Special Notice 12-SN-0007

Special Program Announcement for 2012 Office of Naval Research

"OFFICE OF NAVAL RESEARCH BASIC RESEARCH CHALLENGE - ENHANCING INTUITIVE DECISION MAKING THROUGH IMPLICIT LEARNING"

I. INTRODUCTION:

This announcement describes a *revolutionary* research program, "Enhancing Intuitive Decision Making Through Implicit Learning" to be launched under the ONRBAA12-001, Long Range Broad Agency Announcement for Navy and Marine Corps Science and Technology which can be found at http://www.onr.navy.mil/Contracts-Grants/Funding-Opportunities/Broad-Agency-Announcements.aspx. The research opportunity described in this announcement specifically falls under numbered paragraphs 5 of the Expeditionary Maneuver Warfare & Combating Terrorism Department (Code 30) sub section and 1 of the Warfighter Performance Human and Bioengineered Systems (Code 34) subsection. The submission of proposals, their evaluation and the placement of basic research contracts and grants will be carried out as described in that Broad Agency Announcement.

The purpose of this announcement is to focus the attention of the scientific community on (1) the area to be studied, and (2) the planned timetable for the submission of white papers and full proposals.

II. TOPIC DESCRIPTION:

Research in human pattern recognition and decision-making suggest that there is a "sixth sense" through which humans can detect and act on unique patterns without consciously and intentionally analyzing them. Evidence is accumulating that this capability, known as intuition or intuitive decision making, enables the rapid detection of patterns in ambiguous, uncertain and time restricted information contexts, that it informs the decision making process and, most importantly, that it may not require domain expertise to be effective. These properties make intuition a strong candidate for further exploration as the basis for developing a new set of decision support training technologies.

The proposed topic will lead to new insights into intuitive decision making, and develop new approaches for enhancing this process. The proposed topic will do this by:

- Characterizing the nature of intuition at the neural, cognitive and behavioral levels in order to develop approaches to train & measure it
- Developing a computational cognitive model of intuition, in order to facilitate the delivery of scenario based training to enhance intuitive decision making
- Demonstrating that implicit learning techniques, guided by these models and embedded in a scenario based training technology, can enhance intuitive decision making in non-experts, in order to increase baseline abilities to make more effective decisions under conditions in which information is ambiguous, and time to analyze is restricted

The program will pursue a wide variety of approaches that address **four challenges** that are key to understanding and enhancing intuitive decision making: 1) Combining advances in measuring performance at multiple representation levels (e.g., neural, cognitive & behavioral) with advances in simulation – based paradigms for assessing decision making to understand the foundations of intuitive decision making; 2) Leveraging advances in cognitive modeling and machine learning techniques to represent individual intuitive decision making processes; 3) Developing an implicit learning based approach for enhancing intuitive decision making; and, 4) Combining these efforts, through scenario/simulation based training, to test and validate the hypothesis that implicit learning can enhance intuitive decision making for one or more operationally valid tasks.

Background:

This topic outlines four challenges that must be addressed in order to develop training technologies for intuitive decision making. First, the nature of intuitive decision making must be characterized, at the neural, cognitive and behavioral levels. Second, these characterizations must be integrated into a single model, providing the foundation for developing adaptive and individualized training technologies. Third, implicit learning based paradigms for enhancing intuitive decision making must be developed. Fourth, the resultant measures, models and learning approach must be implemented into a training technology that demonstrably enhances an individual warfighters' intuitive decision making capabilities.

"In hindsight, some of the soldiers acknowledge their "spidey sense" was tingling. It was quiet that day. Possibly too quiet, as the platoon motored through ..." - The Star.com "Story of Company C." September 30, 2006 Mitch Potter, Middle East Bureau. http://www.thestar.com/printArticle/106992

"… Thanks to the awareness and quick actions of a 99th Regional Readiness Command (RRC) Soldier, however, no one was seriously injured by the [IED] attack--and he did this all while communicating with his wife on a cell phone..." - Soldier's intuition and situational awareness a lifesaver in Iraq. (UPDATE ON Operation Iraqi Freedom)Publication: Army Reserve Magazine Publication Date: 22-MAR-07Author: Coleman, Chris

Today's military missions pose complex time-constrained challenges, such as detecting IED emplacements while in a moving vehicle or detecting anomalous civilian behaviors indicative of impending danger. These challenges are compounded by recent doctrinal requirements that require less-experienced Warfighters to make ever-more complex decisions. Current understanding of decision making, which is based on concepts developed around theories of analytic decision making (Newell and Simon, 1972), cannot effectively address these new challenges since they are based on the notion of enabling experts to apply their expertise to addressing new problems.

Yet, there are actually two types of recognized decision making processes, analytical and intuitive which appear to be mediated by different processes or systems (Ross et al, 2004; Evans, 2008; Kahneman & Klein, 2009). Analytical decision making is mediated by processes that reflect a sequential, step-by-step, methodical, and time consuming process. In contrast, intuitive decision making relies upon a more holistic approach to processing information. Importantly, intuitive decision making can support analytic decision making processing to continue accounting for prospective outcomes as the external problem

space changes (Evans, 2008). Intuition is a rapid, non-conscious, cue to the existence of meaningful information detected through one or more sensory modalities (Luu et al, 2010). Intuition permits information extracted by automatic sensory processes, which operate on the time scale of 100's of milliseconds, to be organized by pre-existing (top-down) knowledge. This unconscious organization of incoming information may elicit a feeling or impression of a solution (Luu et al, 2010), which precedes insight or a sudden awareness of the solution. Recent studies suggest that these systems can also be distinguished on the basis of the neural structures that facilitate their actions (Lieberman, 2000, 2007; Volz, 2008; Luu, 2010).

According to Bowers et al. (1990) intuition can guide the judgment process by assisting with the discovery of plausible solutions from which to choose. This characterization of intuition, and many others that follow from it, assumes a high level of familiarity with the information being detected. In fact, until recently, intuitive decision making was assumed to require significant domain expertise (Kahneman & Klein, 2009). Yet a growing body of results ranging from the biological (mainly, neural) to the cognitive (Lieberman, 2000; Jung-Beeman et al., 2004; Luu et al 2010) suggests that pre-existing expertise, which requires years of practice to attain (Dreyfus & Dreyfus, 1980; Ericsson et al, 1993) may not be a key requirement for intuitive decision making processes. These studies, and others, suggest that intuitive decision making processes share some of the same underlying neural structures and cognitive processes as a type of learning known as implicit learning (Frensch, 2003; Lieberman, 2000, 20007; Kaufman et al, 2010). Consequently, by acquiring domain knowledge through implicit learning, one may be able to automatically strengthen, at the neural, cognitive and behavioral levels, the same capabilities that are needed for effective intuitive decision making.

Objectives:

The objective of this proposed topic is to build a deeper understanding of the neural, cognitive and behavioral processes underlying intuitive decision making, in order to train non-experts to be more effective decision makers. The expected outcomes of this project will include a characterization of how intuition works; a computational model representing these findings; and, training techniques & technologies that enhance intuitive decision making performance. It is expected that these results will lay a scientific foundation for understanding intuitive decision making that will support Cyberwarfare, Unmanned System Operators, Information Analysts, Small Unit Leaders and other domains that require individuals to process and make sense of large volumes of information in time constrained or information-degraded conditions. As well, this effort will establish a technical basis from which to develop new classes of applications that support selection, training, decision aiding and interface design. The Enhancing Intuitive Decision Making Through Implicit Learning Basic Research Challenge will provide the right blend of incentive, risk and benefit to revolutionize the state of the art in improving decision making. Successful proposals will focus on developing innovative, scalable, and affordable technologies that blend the best measurement technologies and modeling approaches with scenario/simulation based training solutions to enable cost effective dissemination of these technologies to a wide range of users.

Research Areas:

The primary hypothesis underlying this topic is that *implicit learning facilitates intuitive decision making*. Testing this hypothesis requires advances in specific research areas that include:

1) **Characterizing intuitive decision making and implicit learning across neural, cognitive and behavioral levels of representation.** There is a range of measurement techniques available to do this. It is expected that proposers to this effort will leverage and extend these wherever possible, to ensure that the resultant data are of sufficient quality to develop effective models;

2) **Representing intuitive decision making through cognitive models in order to guide implicit learning techniques.** Based in large part on advances in understanding of the human brain AND advances in machine learning techniques, it is possible to develop representations of cognition that can represent individual differences, adapt to new contexts and information and that can be modified based on other physiological features like stress and fatigue (Mitchell et al 2004; Shinkareva et al 2008). These new techniques enable a greater ability to represent an individual's current 'state' and forecast future 'states' in order to anticipate and tailor to the individual's specific needs;

3) **Applying simulation / scenario based techniques to develop implicit learning approaches that enhance intuitive decision making.** Simulation based training provides a flexible environment for both delivering training and for collecting a range of performance measures (Oser et al, 1999). The scenario based training approach provides a validated process for identifying training requirements, developing the scenario(s) to support these requirements and establishing metrics and techniques for analyzing and assessing trainee performance. There are numerous training simulations available that represent domains in which effective intuitive decision making is critical (e.g. IED detection; Social interaction training; Intelligence analysis; etc) and it is expected that existing systems will be leveraged and extended rather than new ones being developed for this effort;

 4) **Testing and validating the hypothesis that *implicit learning facilitates intuitive decision making.*** This includes comparing neural, cognitive and behavioral performance measures across different conditions. Successful validation plans will include approaches capable of demonstrating that: the neural structures that are active during implicit learning are also active during intuition; that in the absence of implicit learning there are different / distinct patterns of neural activity during an intuitive decision making task; that in control tasks in which neither implicit learning was provided or intuitive decision making required, these structures are minimally active; and, that under those conditions in which implicit learning was provided and intuitive decision making was present, there is a significant improvement in decision making compared to other conditions – for example, as represented by a receiver operator characteristic curve. Specific measures and assessment approaches are left to the proposer but must include approaches that will cut across multiple representation levels and provide a means for distinguishing the effects of implicit learning on intuitive making, if such are present, from other conditions.

The Enhancing Intuitive Decision Making Through Implicit Learning Basic Research Challenge will proceed as a four year effort encompassing the above research areas. It is anticipated that addressing each of these research areas will require a multi-year effort to complete and that performance on each

research area may overlap in time. Teaming is encouraged within and across research areas. Decomposing each research area into subareas (e.g., breaking up research area 1 into a neural, a cognitive and a behavioral task), each of which is covered by different team members is acceptable if reasonably justified and supported by a clear management / team coordination plan.

III. WHITE PAPER SUBMISSION

White papers should not exceed 6 single-sided pages, exclusive of cover page and resume of principal investigator, and should be in 12-point Times New Roman font with margins not less than one inch. The cover page should be labeled "White Paper for **BASIC RESEARCH CHALLENGE - ENHANCING INTUITIVE DECISION MAKING THROUGH IMPLICIT LEARNING**" and include the following information: title of the proposed effort, technical point of contact, telephone number, fax numbers, and e-mail address. The 4-page body of the white paper should include the following information: (1) Principal Investigator; (2) Relevance of the proposed effort to the research areas described in Section II; (3) Technical objective of the proposed effort; (4) Technical approach that will be pursued to meet the objective; (5) A summary of recent relevant technical breakthroughs; and (6) A program management plan that includes a high level timeline for proposed tasks, indicates proposed team members who will be accomplishing those tasks and a funding plan showing requested funding per fiscal year. A resume of the principal investigator, not to exceed 1 page, should also be included after the 6-page body of the white paper.

White papers are required for all offerors seeking funding. Each white paper will be evaluated by the Government to determine whether the technology advancement proposed appears to be of particular value to the Department of the Navy. Only the authors of white papers that appear to be of particular value to the Department of the Navy will be invited to submit full proposals. Initial Government evaluations and feedback will be issued via e-mail notification from the Technical Points of Contact.

Detailed Full Proposal (Technical and Cost volumes) will be subsequently encouraged from those offerors whose proposed technologies have been identified through the above referenced e-mail as being of "particular value" to the Government. However, any such encouragement does not assure a subsequent award.

For white papers that propose efforts that are considered of particular value to the Navy but either exceed available budgets or contain certain tasks or applications that are not desired by the Navy, ONR may suggest a full proposal with reduced effort to fit within expected available budgets or an effort that refocuses the tasks or application of the technology to maximize the benefit to the Navy.

White papers should be submitted electronically to the business point of contact whose e-mail address appears at the end of this Special Notice. These white papers shall be in Microsoft Word or Adobe PDF format.

To ensure full, timely consideration for funding, white papers should be submitted no later than 15 March 2012. White Papers received after that date will be considered as time and availability of funding permit.

The planned date for completing the review of white papers is on or about 15 April 2012.

IV. FULL PROPOSAL SUBMISSION AND AWARD INFORMATION

Full proposals (including one technical volume and one cost volume) should be submitted under ONR BAA 12-001 by 15 May 2012. Full Proposals received after that date will be considered as time and availability of funding permit.

ONR anticipates that both grants and contracts will be issued for this effort. Proposals for contracts should be submitted in accordance with the instructions at Section IV, Application and Submission Information, item 2.b., Full Proposals. Full proposals for grants should be submitted in accordance with the instructions at Section IV., Application and Submission Information, item 5., Submission of Grant Proposals thorough Grants.gov. All full proposals for grants must be submitted through www.grants.gov. All attachments to the application should also include this information to ensure the proposal and its attachments are received by the appropriate Program Office. http://www.grants.gov. The following information must be completed as follows in the SF 424 to ensure that the application is directed to the correct individual for review: Block 4a, Federal Identifier: enter N00014; Block 4b, Agency Routing Number: Enter the Program Office Code (30) and the Business Point of Contact's name, last name first, in brackets. All full proposals for grants must be submitted through Grants.gov website located at http://www.grants.gov/.

Total funds available for this effort are approximately $3.85M, roughly broken down across the research areas as follows:

- Characterizing intuitive decision making and implicit learning across neural, cognitive and behavioral levels of representation – $1.45M;
- Representing intuitive decision making through computational cognitive models in order to guide implicit learning techniques - $1.40M;
- Applying simulation / scenario based techniques to develop implicit learning approaches that enhance intuitive decision making and testing and validating the hypothesis that *implicit learning facilitates intuitive decision making* - $1.00M

The anticipated period of performance for Phase 1 is two years, for Phase 2 the anticipated period of performance is 1 year. Funding decisions are anticipated to be made by **15 June 2012**. Projects will have an estimated contract or grant award date of **1 November 2012**. Although ONR expects the above described program plan to be executed, ONR reserve the right to make changes.

V. POINTS OF CONTACT

Business Point of Contact:
Questions of a Business Nature should be submitted to:
Jeff Wellen
Office of Naval Research
Code 254
One Liberty Center
875 N. Randolph St.
Arlington, VA 22203-1995
Jeff.wellen@navy.mil

Technical Points of Contact:
Questions of a Technical Nature should be submitted to:
Dr. Ivy Estabrooke, ivy.estabrooke@navy.mil
CDR Joseph Cohn, PhD joseph.cohn@navy.mil

VI. Submission of Questions

Any questions regarding this announcement must be provided to the Technical Points of Contact and/or the Business Point of Contact listed above. All questions shall be submitted in writing by electronic mail.

Answers to questions submitted in response to this Special Notice will be addressed in the form of an Amendment and will be posted to the following web pages:

• Federal Business Opportunities (FEDBIZOPPS) Webpage – https://www.fbo.gov/

• Grants.gov Webpage – http://www.grants.gov/

• ONR Special Notice Webpage - http://www.onr.navy.mil/Contracts-Grants/Funding-Opportunities/Special-Notices.aspx

Questions regarding **White Papers or Full Proposals** should be submitted NLT two weeks before the dates recommended for receipt of White Papers and Full Proposals.

VII. References

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