrated their suggestions into our definition, antecedents, defining attributes and consequences (see Appendix I for results).

Although we were originally hoping to include the concept analysis in the Interface Focus special issue, the editors did not believe this was the appropriate venue for publication. We also explored publishing it in the *Journal of Advanced Nursing* in September 2014.

The concept analysis was a critical methodological step in developing the search strategy for the literature review and in producing a definition of reintegration informed by peer-reviewed and grey literature in addition to expert opinion. Hence, we believe it would be best to publish four manuscripts in a methodology journal that would include: the concept analysis and expert panel leading to the development of our definition of reintegration, the literature review and model development methodology, an article on the usefulness of the expert panel, and an article on how to successfully use this model within military communities and potentially other similar communities (such as refugee and internally displaced peoples (IDPs)).

2. CERP Special Issue Update

¹ No longer a Co-PI on this project nor is she a member of Samueli Institute.

After working with PNAS in attempt to publish a subset of high quality data papers that exemplified and highlighted the concepts and major themes of the HARNESS meeting, PNAS decided they were not interested in including such articles in their journal.

Since PNAS did not accept our special issue for publication, we found another journal focused on publishing inter/transdisciplinary articles. The concept proposed to them was a systems approach to resilience, one that would include articles on resilience that looked at the topic from varied viewpoints: from the cell to society. This idea was accepted for publication as a special issue in the journal *InterfaceFocus*. This journal is produced by the Royal Society Publishing, which has a longstanding reputation as a reputable publishing company. The Journal's mission is as follows; "Each Interface Focus themed issue is devoted to a particular subject at the interface of the physical and life sciences. Formed of high-quality articles, they aim to facilitate cross-disciplinary research across this traditional divide by acting as a forum accessible to all. Topics may be newly emerging areas of research or dynamic aspects of more established fields. Organizers of each Interface Focus are strongly encouraged to contextualize the journal within their chosen subject." *InterfaceFocus* is a relatively new journal (has been in publication for 4 years) and has recently been approved for indexing in PubMed Central, Scopus, WOS, JCR, Biosis Previews and Biological Abstracts, has around a 3.5 impact factor and is ranked 17th out of 87 in "biology" journals.

In January, research papers for the special issue were submitted to *Interface Focus*: fifteen papers were submitted for publication, eight were accepted, three rejected, and the rest of the papers are still under review. We are exploring other avenues and journals to publish the papers that were rejected as well as other publications on which the Institute is currently working which are applicable to the study of resilience and the aims of the CERP project. (Please see Appendix II for more information on the papers rejected for the publication.)

The special issue was published online August 22 and available in print October 2014. The following is the citation for the special issue:

Towards a Systems Model of Resilience: Papers of a Theme Issue organized by Meredith Sprengel, Shamini Jain, Kevin Berry, John Ives, and Wayne Jonas. *Interface Focus* 2014; 4(5).

The authors whose papers were accepted and included in the special issue attended our HARNESS meeting in January 2013 and/or are known as exceptional researchers in the field of resilience.

The following is a list of papers includes their abstracts, authors and the author's affiliations:

Review article: The mathematician's control toolbox for management of type 1 diabetes

Authors:

Marie Csete

Huntington Medical Research Institutes

John Doyle

California Institute of Technology

Citation:

Csete M, Doyle J. 2014 The mathematician's control toolbox for management of type 1 diabetes. *Interface Focus* 4: 20140042. <http://dx.doi.org/10.1098/rsfs.2014.0042>

Abstract:

Blood glucose levels are controlled by well-known physiological feedback loops: high glucose levels promote insulin release from the pancreas, which in turn stimulates cellular glucose uptake. Low blood glucose levels promote pancreatic glucagon release, stimulating glycogen breakdown to glucose in the liver. In healthy people, this control system is remarkably good at maintaining blood glucose in a tight range despite many perturbations to the system imposed by diet and fasting, exercise, medications and other stressors. Type 1 diabetes mellitus (T1DM) results from loss of the insulin-producing cells of the pancreas, the beta cells. These cells serve as both sensor (of glucose levels) and actuator (insulin/glucagon release) in a control physiological feedback loop. Although the idea of rebuilding this feedback loop seems intuitively easy, considerable control mathematics involving multiple types of control schema were necessary to develop an artificial pancreas that still does not function as well as evolved control mechanisms. Here, we highlight some tools from control engineering used to mimic normal glucose control in an artificial pancreas, and the constraints, trade-offs and clinical consequences inherent in various types of control schemes. T1DM can be viewed as a loss of normal physiologic controls, as can many other disease states. For this reason, we introduce basic concepts of control engineering applicable to understanding pathophysiology of disease and development of physiologically based control strategies for treatment.

Research article: The hypothalamic–pituitary–adrenal–leptin axis and metabolic health: a systems approach to resilience, robustness and control

Authors:

Kirstin Aschbacher

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The Institute for Integrative Health, Baltimore, MD

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Department of Analytical Biosciences, Leiden University, The Netherlands

Citation:

Aschbacher K, Rodriguez-Fernandez M, van Wietmarschen H, Tomiyama AJ, Jain S, Epel E, Doyle III Fj, van der Greef J. 2014 The hypothalamic-pituitary-adrenal-leptin axis and metabolic health: a systems approach to resilience, robustness and control. *Interface Focus* 4: 20140020.

<http://dx.doi.org/10.1098/rfs.2014.0020>

Abstract:

Glucocorticoids contribute to obesity and metabolic syndrome; however, the mechanisms are unclear, and prognostic measures are unavailable. A systems level understanding of the hypothalamic–pituitary–adrenal (HPA)–leptin axis may reveal novel insights. Eighteen obese premenopausal women provided blood samples every 10 min over 24 h, which were assayed for cortisol, adrenocorticotropin releasing hormone (ACTH) and leptin. A published personalized HPA systems model was extended to incorporate leptin, yielding three parameters: (i) cortisol inhibitory feedback signalling, (ii) ACTH–adrenal signalling, and (iii) leptin–cortisol antagonism. We investigated associations between these parameters and metabolic risk profiles: fat and lean body mass (LBM; using dual-energy X-ray absorptiometry), and insulin resistance. Decreased cortisol inhibitory feedback signalling was significantly associated with greater fat (kg; $p = 0.01$) and insulin resistance ($p = 0.03$) but not LBM. Leptin significantly antagonized cortisol dynamics in eight women, who exhibited significantly lower 24 h mean leptin levels, LBM and higher ACTH–adrenal signalling nocturnally (all $p < 0.05$), compared with women without antagonism. Traditional neuroendocrine measures did not predict metabolic health, whereas a dynamic systems approach revealed that lower central inhibitory cortisol feedback signalling was significantly associated with greater metabolic risk. While exploratory, leptin–cortisol antagonism may reflect a ‘neuroendocrine starvation’ response.

Review article: Computational modelling of the inflammatory response in trauma, sepsis and wound healing: implications for modelling resilience

Authors:

Yoram Vodovotz

Department of Surgery, University of Pittsburgh, PA

Citation:

Vodovotz Y. 2014 Computational modelling of the inflammatory response in trauma, sepsis and wound healing: implications for modelling resilience. *InterfaceFocus* 4: 2014.0004.

<http://dx.doi.org/10.1098/rsfs.2014.0004>

Abstract:

Resilience refers to the ability to recover from illness or adversity. At the cell, tissue, organ and whole-organism levels, the response to perturbations such as infections and injury involves the acute inflammatory response, which in turn is connected to and controlled by changes in physiology across all organ systems. When coordinated properly, inflammation can lead to the clearance of infection and healing of damaged tissues. However, when either overly or insufficiently robust, inflammation can drive further cell stress, tissue damage, organ dysfunction and death through a feed-forward process of inflammation → damage → inflammation. To address this complexity, we have obtained extensive datasets regarding the dynamics of inflammation in cells, animals and patients, and created data-driven and mechanistic computational simulations of inflammation and its recursive effects on tissue, organ and whole-organism (patho)physiology. Through this approach, we have discerned key regulatory mechanisms, recapitulated in silico key features of clinical trials for acute inflammation and captured diverse, patient-specific outcomes. These insights may allow for the determination of individual-specific tolerances to illness and adversity, thereby defining the role of inflammation in resilience.

Review article: Sleep and inflammation in resilient aging

Author:

Michael R. Irwin

Cousins Center for Psychoneuroimmunology, UCLA Semel Institute for Neuroscience,
University of California, Los Angeles, CA &
Department of Psychiatry and Biobehavioral Sciences, David Geffen School of Medicine,
University of California, Los Angeles

Citation:

Irwin MR. 2014 Sleep and inflammation in resilient aging. *Interface Focus* 4: 20140009.

<http://dx.doi.org/10.1098/rsfs.2014.0009>

Abstract:

Sleep quality is important to health, and increasingly viewed as critical in promoting successful, resilient aging. In this review, the interplay between sleep and mental and physical health is considered with a focus on the role of inflammation as a biological pathway that translates the effects of sleep on risk of depression, pain and chronic disease risk in aging. Given that sleep regulates inflammatory biologic mechanisms with effects on mental and physical health

outcomes, the potential of interventions that target sleep to reduce inflammation and promote health in aging is also discussed.

Review article: Biological mechanisms underlying the role of physical fitness in health and resilience

Author:

Marni N. Silverman

Consortium for Health and Military Performance, Department of Military & Emergency Medicine, Uniformed Services University of the Health Sciences, Bethesda, MD

Patricia A. Deuster

Consortium for Health and Military Performance, Department of Military & Emergency Medicine, Uniformed Services University of the Health Sciences, Bethesda, MD

Citation:

Silverman MN, Deuster, PA. 2014 Biological mechanisms underlying the role of physical fitness in health and resilience. *InterfaceFocus* 4: 20140040. <http://dx.doi.org/10.1098/rsfs.2014.0040>

Abstract:

Physical fitness, achieved through regular exercise and/or spontaneous physical activity, confers resilience by inducing positive psychological and physiological benefits, blunting stress reactivity, protecting against potentially adverse behavioural and metabolic consequences of stressful events and preventing many chronic diseases. In this review, we discuss the biological mechanisms underlying the beneficial effects of physical fitness on mental and physical health. Physical fitness appears to buffer against stress-related disease owing to its blunting/optimizing effects on hormonal stress responsive systems, such as the hypothalamic–pituitary–adrenal axis and the sympathetic nervous system. This blunting appears to contribute to reduced emotional, physiological and metabolic reactivity as well as increased positive mood and well-being. Another mechanism whereby regular exercise and/or physical fitness may confer resilience is through minimizing excessive inflammation. Chronic psychological stress, physical inactivity and abdominal adiposity have been associated with persistent, systemic, low-grade inflammation and exert adverse effects on mental and physical health. The anti-inflammatory effects of regular exercise/activity can promote behavioural and metabolic resilience, and protect against various chronic diseases associated with systemic inflammation. Moreover, exercise may benefit the brain by enhancing growth factor expression and neural plasticity, thereby contributing to improved mood and cognition. In summary, the mechanisms whereby physical fitness promotes increased resilience and well-being and positive psychological and physical health are diverse and complex.

Review article: Resilience in the aftermath of war trauma: a critical review and commentary

Author:

Brett T. Litz

Massachusetts Veterans Epidemiological Research and Information Center, VA
Boston Healthcare System, Boston, MA &
Departments of Psychology and Psychiatry, Boston University, Boston, MA

Citation:

Litz BT. 2014 Resilience in the aftermath of war trauma: a critical review and commentary.
InterfaceFocus: 4: 20140008. <http://dx.doi.org/10.1098/rsfs.2014.0008>

Abstract:

The resilience construct has received a great deal of attention as a result of the long wars in Iraq and Afghanistan. The discourse about resilience, especially the promise of promoting it and mitigating risk for serious post-traumatic negative outcomes among service members and veterans, is hopeful and encouraging. Remarkably, most service members exposed to horrific war trauma are not incapacitated by the experience. Yet, resilience is elusive and fleeting for many veterans of war. In this paper, I address some of the complexities about resilience in the context of exposure to war stressors and I offer some assumptions and heuristics that stem from my involvement in the dialogue about resilience and from experiences helping prevent post-traumatic stress disorder among active-duty service members with military trauma. My goal is to use my observations and applied experiences as an instructive context to raise critical questions for the field about resilience in the face of traumatic life-events.

Research article: Glucocorticoid-related predictors and correlates of post-traumatic stress disorder treatment response in combat veterans

Authors:

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Citation:

Yehuda R, Prachtchett LC, Elmes MW, Lehrner A, Daskalakis NP, Koch E, Makotkine I, Flory JD, Bierer LM. 2014 Glucocorticoid-related predictors and correlates of post-traumatic stress disorder treatment response in combat veterans. *Interface Focus* 4: 20140048.
<http://dx.doi.org/10.1098/rfs.2014.0020>

Abstract:

The identification of biomarkers for post-traumatic stress disorder (PTSD) and resilience/recovery is critical for advancing knowledge about pathophysiology and treatment in trauma-exposed persons. This study examined a series of glucocorticoid-related biomarkers prior to and in response to psychotherapy. Fifty-two male and female veterans with PTSD were randomized 2 : 1 to receive either prolonged exposure (PE) therapy or a weekly minimal attention (MA) intervention for 12 consecutive weeks. Psychological and biological assessments were obtained prior to and following treatment and after a 12-week naturalistic follow-up. Response was defined dichotomously as no longer meeting criteria for PTSD at post-treatment based on the Clinician Administered PTSD Scale for DSM-IV (CAPS). Clinical improvement on the CAPS was apparent for both PE and MA, with no significant difference according to treatment condition. Biomarkers predictive of treatment gains included the BCL1 polymorphism of the glucocorticoid receptor gene. Additional predictors of treatment response were higher bedtime

salivary cortisol and 24 h urinary cortisol excretion. Pre-treatment plasma dehydroepiandrosterone/cortisol ratio and neuropeptide Y (NPY) levels were predictors of reductions in PTSD symptoms, and, for NPY only, of other secondary outcomes as well, including anxiety and depression ratings. Glucocorticoid sensitivity changed in association with symptom change, reflecting clinical state. It is possible to distinguish prognostic and state biomarkers of PTSD using a longitudinal approach in the context of treatment. Identified markers may also be relevant to understanding mechanisms of action of symptom reduction.

Research article: One bad apple: experimental effects of psychological conflict on social resilience

Author:

David Pincus

Department of Psychology, Chapman University, Orange, CA

Citation:

Pincus D. 2014 One bad apple: experimental effects of psychological conflict on social resilience. *InterfaceFocus* 4: 20140003. <http://dx.doi.org/10.1098/rsfs.2014.0003>

Abstract:

Past research suggests that small groups are self-organizing systems, and that social resilience may be measured as the meta-flexibility of group dynamics: the ability to shift back and forth from flexibility to rigidity in response to conflict. This study extends these prior results, examining the impact of experimentally induced internal conflict and group-level conflict resolution on group dynamics—whether one bad apple can spoil the bunch. Six experimental groups with four members each participated in a series of four 25 min discussions. The first two discussions served as a baseline condition. Internal conflict was induced to one or more group members prior to discussion three, with the prediction that higher levels of conflict induction would lead to significant drops in group flexibility—creating a press on the group's resilience, whereas conflict resolution in discussion four was expected to allow for a rebound in group flexibility. Consistent with prior research, the turn-taking dynamics of each the 24 groups were distributed as inverse power laws ($R^2 = 0.86\text{--}0.99$) providing evidence for self-organization. Furthermore, there were significant study-wise negative correlation between levels of personality conflict and two measures of flexibility: information entropy ($r = -0.47$, $p = 0.019$) and fractal dimension ($r = -0.42$, $p = 0.037$). Altogether, these results suggest that: (i) small groups are self-organizing systems with structure and flexibility providing social resilience and (ii) individual conflict is able to spread to higher level social dynamics, creating pressure on social resilience. Practical implications for assessment of, and intervention with, psychosocial resilience are discussed.

3. Literature Review for Model Development

In 2014, a literature review was conducted that informed the development of our reintegration model that TNO has begun to construct. The literature review process began by evaluating our concept analysis on reintegration and four resilience-oriented models/frameworks: Total Force Fitness (TFF), Allostatic Load, Comprehensive Soldier Fitness (CSF) and parameters of the MIDUS study. From the concept analysis and models/frameworks we extracted their domains, subdomains, categories, variables and any metrics/questionnaires used to measure these constructs. Using the information extracted from the resilience oriented models/frameworks and the antecedents, defining attributes and consequences from the concept analysis performed on the term reintegration, a search string was developed (see Appendix III).

The search string yielded 11,251 articles that will be screened for the following criteria:

- Population: military personnel and their families (if included)
- Intervention: not restricted (any and all interventions or no interventional studies)
- Control: not restricted (or may not be a controlled study as well)
- Outcome: outcome included within the CERP Variable List (see list below) fitting within a domain as defined by SI
- Study design: any study design (has to be a study or review)

A rulebook was composed which outlines the screening process and includes all the variables and outcomes that were extracted from the resilience models/frameworks and the concept analysis (see Appendix IV). During the screening phase all of the outcomes and variables featured in the studies reviewed that were extracted from the models/frameworks and the concept analysis will be identified.

This quarter we began screening the 11,251 abstracts that were extracted from PubMed and PsychInfo and worked with our TNO colleagues to refine the screening process in order to collect the most appropriate information from the abstracts being screened. During this process we realized that the inclusion rate of abstracts screened was approximately 50%. Due to this high inclusion rate it was not feasible to screen all of the articles that the search string yielded. A random subset of 20% of the abstracts was screened: 2262. Of the screened abstracts, 1119 articles met the inclusion criteria resulting in a 51% inclusion rate. The breakdown by domain and study type of the abstracts included is as follows:

- Domain
 - o 31.2% Behavioral
 - o 10.8% Psychological
 - o 22.4% Physiological
 - o 21.8% Social
 - o 3.3% Spiritual
 - o 4.1% Policy
- Study Type
 - o 10% Interventions
 - o 79% Observational

- o 2.5% Systematic Reviews & Meta-Analyses
- o 1.5% Other

In an effort to develop a model on reintegration that was applicable and implementable, we decided to focus the model around articles with an outcome focused on social reintegration. We have divided these articles with outcomes focused on social reintegration into the following categories:

- Family
 - o Domestic Violence
 - o Marriage/Spouse/Divorce/Relationships
 - o Family
- Sociodemographic
 - o Employment
 - o Work/Life Satisfaction; Work/Life Conflict; Role Strain
 - o Work Stress/Burnout
 - o Work Performance
 - o Sociodemographics
- Community/Social Support
- Military
 - o Unit Cohesion
 - o Teamwork
 - o Leadership
 - o Organization
 - o Sexual Harassment/Sexism
 - o Reentry into Civilian Life
 - o Altruism
 - o Values/Beliefs
 - o Veteran Homelessness
 - o Military Performance/Readiness
 - o Turnover/Attrition/Reenlistment

While Samueli Institute reviewed the literature, TNO created a framework of model and pathways with the use of expert knowledge at TNO. They also developed the model and pathways by reviewing the relationships shared from a screening activity conducted at SI to identify the important variables both through a concept analysis as well as a robust search and screening activity. From the pathways developed, the studies found through the literature review are now being mapped to the pathways to determine if the data supports the model thus far and to adjust the model as needed with additional pathways, more supportive directions, strengths and time course based on what the literature explicates.

The mapping activity and the procedure for using the literature to inform the pathways was developed when the team visited TNO in order to understand the modeling software and how to manipulate it. We

identified the literature that we need to review more in depth in order to determine the strength of the relationships, direction and time courses as well as other characteristics needed to strengthen and to make a more robust model based on expert opinion and data found in the literature.

The Samueli Institute team and TNO are currently reviewing the literature and mapping it onto the model; altering and making adjustments to it when necessary. A majority of the literature from the social, behavioral and psychological domains depicted the following relationships which we are reviewing and will map onto the model in the coming months:

- Cognitive capability->Cognitive capacity
- Coping capacity->mental fitness
- Externalizing problem behaviour->Family functioning
- Externalizing problem behaviour->Substance abuse
- Family functioning->Social support
- Internalizing problem behaviour->Employment status
- Internalizing problem behaviour->Family functioning
- Internalizing problem behaviour->Substance abuse
- Leadership Autonomy support->Commitment to goal
- psychophysiological stress load->Cognitive capacity
- Substance abuse->Cognitive capacity
- Unit support->Social support
- Unit support->Family functioning

Following this activity we will hold another expert panel comprised of mostly military personnel involved in the reintegration process to review the model.

IV. Key Research Accomplishments

- Created and defined guidelines for model development
- Published *Interface Focus* Special Issue- Towards a Systems Model of Resilience
- CERP model presented at American Psychosomatic Society March 2014 (see previous report for abstract submitted)
- Developed a Preliminary Model

V. Reportable Outcomes

- Published *Interface Focus* Special Issue- Towards a Systems Model of Resilience
- CERP model development methodology presented at American Psychosomatic Society March 2014
- Literature Review Completed
- Preliminary Model Constructed

VI. Conclusion

The long-term goal underlying the CERP effort is to build the science of health and resilience through research and to facilitate the uptake of the evidence-based practices through dissemination of this knowledge. The success of reaching these long-term goals depends on the success in achieving the short-term goals of the CERP program, which are to build a research and best practices network (HARNESS) that will develop a preliminary set of systems metrics and analytic processes for evaluation of practices and programs aimed at enhancing resilience, primarily within the context of re-integration. Through creating a set of biometric standards and analytical processes for the use of a systems-based approach to resilience, the military will enhance performance and provide safer and more effective programs for pain, stress conditions, chronic disease and performance enhancement.

VII. References

None.

VIII. Appendices

- I. No Cost Extension- Request Letter and Model Development Timeline
- II. Concept Analysis Results
- III. Literature Review Rulebook
- IV. American Psychosomatic Society- Abstract and Accepted Poster
- V. Potential Papers that will be published as a product of the CERP Program (Some of these papers were not accepted for publication in the InterfaceFocus Special Issue)
- VI. Search String for Model Development
- VII. Current Version of Model
- VIII. Cover Image of Special Issue
- IX. InterfaceFocus Editorial Board
- X. Introduction to Special Issue

Appendix I - No Cost Extension- Request Letter and Model Development Timeline

June 5, 2014

Samueli Institute

Wayne Jonas, M.D., & Shamini Jain, Ph.D.

1737 King Street, Suite 600

Alexandria, VA 22314

Ph: 703.299.4805

To: Ms. Elena Bane

U.S. Army Medical Research Acquisition Activity

820 Chandler Street
Fort Detrick MD 21702

Dear Ms. Bane,

We would like to request a 12-month No Cost Extension under grant# W81XWH-11-2-0173, through October 16 2015 for the project entitled "Central Evaluation of Resilience Programs (CERP)". The grant is currently scheduled to end on October 16, 2014.

As we previously discussed and have indicated in our quarterly reports, the CERP project has been very fruitful to date, with major accomplishments and milestones achieved, including the establishment and meeting of the HARNESS experts, a concept analysis and expert panel on the meaning of reintegration and the development of the special issue. While in the process of developing the model, the systematic review yielded 11,251 abstracts and the inclusion rate of articles was approximately 50 percent. Due to this high inclusion rate and the number of abstracts, model development is delayed. We will need another 12 months to complete the systematic review and develop the model as planned in our SOW.

We have attached the details (including a timeline) for the development of the model for the CERP project. We understand no additional funds are a part of this action, and we have sufficient funds to complete this work.

Thank you for your understanding and review. Please do not hesitate to contact either one of us for any reason.

Sincerely,



Wayne Jonas, M.D., PI



Shamini Jain, Ph.D., Co-PI

Literature Review, Data Extraction and Model Development & Dissemination																												
Tasks	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-14	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-14	Sep-14	Oct-14	
Identify and recruit subject matter experts																												
Formulate a research question																												
Search Strategy and Inclusion/Exclusion Criteria Decided																												
Comprehensive literature search Performed																												
Decide on Variables to be included in the Model																												
Data management System Setup																												
Rulebook for Model Development Created																												
First Iteration of Model Developed and Tested																												
Model Vetted and Refined with Samueli Institute Members																												
Model Vetted and Refined with Expert Panel																												
Final Model Developed and Tested																												
Model Dissemination																												

Appendix II - Concept Analysis Results

Original Results Prior to Expert Panel Meeting

Group: Meredith Sprengel, Cindy Crawford, Rachel Draper & Lynn Teo

Reintegration: a continuous, complex, transformative process toward a sustainable life involving the reunification of service members and families into their community; this encompasses psychological, social, economic, and political aspects. This process may or may not be part of the deployment cycle.

<u>Antecedents</u>	<u>Defining Attributes</u>	<u>Consequences</u>
Fractured	Continuous	Restore to unity
Disparate	Complex	Reconciliation
Broken	Transformative process	Repatriation
Deranged	Sustainable Life	Acceptance
Disruption	Reunification	Unified State
Illness	Service members	Restore to Livelihood
Exclusion	families	Complete
Alienation	Community	Peaceful (modifier)
Separation	psychological	Change
Struggle	Social	Productive Life
Expectations	Political	Sense of Feeling
Attitudes	Part of the deployment cycle	
Habits/Customs		
Normative Values		
Desire		
Help		

Results Combining Concept Analysis and Expert Panel Findings

Explanation of Process: Following the expert panel meeting, we combined the suggestions regarding the definitions, antecedents and consequences of the working groups with the formal concept analysis definition that was derived from the literature. Consequently, this had an impact on the definition's defining attributes. Please see below:

Reintegration: a continuous, transformative and restorative process striving towards a sustainable life and comprehensive state of well-being involving the reunification of service members, families and their communities.

Addendums:

- This process is active and resource consuming as well as efficient and outcome driven.

- Psychological, social, physiological, economic, political, educational and occupational domains

<u>Antecedents</u>	<u>Defining Attributes</u>	<u>Consequences</u>
Fractured	Continuous	Restore to unity
Disparate	Transformative	Reconciliation
Deranged	Process	Repatriation
Disruption	Sustainable Life	Acceptance
Illness	Reunification	Unified State
Exclusion	Service members	Restore to Livelihood
Alienation	Families	Complete
Separation	Community	Peaceful (modifier)
Struggle	Restorative	Change
Expectations	Well-being	Productive Life
Attitudes	Striving towards	Sense of Feeling
Habits/Customs	Comprehensive State	Cohesion
Normative Values	Psychological	Sense of purpose
Desire	Social	Service orientation
Help	Physiological	Enhanced resilience
Trauma	Economic	
Bereavement	Political	
	Educational	
	Occupational	

Appendix III – CERP Screening Codebook

RESEARCH PURPOSE/QUESTION

To conduct a literature review to support a model development of reintegration by extracting data on the relationship between variables that fit into the domains of reintegration pertinent to military

The **purpose of this literature review** is to

(1) comprehensively search the literature for studies published in the English language on active duty military with an analysis of variables that fit within the domains of reintegration as identified by SI Concept Analysis and expert roundtable

(2) extract data in relation to correlations between identified variables and other pertinent information in relation to these studies TBD

- P:** military personnel and their families (if included)
- I:** not restricted (any and all interventions or no interventional studies)
- C:** not restricted (or may not be a controlled study as well)
- O:** outcome included within the CERP Variable List (see list below) fitting within a domain as defined by SI
- S:** any study design (has to be a study or review)

SRS DIRECTIONS

When screening, do NOT look up articles. Base your answers on the title/abstract and avoid heavily relying on the keywords. Keywords should only be a reference.

SCREENING QUESTIONS:

1. **Is the population comprised of military personnel?**

Answer Yes, No or Unsure.

If NO, this will automatically exclude this study. Do not proceed to the next question.

If YES or UNSURE, proceed to next question.

Note for Screener: Exclude Child-soldiers

2. **Is this a study or a review? A non-study includes commentaries, editorials or narrative reviews or protocols (ie. the study must have data).**

Answer Yes, No or Unsure.

If NO, this will automatically exclude this study. Do not proceed to the next question.

If YES or UNSURE, identify study design in the text box provided.

If OTHER, identify the study design as “Validation of Outcome Measure”

Study Design Options include:

- *RCT (Randomized Control Trial)*

- *Clinical Trial Non-Randomized*
- *OBS (Observational Trial) (This includes Data analysis, Prospective / Retrospective Longitudinal Cohorts; Case-Controls & Cross-sectionals)*
- *SR (Systematic Review)*
- *MA (Meta-Analysis)*
- *Validation of Outcome Measure (to be classified as OTHER)*

Note: If you are seeking clarification about a certain study design you can select UNSURE or email Lynn to discuss.

3. Does the study contain one or more outcome measures included within the CERP Variables List?

Notes for Screener:

- *Use the CERP Variable List included in your CERP Screening Rulebook as a reference.*
- *Input the outcome as written in the abstract, not as it is written in the CERP Variable List.*
- *If an outcome measure is listed you can either use the full name of the outcome measure or an outcome related to the outcome measure. Ie. PTSD Checklist (PCL) or PTSD; Beck Depression Inventory-II (BDI-II) or Depression*

Answer Yes, No or Unsure.

If NO, this will automatically exclude this study. Do not proceed to the next question.

If YES or UNSURE identify the outcome(s) of interest the text box provided.

4. Please list the domains and variables.

Please check all the domains that apply.

Under each chosen domain, please list in the text box provided the variables measured within the study.

Note for Screener:

- *Use the CERP Variable list included in your CERP Screening Rulebook as a reference. Be sure to include the outcome measure(s) from question 3 as well as risk factors associated with the outcome.*
- *Input the outcome as written in the abstract, not as it is written in the CERP Variable List.*

Is this an intervention?

Answer Yes, No or Unsure. If YES or UNSURE, please input the type of intervention in the text box provided.

CERP VARIABLE LIST

DOMAIN	SUBDOMAIN	VARIABLE
SOCIAL	FAMILY RELATIONSHIP	• <u>Parent-child relationship</u>: Child Abuse; Parental Support • <u>Spousal Relationship</u>: Spousal Strain / Support, Divorce Rate • Family Support / Strain / Stressors, Family Demands • Work Interfering with Family / Family Interfering with Work • Family Resources • Family Fitness • Violence in Childhood • Daily Time Use (time with children, working, relaxing, etc)
	SOCIO DEMOGRAPHIC	• Education • Income • Work (Work Situation Quality, Opportunities at Work, Work Performance Appraisal)
	COMMUNITY	• Social / Neighborhood Cohesion; Sense of Community • Social Support • Social Well-Being • Neighborhood Socioeconomic Status
	MILITARY	• Unit Cohesion • Unit Climate (eg. respect of diversity & differing values; interpersonal support; care & concern demonstrated by unit members) • Ethical Behavior & Decision Making modeled by leadership • Team / Organizational Job & Task Performance
PHYSICAL	OBJECTIVE HEALTH	• Allostatic Load • Body Mass Index / Overweight / Obesity • <u>Cardiovascular</u>: Cardiovascular Disease Risk Factors; Cardiovascular Function • <u>Cognitive Function</u>: Executive Function, Post-Concussion Assessment, Neuropsychological Assessment • Cortisol • Glucoregulation • <u>HEENT</u>: Dental Readiness; Vision Readiness; Hearing Readiness • HIV Status • Medication Use • Pregnancy • Serum IL-6
	SUBJECTIVE HEALTH	• <u>Assessments</u>: Physical Symptoms / Periodic Health Assessment / Subjective Health Assessment / Complete Health / Somatic Symptoms • Control over health • Menopausal Symptoms • <u>Military</u>: Medical Nondeployable Profile DNA Sample; Limited Duty Profile • Pain • <u>Sleep / Fatigue / Energy</u>: Sleep Quality, Sleepiness, Insomnia, Daytime Fatigue
	ABILITIES / LIMITATIONS	• Endurance • Strength & Power • Flexibility • Mobility • Activities of Daily Living / Functional Limitations / Physical Disability

Definitions

Allostatic Load - "the wear and tear on the body" which grows over time when the individual is exposed to repeated or chronic stress. It represents the [physiological](#) consequences of chronic exposure to fluctuating or heightened [neural](#) or [neuroendocrine response](#) that results from repeated or chronic [stress](#). *Wikipedia*

Control - Personal control beliefs, also referred to as locus of control and personal mastery beliefs, reflect individuals' beliefs regarding the extent to which they are able to control or influence outcomes.
<http://www.macses.ucsf.edu/research/psychosocial/control.php>

Environmental Mastery - component of psychological well-being that assesses an individual's sense of mastery and competence in managing the surrounding environment. *Ryff, 1989*

Eudaimonia - a contented state of being happy and healthy and prosperous.
<http://www.thefreedictionary.com/Eudaimonic>

Executive Self - The *executive self* refers to the agentic aspect of the self-system, the part involved actively in monitoring itself, choosing how to behave, and enacting chosen responses. The executive self encompasses several phenomena, including control beliefs, control strategies, and self-regulation. *Neiss et al. Journal of Personality and Social Psychology, 2005, Vol. 89, No. 4, 593–606*

Family fitness is the immediate military family's ability to use physical, psychological, social, and spiritual resources to prepare for, adapt to, and grow from military lifestyle demands. *Military Medicine, Vol. 175, August Supplement 2010, Pg 97*

Generativity - a desire to leave a legacy by providing for the welfare of others. *Son & Wilson. Sociological Forum, Vol. 26, No. 3, September 2011*

Hedonic - 1. Of, relating to, or marked by pleasure. 2. Of or relating to hedonism or hedonists.
<http://www.thefreedictionary.com/hedonic>

Measures of shift - measures to capture the tendency to shift oneself in response to stressors. *Chen et al. Psychosom Med. 2012 February ; 74(2): 178–186.*

Moral Injury - moral injury has been defined as "perpetrating, failing to prevent, bearing witness to, or learning about acts that transgress deeply held moral beliefs and expectations". *Litz, B. T., Stein, N., Delaney, E., Lebowitz, L., Nash, W. P., Silva, C., et al. (2009). Moral injury and moral repair in war veterans: A preliminary model and intervention strategy. Clinical Psychology Review, 29, 695-706. doi: 10.1016/j.cpr.2009.07.003.*

Overloads – having too little time or other resources; a type of stressor that may result in more serious stress reactions such as anxiety and depression. *Almeida (2005) Current Directions, Volume 14—Number 2*

Appendix IV - American Psychosomatic Society- Abstract and Accepted Poster

Towards a Systems Model of Resilience – From Concept Analysis to Quantitative Modeling

Shamini Jain, Meredith Sprengel, Lynn Teo, Rachel Draper, Cindy Crawford, Herman van Wietmarchen, Albert A. de Graaf, Jan van der Greef, John Ives, Wayne Jonas

Resilience is a popular construct that continues to be operationalized as either psychological or physiological in nature, with few to no operational definitions that encompass and integrate mental, emotional, social, and physiological components. Understanding and tracking resilience from an integrated perspective is essential to inform preventative and therapeutic measures to enhance resilience in various contexts. Through our DOD-funded project, Central Evaluation of Resilience Processes, we have begun the development of a systems model of resilience, within the context of military reintegration (return of active duty military to civilian life). This comprehensive approach includes both aspects that are both qualitative (concept analysis and expert panel) and quantitative (systematic review and data extraction, and quantitative modeling). First, the concept analysis on the term “reintegration” was conducted. From over 2000+ sources explored through PubMed, PsychInfo, Google and GoogleScholar, 179 definitions of the term “reintegration” were noted. These definitions were then examined to determine literature-based antecedents, consequences, defining attributes of the term reintegration, and based on these data, a comprehensive definition of the term reintegration was created. This information was then vetted and refined with a panel of experts in military mental health, psychoneuroimmunology, psychoneuroendocrinology, family systems, and DOD leaders. The antecedents, consequence and defining attributes were used to develop a comprehensive search string for a literature review, where quantitative data on variables within the determined domains of social, psychological, physiological, behavioral, spiritual, medical policy, and stressors are being extracted. This data will be extracted to input into a systems modeling tool (Marvelous, TNO), which allows for the visual examination and quantitative relationship testing between variables. Following vetting with an expert panel, this systems model will be transferred into a Vensim-coded model, to provide a quantitative and systems-based approach to better understanding and tracking resilience for military members within a reintegration context.



Towards a Systems Model of Resilience – From Concept Analysis to Quantitative Modeling

Shamini Jain^{1,2}, Meredith Sprengel,¹ Lynn Teo,¹ Rachel Draper,¹ Cindy Crawford,¹ Herman van Wietmarschen,³
Albert de Graaf,³ Jan van der Greef,³ John Ives,¹ Wayne Jonas¹

1 Samueli Institute, Alexandria VA; 2 University of California San Diego; 3 TNO-Innovation for Life, Leiden, Netherlands



Resilience – Current Understandings

Resilience has been defined generally as the ability to adapt to changing, stressful or adverse circumstances. Recent definition (over 122) highlight resilience as:

- A process or capacity that develops over time
- Adaptability to change
- "Return to homeostasis", or growth

Issues with Current Definition of Resilience

- While the impact of traumatic stress affects multiple systems, resilience continues to be defined chiefly either psychologically, or physically
- Lack of personalized, systems-based metrics for understanding and predicting Resilience

Multidisciplinary Meeting

Expert scientists in the fields of systems biology, control systems engineering, systems modeling, neuroscience, PNLPNE convened to:

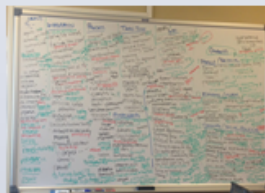
- Discuss current understandings of resilience
 - Aid in creating a multidisciplinary, systems-based model of resilience
 - Outcome includes Special Issue (2014)
- Group Suggestion – for most current cultural relevance, consider modeling resilience within the reintegration context



Defining Reintegration

Concept Analysis

- Designed to provide an overarching understanding of a concept or term by:
 - extracting definitions from academic peer-reviewed articles, websites, grey literature, encyclopedias and dictionaries
 - review of definitions, and determination of antecedents, consequences, and attributes of the term
- Creates a comprehensive, literature-informed definition of the term that includes the concept's defining attributes.
- Databases Searched: PubMed, PsychInfo, Encyclopedias (found at Georgetown University Google & Google Scholar)
- 2000+ articles/websites/grey literature reviewed for definitions
- 179 definitions were extracted and reviewed
- Most common antecedents, attributes and consequences were extracted and a definition composed



Expert Panel Review

An expert panel of scientists, military leaders, and policymakers convened on August 5, 2013 to review and critique the findings of the concept analysis, and add their expert opinion on what successful reintegration looks like for members of the military and their families.

Results Combining Concept Analysis and Expert Panel

Process: Integrated expert panel input with the formal, literature-defined concept analysis for a final definition, antecedents, attributes, and consequences of reintegration:

Definition of Reintegration: a continuous, transformative and restorative process striving towards a sustainable life and comprehensive state of well-being involving the reunification of service members, families and their communities.

Addendums:

- This process is active and resource consuming as well as efficient and outcome driven.
- This process is comprised of psychological, social, physiological, economic, political, educational and occupational domains

Antecedents: Fractured, Disparate, Damaged, Disruption, Illness, Exclusion, Alienation, Separation, Struggle, Expectations, Attitudes, Habits Customs, Normative Values, Desire, Help, Trauma & Bewavement

Define Attributes: Continuous, Transformative, Process, Sustainable Life, Reunification, Service members, Families, Community, Restorative, Well-being, Striving towards, Comprehensive State, Psychological, Social, Physiological, Economic, Political, Educational, Occupational, Active, Resource Consuming, Efficient & Outcome Driven

Consequences: Restore to unity, Reconciliation, Reparation, Acceptance, Unified State, Restore to Livelihood, Complete, Peaceful (modifier), Change, Productive Life, Sense of Feeling, Cohesion, Sense of purpose, Service orientation & Enhanced resilience

Quantitative Modeling

Literature Review/Data Extraction

- Databases Searched: PubMed, PsychInfo
- Comprehensive search string that included search terms drawn from concept analysis (related to military reintegration) with outcomes from several domains informed from the concept analysis
- 11,251 "Hits" from search string
- 20% Random subset of articles (2262) screened for inclusion; 51% inclusion rate
 - 31.2% Behavioral, 10.8% Psychological, 22.4% Physiological, 21.8% Social, 3.3% Spiritual, 4.1% Policy
 - 10% Interventions, 79% Observational, 2.5% Systematic Reviews & Meta-Analyses, 1.5% Other
- Inter-correlations between variables to be extracted for quantitative systems model

MARVEL Model

- Method to Analyze Relations between Variables using Enriched Loops (MARVEL), developed by Toegestap Netwurwettenschappelijk Onderzoek(TNO)/Dutch Organization for Applied Scientific Research
- Allows for dynamic behavior analysis, based on combined qualitative and quantitative data
- Assigns control and goal variables, and numeric values for speed and strength of relations between variables
- Allows semi-quantitative prediction of the effect of control variable settings on goal variable outcomes
- Will provide preliminary systems model to better understand and predict successful reintegration in military members and their families



This Research Program is supported by DoD TATRC W81XWH120173, entitled "Control Evaluation of Resilience Programs (CEREP)".

Appendix V - Potential Papers that will be published as a product of the CERP Program

1. Systems Modeling: Overview, Relevance, and Advantages to Advance the Study of Resilience
2. Depressive symptoms and spirituality in asymptomatic heart failure patients
3. Neurobiology of Resilience - Personality and Functional Connectivity of the Default Mode and Salience Networks
4. The Military Psychological Resilience Model: Valuing personal and environmental resources for resilience under varying conditions
5. Systems biology of resilience and optimal health: Integrating Chinese and Western medicine perspectives
6. Methodology Paper- Building a Model Based on Expert Panel Feedback and Literature Reviews
7. Concept Analysis on Reintegration and Expert Panel- Defining Reintegration
8. A Model of Resilience- Reintegration into Civilian Life Following Deployment
9. Spirituality, Resilience & Moral Injury
10. War, Peace & Resilience- From Adaptation to Transformation in the United States Military

Appendix VI – Search String for Model Development

CERP Preliminary Searches

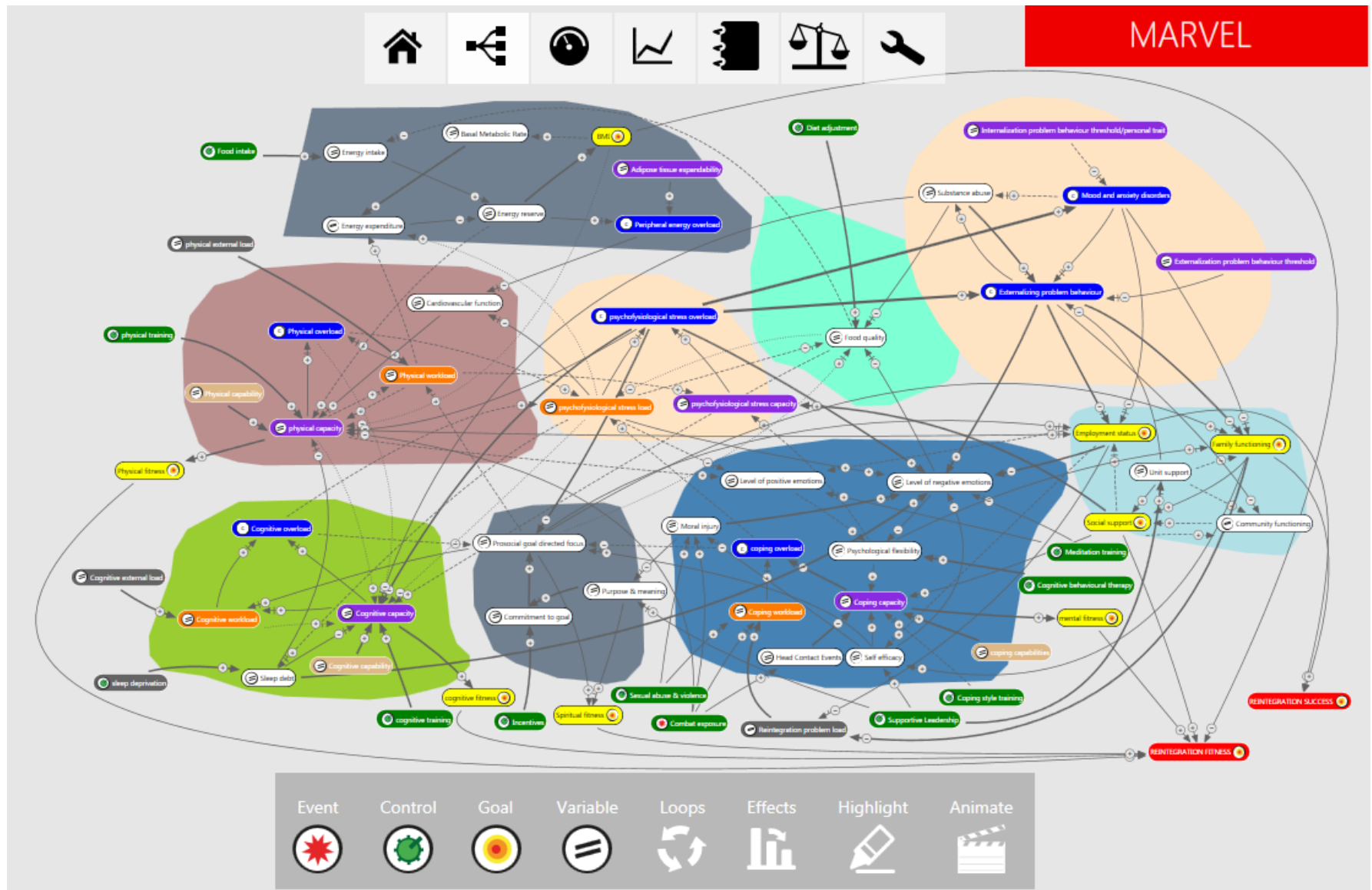
PubMed Search *searched on 21NOV13, Filters activated: Clinical Trial, Clinical Trial, Phase I, Clinical Trial, Phase II, Clinical Trial, Phase III, Clinical Trial, Phase IV, Comparative Study, Controlled Clinical Trial, Meta-Analysis, Multicenter Study, Randomized Controlled Trial, Research Support, American Recovery and Reinvestment Act, Research Support, N.I.H., Extramural, Research Support, N.I.H., Intramural, Research Support, Non-U.S. Gov't, Research Support, U.S. Gov't, Non-P.H.S., Research Support, U.S. Gov't, P.H.S., Research Support, U.S. Government, Review, Systematic Reviews, Validation Studies, Humans, English

PsycInfo Search *searched on 2DEC13, Filters activated: Clinical Case Study, Empirical Study, Experimental Replication, Followup Study, Longitudinal Study, Prospective Study, Retrospective Study, Literature Review, Systematic Review, Meta Analysis, Qualitative Study, Quantitative Study, Scientific Simulation, Treatment Outcome/Clinical Trial, Humans, English, Peer-Reviewed Journals

Search	String	Hits
(variables or outcome measures) AND (military)	(psychology, social or divorce or spouses or child abuse or socioeconomic factors or social class or employee performance appraisal or job satisfaction or social environment or community networks or task performance and analysis or time management or decision making or allostasis or overweight or obesity or body mass index or interleukin-6 or blood glucose or pharmacoepidemiology or cognition or executive function or neuropsychological tests or oral health or vision tests or diagnostic techniques, otological or diagnostic techniques, cardiovascular or hypertension or pregnancy tests or HIV or post-concussion syndrome or health status or blood pressure determination or vital signs or signs and symptoms or sleep disorders or diagnostic self-evaluation or muscle strength or physical endurance or range of motion, articular or activities of daily living or disability evaluation or environmental pollution or stress, physiological or altitude sickness or noise or hearing loss, noise-induced or occupational diseases or wounds and injuries or food habits or nutritional assessment or leisure activities or work or health services accessibility or health care disparities or medical indigency or religion or spirituality or personal satisfaction or quality of life or freedom or depression or extraversion or emotions or personality or mental health or personal autonomy or adaptation, psychological or stress, psychological or social behavior or mental disorders or accidents or resilience, psychological or substance-related disorders or substance abuse detection or suicide or binge drinking or Prescription Drug Misuse or conflict or culture or attitude or economic or political systems or "family support" or "family resource*" or "family fitness" or "family assessment" or "new parent support" or "well-being" or "military unit" or "social cohesion" or respect or cortisol or "Cardiovascular Disease Risk Factor*" or "Immediate Post-Concussion Assessment and Cognitive Testing" or "DNA Sample" or "limited duty" or "chemical stressor*" or "food environment" or "community need*" or "nutrition knowledge" or "Home Demand*" or "Work family balance" or "Relationship Quality" or "deployment stress" or overload* or transcend* or "unit support" or self-sufficiency or optimism or "life priorit*" or "moral injur*" or "executive self" or initiative or "shift and persist" or	PUBMED 6496 PSYCINFO 4761 TOTAL 11257 AFTER DEDUPLICATION 11251

	"work strain*" or "occupational stress" or "perceived change*" or engagement or "disengagement" or reintegrat* or indiscipline or "generativity" or fracture* or disparate or derange* or disrupt* or illness or desire or expectation* or continuous or transform* or process* or sustainable or reunif* or restor* or striv* or "comprehensive" or accept* or reconcil* or repatriat* or unif* or complete or peace* or cohesion or "sense of purpose" or "service orientation" or "Global Assessment Tool" or "GAT" or "Family Sense of Coherence" or "FSOC" or "Family Crisis Oriented Personal Evaluation Scale" or "F COPEs" or "Daily Inventory of Stressful Events" OR "Perceived Social Support, Family" OR "PSS-Fa" OR "Family Assessment Device" OR "Family Adaptation Scale" OR "Conflict Tactics Scale" OR "SF-36" OR "Short Form 36" OR "MOS-36" OR "Medical Outcomes Study" OR "Non-Specific Psychological Distress Scale" OR "MASQ" OR "Mood and Anxiety Symptom Questionnaire" OR "WHO-CIDI-SF" OR "CIDI Short Form" OR "World Health Organization CIDI-SF" OR "World Health Organization Composite International Diagnostic Interview Short-Form" OR "WHO Composite International Diagnostic Interview Short-Form" OR "WHO Composite International Diagnostic Interview SF" OR "PSS" OR "Perceived Stress Scale" OR "Satisfaction with Life Scale" OR "Measurement Instrument for Primary and Secondary Control Strategies" OR "Interpersonal Responses to Stress" OR "Pittsburgh Sleep Quality Index" OR "PSQI" OR "Daily Inventory of Stressful Experiences" OR "DISE" OR "Brief Test of Adult Cognition by Telephone" OR "BTACT" OR "Michigan Alcoholism Screening Test" OR "MAST" OR "Ryff Scale of Psychological Well-Being" OR "Religious Identification Scale" OR "Ryff's Purpose in Life Index" OR "PANAS" OR "Positive and Negative Affect Scale" OR "Affect Balance Scale" OR "Mastery and Perceived Constraints Scale" OR "Eysenck Personality Inventory Q" OR "Eysenck Personality Questionnaire" OR "EPQ" OR "Five-Factor Personality Dimensions" OR "Midlife Development Inventory" OR "MIDI" OR "Loyola Generativity Scale" OR "LGS" OR "Brief Test of Adult Cognition" OR "BTAC" or "World Health Organization's Health and Work Performance Questionnaire" or "HPQ" or "Platoon Cohesion Index" or "PCI" or "Interpersonal Support Evaluation List" or "ISEL" or "Immediate Post-Concussion Assessment and Cognitive Testing" or "ImPACT" or "Automated Neuropsychological Assessment Metrics" or "ANAM" or "Epworth Sleepiness Scale" or "ESS" or "Index of Core Spiritual Experiences" or "INSPIRIT" or "Organizational Citizenship Behaviors Questionnaire" or "Alcohol Use Disorder Identification Test" or "AUDIT" or "Single-Item Alcohol Screening Questionnaire" or "SASQ" or "Post-Deployment Readjustment Inventory" or "PDRI" or "Connor Davidson resilience Scale" or "CD-RISC" or "Gallup Q12" or "Utrecht Work Engagement Scale" or "UWES" or "Cognitive Flexibility Scale" or "Coping Self-Efficacy Scale" or "CSES" or "Post-Traumatic Cognitions Inventory" or "PTCI" or "Situational Self-Efficacy Scale" or "SSE" or "Dispositional Resilience Scale" or "DRS-15" or "Metacognitive Awareness Inventory" or "Attention Network Test" or "ANT" or "Shirom-Melamed Burnout measure" or "SMBM" or "Veterans RAND 12-Item Health Survey" or "VR-12" or "Veterans SF-12" or "Post-Deployment Health Assessment and Re-Assessment" or "PDHA" or "PDHRA" or "Patient Health Questionnaire" or "PHQ-2" or "Freiburg Mindfulness Inventory" or "FMI" or "Duke Religion Index" or "DUREL" or "Spiritual Attitudes Inventory" or "SAI" or "Sense of Coherence Questionnaire" or "SOC" or "Daily Spiritual Experience Scale" or "DSES") AND (Military) [Title/Abstract]	
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Appendix VII - Current Version of Model



Interface FOCUS



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6 October 2014
volume 4 • issue 5

Towards a systems model of resilience

Papers of a Theme Issue organised by Meredith Sprengel, Shamini Jain, John Ives and Wayne Jonas

Introduction

The tapestry of resilience: an emerging picture
S. Jain, M. Sprengel, K. Berry, J. Ives & W. Jonas

Articles

The mathematician's control toolbox for management of type 1 diabetes
M. Csete & J. Doyle

The hypothalamic–pituitary–adrenal–leptin axis and metabolic health: a systems approach to resilience, robustness and control
K. Aschbacher, M. Rodriguez-Fernandez, H. van Wietmarschen, A. J. Tomiyama, S. Jain, E. Epel, F. J. Doyle III & J. van der Greef

Computational modelling of the inflammatory response in trauma, sepsis and wound healing: implications for modelling resilience
Y. Vodovotz

Sleep and inflammation in resilient aging
M. R. Irwin

Biological mechanisms underlying the role of physical fitness in health and resilience
M. N. Silverman & P. A. Deuster

Resilience in the aftermath of war trauma: a critical review and commentary
B. T. Litz

Glucocorticoid-related predictors and correlates of post-traumatic stress disorder treatment response in combat veterans
R. Yehuda, L. C. Pratchett, M. W. Elmes, A. Lehrner, N. P. Daskalakis, E. Koch, I. Makotkine, J. D. Flory & L. M. Bierer

One bad apple: experimental effects of psychological conflict on social resilience
D. Pincus

Article ID

20140057

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Towards a systems model of resilience

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Towards a systems model of resilience

Papers of a Theme Issue organised by Meredith Sprengel, Shamini Jain, John Ives and Wayne Jonas



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The tapestry of resilience: an emerging picture

Shamini Jain, Meredith Sprengel, Kevin Berry, John Ives and Wayne Jonas

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Introduction

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The tapestry of resilience: an emerging picture

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As clinicians and the public move from a pathological (disease-focused) to a salutogenic (health-focused) understanding of the human condition, protective factors contributing to the health of individuals and societies have received more attention. The study of resilience is a foundational aspect of this critical shift and a promising way to understand and interpret our responses to complex multi-domain perturbations from stressful and traumatic experiences. However, as researchers from different fields engage in resilience research, a plethora of definitions and understandings have emerged requiring detailed academic discourse. Rapidly changing global, political, economic and environmental circumstances highlight the need for effective solutions to understand and enhance resilience. These solutions require a multidisciplinary understanding of the concept of resilience.

In January 2012, Samueli Institute convened a meeting entitled 'Towards a systems model of resilience: state of the science and future directions' held at the National Academy of Sciences' Beckman Center to help bridge the current gaps in understanding interdisciplinary approaches to the study of resilience and to encourage cross-discipline dialogue on the potential promise of creating systems models of resilience. Prominent scientists in scientific fields such as systems biology, systems engineering, mathematics, biology, psychoneuroimmunology, psychoneuroendocrinology, sociology, medicine and psychology, along with key Department of Defense leaders, gathered to both share perspectives and explore the possible utility of creating interdisciplinary, systems-based models for understanding resilience. The meeting was highly successful in engendering collaborative education and enthusiasm for forwarding the study of resilience in an interdisciplinary and systems-oriented fashion. In this Theme Issue of *Interface Focus*, we summarize findings that arose from a first major effort to explore resilience from a diversity of disciplines and perspectives. The culmination of these efforts is a rich tapestry of views, ready to be woven into a coherent whole.

The classical Latin-origin definition of resilience (*resili (ens), present participle of resilire—to spring back, or rebound*) was used to describe the tensile properties of material objects (also known as elastic memory) such as wood and metals [1]. This conceptualization of resilience is understood as 'recoiling' to an original state after a perturbation. Since the use of the term in the early 1800s, the concept of resilience has been applied to many fields of human endeavour, including the study of ecosystems and human responses to adverse conditions such as natural disasters, war and personal loss [2]. Although this Theme Issue is focused on the domain of health-oriented resilience, the study has expanded to include many disciplines such as politics, diplomacy and economics, to name a few.

While the interest and efforts in studying resilience expand, our understanding of what resilience is and how best to enhance it in various contexts remains fragmented. A consensus definition of the term resilience has not come to fruition, although several themes emerge from the existing data. A literature search conducted by the RAND Corporation unearthed 122 definitions of resilience. Three major themes emerge from these varied definitions that indicate our current understanding of resilience as (i) a dynamic process (rather than as a 'trait') that evolves across time, (ii) adaptability to change and, generally, to adversity, and (iii) either a return to homeostasis, or an enhanced state of functioning (e.g. growth) [3]. When examining resilience as a response to adversity, our current understanding needs to expand beyond the concept of a *return to homeostasis*, to instead a *new normal* that is characterized by *stability through*

change. Being resilient entails more than the ability not only to adjust and adapt to a perturbation, but also to transform when the perturbation requires a new conceptualization of the way in which to effectively proceed forward. This process does not return an individual or system to a previous homeostatic set-point. Rather, the concept of resilience uses learning from prior experiences to effectively adapt by anticipating and predicting current needs, and modifying feedback inputs to achieve maximal efficiency of that system within a particular context and timeline. This evolution in understanding resilience from a dynamic perspective is consistent with a control systems model of allostatic, versus homeostatic, regulation [4]. The relationship between adversity and enhanced resilience has been documented previously; non-specific resilience is enhanced by prior moderate stressors [5–7]. In other words, resilience does not occur and cannot be detected outside of a stressor or changing context. However, individuals with a history of high adversity report decreased well-being and psychological functioning. The act of *being resilient* is an adaptive response to stressors that is, ultimately, dependent on context. The most common reaction and/or response to a traumatic incident is resilient behaviours: ‘although symptom levels tend to vary for different potentially traumatic events, resilience has consistently emerged as the most common outcome trajectory’ [8, p. 136].

Fully understanding resilience requires systems approaches that facilitate the modelling of dynamic interactions in multiple domains (e.g. psychological, physical and social) within a person and between his or her social and physical environment. There is an increasing interest in systems-based approaches to understanding resilience between people and their surrounding environments, such as those in socio-ecological systems [9,10]. Reductionist approaches used by some researchers when developing and testing hypotheses about resilience separate the person from his/her environment or subjugate the environmental variable when performing analyses. In these analyses, the environment only becomes an important variable when ‘it provides a forum in which resilience-promoting-processes that contribute to individual growth take place’ [11, p. 4]. As a consequence, outcomes remain void of cultural, historical and political constructs [12].

The structure of our current academic systems facilitates highly specialized, narrowly focused disciplines that often do not promote opportunities to effectively communicate across fields of study. Specialization generates monumental progress within our isolated fields of discipline and allows us to use more precise tools for examining parts of the whole. However, it also constructs barriers to integrated thinking required for solving complex scientific puzzles such as resilience. Ongoing cross-discipline dialogue will be essential for fostering a complete understanding of resilience within the whole person and his/her environment. Models of resilience that incorporate mental, emotional, social and physical processes will be maximally effective in helping understand and enhance resilience within individuals and societies.

The meeting held addressed the pressing need to induce dialogue across various disciplines and among academics studying resilience. The publications in this Theme Issue of *Interface Focus* on resilience reflect some of the thinking and research on resilience from academic experts who attended, as seen through their particular scientific lens. Several articles reflect the promise of systems-based modelling approaches for helping solve issues related to physiological resilience.

We now move to a discussion of these articles, starting with the articles that describe the value of systems modelling approaches to understanding resilience in medical and physiological settings. We then continue our discussion noting the articles that discuss systems thinking surrounding mind–body interventions for enhancing resilience, and conclude with the articles that discuss resilience within military contexts and other social settings.

Csete & Doyle’s [13] article, ‘The mathematician’s toolbox for management of type 1 diabetes’, offers a non-technical summary of the utility of control systems modelling in the development of the artificial pancreas, noting both its promise and shortcomings. It also provides the reader with an opportunity to reflect on the utility of control engineering tools to better understand and enhance resilience within medical settings. Aschbacher *et al.*’s [14] study entitled ‘The hypothalamic–pituitary–adrenal–leptin axis and metabolic health: a systems approach to resilience, robustness and control’ further explores the utility of control systems tools and thinking in its exploration of robustness as a key indicator of stress system resilience. This study employs relatively simple, yet novel systems-based mathematical tools to examine the dynamics of the HPA–leptin feedback sensitivity—these dynamics predicted metabolic risk in the population studied, whereas traditional neuroendocrine measures did not. The study, along with Aschbacher’s previous work, points to the promise of using dynamic systems modelling approaches in the field of psychoneuroendocrinology to better understand mind–brain–body relationships as they relate to resilience.

Vodovotz’s [15] article, ‘Computational modelling of the inflammatory response in trauma, sepsis, and wound healing: implications for modelling resilience’, also speaks to the promise of employing systems modelling approaches to the study of sepsis, an acute inflammatory response to a noxious agent that can be life-threatening. This article provides an overview of the relevance of both data-driven and mechanistic models for understanding and predicting acute inflammation, and suggests the promise of integrating both approaches for understanding inflammation that may be used clinically. Vodovotz provides a provocative hypothesis that inflammation may be a key factor in understanding resilience at the whole organism, under the skin, level, and proposes some methods by which this hypothesis could be tested.

Irwin’s [16] review on ‘Sleep and inflammation in resilient aging’ builds on this theme by discussing the complex relationships between sleep, inflammation and resilient aging, noting that high versus poor sleep quality may act as a resilience-enhancing or perturbing factor, respectively, within the context of aging. Irwin reviews the data for sleep’s relationship to resilient aging as well as its relationship to resilience-interfering factors such as depression, pain, morbidity and mortality in the elderly. Irwin further suggests that proper sleep may buffer increases in inflammation that are found for aging populations, speaking to the promise of behavioural interventions that improve sleep quality as a method of enhancing psychobiological resilience in the elderly.

Similarly, in Silverman & Deuster’s [17] review, ‘Biological mechanisms underlying the role of physical fitness in health and resilience’, the biological systems that may underlie the impact of physical fitness on resilience and health are discussed. The authors suggest that physical fitness may enhance psychophysiological resilience through multiple pathways, including by optimizing neuroendocrine and psychosocial reactivity to

stressors, as well as by reducing tonic levels of inflammation and enhancing neuroplasticity and growth factor expression. Similar to Irwin, the authors call for the need for easily implementable behavioural strategies such as exercise to enhance human resilience, as a self-modifiable characteristic.

Understanding resilience includes investigating key biological factors that may play a role in identifying resilience within the context of traumatic stress. This is a key to helping individuals who are required to engage in highly stressful and life-threatening scenarios such as war fighting, disaster scene search and rescue, civil disturbance response, fire and police work. The thoughtful and thorough commentary by Litz [18] entitled 'Resilience in the aftermath of war trauma: a critical review and commentary' illustrates the complexity of understanding resilience in the context of war trauma, and speaks to the need for us to carefully develop effective assessment, prevention and treatment strategies to enhance resilience to war trauma within various contexts and across the deployment cycle.

Yehuda *et al.*'s [19] article also discusses resilience factors within the context of traumatic stress. In the article, 'Glucocorticoid related predictors and correlates of post-traumatic stress disorder treatment response in combat veterans', the authors examined the potential relevance of glucocorticoid variables in predicting responses to psychotherapeutic treatment for post-traumatic stress disorder (PTSD). Interestingly, the study indicated that both prolonged exposure and a minimal attention control considerably reduced PTSD symptoms over time. Genotype for the glucocorticoid receptor (BCL1 polymorphism), as well as pre-treatment levels of neuropeptide Y, predicted treatment responses, and 24 h urine cortisol

levels as well as glucocorticoid sensitivity appeared to be sensitive biomarkers of change in response to the intervention. The study indicates the promise of systems-oriented approaches (psychoneuroendocrinology) in linking mind–body processes associated with resilience and the potential value of neuroendocrine biomarkers in predicting risk and resilience to PTSD. Finally, related to systems models on social resilience, Pincus's [20] article, 'One bad apple: experimental effects of psychological conflict on social resilience', demonstrates both the impact of individual-level conflict on higher-order (group) systems, and the value of dynamic analyses in assessing potential 'ripple effects' related to the social domain of resilience.

This tapestry of articles reflects the varied approaches and levels of investigation that are apparent in understanding human resilience today. We note that this is far from a complete representation of the breadth of the current theory and investigation that comprises the study of resilience. It does not at this point reflect the integration of cross-discipline thinking and collaboration that the future may hold. However, the integration of these multiple perspectives on resilience as reflected is the first necessary step towards a truly whole systems model of resilience. We are confident that the breadth and overlapping nature of the current articles will be both informative and interesting to the reader and help the scientific community better understand the current terrain of inquiry surrounding the study of resilience.

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