Cognitive neuroscience of second language acquisition

The Department of Defense research landscape

PURPOSE
To evaluate the potential use of cognitive neuroscience methods in second language acquisition research within the Department of Defense and describe current such studies.

CONCLUSIONS
The Department of Defense can leverage cognitive neuroscience of second language acquisition research conducted by civilian agencies.

RELEVANCE
To aid Department of Defense managers in making better use of research on the cognitive neuroscience of second language acquisition.

Executive summary

PURPOSE
The University of Maryland Center for Advanced Study of Language (CASL) set out to evaluate how the cognitive neuroscience (CNS) approach might benefit Department of Defense (DoD) research on second language acquisition (SLA), to what extent it currently is being utilized, and how it might be better utilized.

CASL did this by conducting a literature review and in-depth interviews with approximately two dozen program managers and researchers.

CONCLUSIONS
CASL research supports the following conclusions:

1 Bilingualism
Whether developing bilingualism during childhood is necessary, merely beneficial, or possibly even a burden is important to DoD efforts to improve access to language-enabled recruits. CNS suggests that it is not necessary for foreign language learning to occur during childhood, but that it can be beneficial. For this reason, it is in the DoD’s interest to help K–12 schools promote foreign language learning.

2 Aptitude
Training recruits in a new language is extremely expensive, so improving the identification of those likely to complete such training successfully could save the DoD substantial sums.

CNS research has helped to separate and distinguish the many cognitive abilities that contribute to language aptitude, such as perceptual acuity, speed of processing, working memory, long-term memory, and induction.

3 Training
Beyond screening for aptitude, improved language training could provide further DoD savings by accelerating training and improving the rate of successful completion.

CNS has helped to develop and evaluate strategies that can improve training at every level of language comprehension.

4 Culture
Some types of DoD personnel, such as attachés, military analysts, and officers negotiating with the local authorities, require high levels of proficiency.

CNS methods have helped to clarify how members of other cultures may have different cognitive styles and make different assumptions. Incorporating these cultural insights into advanced language training could help DoD students reach these higher levels of proficiency.

5 DoD research landscape
CNS of SLA research currently is being supported primarily by the Office of Naval Research, the Defense Advanced Research Projects Agency,
and the Defense Language Institute Foreign Language Center.

6 Gap assessment

Civilian funding agencies are not addressing DoD training needs in the areas of adult students, intensive training, aptitude, retention, pressure, and cross training.

Recommendations include the following:
- For the proposed R-Space website for facilitating researcher interactions: support a dedicated staff for populating it, ensure that it has a critical mass of users, and make it easy to find researchers interested in a particular topic.
- Leverage current DoD research on related topics to supplement second language research.
- Improve communication between civilian and DoD program offices.
- Organize an annual forum for program managers, scientists, and other relevant individuals.
- Establish programs to translate research findings into the classroom.
- Balance long-term as well as short-term research.
- Integrate existing language and culture efforts to bridge the gap between the two.

RELEVANCE

Foreign language preparedness is a major priority of the DoD. Since CNS is playing an increasing role in civilian research on language processes, there is a need to determine what solutions it can provide for DoD second language needs.
Executive report

PURPOSE

The War on Terror initiated by the 9/11 attack made it clear that there would be an increasing need for the analysts and warfighters of the Department of Defense (DoD) to engage with regions of the world through speaking languages not commonly taught in the United States. Furthermore, it became clear that the relevant languages could change quickly as threats arose in different parts of the world.

The University of Maryland Center for Advanced Study of Language (CASL) set out to evaluate how the cognitive neuroscience (CNS) approach might benefit DoD research on second language acquisition (SLA), to what extent CNS currently is being utilized, and how it might better be used. CASL did this by conducting a literature review and in-depth interviews with approximately two dozen program managers and researchers.

In the same way that CNS has informed the study of psycholinguistics, it can contribute significantly to research in SLA. In addition to showing that language processing and representation in second language (L2) becomes more native-like with increased proficiency (see Abutalebi, 2008; Kotz, 2009; van Hell & Tokowicz, 2010 for review; van Heuven & Dijkstra, 2010), as might be expected based on behavioral performance, CNS data can help account for individual differences in L2 acquisition.

Chee et al. (2004) found that individual differences in L2 proficiency, despite similar instructional experience and motivation to learn, may be due to the fact that highly proficient and less proficient learners rely on different neural mechanisms for L2 processing.

It is possible that those less proficient learners will never achieve more than limited attainment in L2, or could benefit from some form of cognitive training (a possibility that future research may clarify). This discovery indicates that CNS methods may be used to assess an individual’s L2 capabilities and/or training needs.

Additionally, CNS research has found neural correlates of aptitude for second language acquisition. Xue et al. (2006) found that activity in a specific brain area predicted participants’ success in learning a new script. CNS research in SLA thus has the potential to improve testing for both proficiency and aptitude. Each of these findings, summarized in our literature review, provides direct application to and impact on DoD language needs, as expanded on in the next section.

CONCLUSIONS

CASL research supports the following conclusions:

1. Bilingualism – Enriching the recruitment pool

On the one hand adults seem to have much more difficulty learning a second language than children. On the other hand, there is concern that overloading children with multiple languages could harm their learning process. Whether developing bilingualism during childhood is necessary, merely beneficial, or possibly even a burden is important to DoD efforts to improve access to language-enabled recruits and even to enhance the cognitive performance of its personnel.

Research by Ellen Bialystok suggests that not only is second language learning not harmful to children, she has found that bilingual children show improved problem solving skills (Bialystok & Majumder, 1998) and greater executive control (specifically, the ability to inhibit distracting information and maintain attention to a task; Bialystok and Martin, 2004; Bialystok and Feng, 2009; see Bialystok, 2009 for review). This finding also raises the possibility that such learning could also benefit adult learners.

As for whether it is necessary to learn a second language during childhood to achieve full proficiency, if it were true that there was a critical period during childhood after which adults would not be able to learn a second language in the same manner (Lenneberg, 1967; Penfield & Roberts, 1959), then one would expect to see a difference in CNS measures between the brain activity of those who learned the second language in childhood and those who learned it as an adult. If so, then it would suggest that adult learners have, in a sense, missed the boat and that while they can still learn a second language, it can never be the same as if they had learned it as a child.

In both brainwave measures (see Kotz, 2009; van Hell & Tokowicz, 2010 for reviews; van Heuven & Dijkstra, 2010) and brain imaging measures (see Abutalebi, 2008; Kotz, 2009; van Heuven & Dijkstra, 2010 for review), what is seen is that in general the patterns of activity are quite similar, so it is not necessary to learn as a child. There are nonetheless some differences however, which underscore observations that those who learn a second language during childhood do have advantages in certain domains, particularly with respect to discriminating between language-specific speech sounds and mastering grammatical systems.

2. Bilingualism – DoD significance

Taken together, the body of research on second language acquisition in early childhood and childhood bilingualism indicates that adult learning programs such as at DLIFLC should indeed be able to provide graduates proficient in second languages to even high levels and able to perform under demanding circumstances. It appears to be never too late to learn a new language.

That said, it does appear to be harder to learn as an adult (whether or not due to a critical period or just due to general aging effects) and there are indications that some aspects, such as perception of sound contrasts and
grammatical sensitivity, and inductive language learning ability.

Phonetic coding refers to the ability to remember and process unfamiliar sounds, especially those in a foreign language. Associative memory is the ability to form a connection between the sound of a word and its meaning. Grammatical sensitivity refers to the ability to identify grammatical functions of words in sentences.

Finally, inductive language learning ability is the capacity to extract patterns and regularities from previously experienced streams of spoken or written foreign language. Although the MLAT showed impressive correlations with achievement in the foreign language classroom, this research program was not successful in explaining why these components were important for SLA.

Specifically, more research was needed to determine whether the MLAT components corresponded to true language-specific abilities, such as sensitivity to grammar, or were explained more plausibly by the role of general abilities, such as IQ (Carroll, 1993).

Cognitive components of aptitude

Perceptual acuity is the ability to perceive and remember important cues in visual or sound information. Auditory perceptual acuity is the capacity to "hear" important differences between sounds. In the context of foreign language learning, it is the ability to detect a difference between a sound not important for one's native language but important for the foreign language being learned.

Speed of processing is the pace of performance of successive mental operations. Mislevy and colleagues (2008) proposed that faster processing can lead to an advantage in learning a language, as it can for other complex activities involving a variety of time-consuming subprocesses. Waters & Caplan (2005) showed the specific role of speed of processing in language, presenting evidence of its contributions to paragraph comprehension differences between college-age and elderly participants.

Other evidence from native-language comprehension suggests an important role for general processing speed. For instance, slow processing speed has been linked to language disability (Tallal, 2004; Tallal & Gaab, 2006) and comprehension deficiencies in Parkinson patients (Lee, Grossman, Morris, Stern, & Hurtig, 2003).

Because speeded reaction time is an element of a variety of cognitive tests, individual variability can be attributed to overall processing speed for many of these tests.

The human memory system is composed of working memory (WM) and long-term storage components. WM itself is a complex system composed of several parts, including a short-term memory store and a host of executive processes that allocate attention between items in short-term memory (Baddeley, 2002; Baddeley & Hitch, 1974).

In short, WM is a space for temporary storage and processing of information and supports a variety of processes, including learning, reasoning, and conceptual behavior. It serves as the main processing point between the senses and the long-term memory store.

Aptitude – DoD significance

A critical question is how to select the best candidates for DoD’s language training, since (1) it is clear that only a small number of military personnel can be admitted, and (2) training is expensive and the DoD would like to maximize its return on investment by limiting attrition in its language schools and maximizing candidates’ output proficiency.

From the 1960s on, the DoD has used the Defense Language Aptitude Battery (DLAB) to select candidates for the Defense Language Institute Foreign Language Center (DLIFLC). The test is designed to predict successful completion of the DLIFLC program and provide predictive information about attrition.
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5 Training – Accelerating second language acquisition

Beyond screening for aptitude, improved language training could provide further DoD savings by accelerating training and improving the rate of successful completion. CNS has helped to develop and evaluate strategies that can improve training at every level of language comprehension.

The latest research, informed by CNS methods, has identified a number of domains in which improved methods can yield more effective language training, including (1) lexical, (2) semantic, (3) syntactic, and (4) working memory.

Lexical

At the lexical level (the perceptual word form), research suggests that one’s upbringing (including native language) affects learning a new language.

It has been observed, for example, that brain imaging studies of native speakers reading Chinese compared to native speakers reading English tend to show more activity in motor areas; it has been suggested that this reflects the instruction in brush stroke order traditionally involved in learning Chinese characters (Tan, Laird, Li, & Fox, 2005), to the extent that when Chinese are trying to clarify an ambiguous spoken word, they will write out the character on their palm.

Semantic

Research has shown the importance of using teaching methods that involve not just rote memorization (which is also important) but also the use of context (Adams, 2004; Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2002) to enrich the memory representations. For example, neural measures revealed improvements from learning words in context (Frishkoff, Perfetti, & Collins-Thompson, 2010) or for Chinese characters in combination with writing (Guan, Liu, Chan, Ye, & Perfetti, 2011).

Additional CNS strategies for enhancing the learning of new words include drug treatments that boost molecular memory mechanisms (Lynch, Granger et al. 1997) and transcranial direct current stimulation (Floel, Rosser et al. 2008).

Initial results have been promising but much more work will be required to determine efficacy and safety.

Syntactic

There also have been important developments at the level of syntax (grammar).

Inductive learning can be either explicit or implicit. Under explicit conditions, a learner actively generates hypotheses and rules to make sense of data.

Learning in a classroom setting often takes the form of explicit induction, in which the student is presented with a rule to be learned and applied to some future situation.

By contrast, implicit learning occurs through passive observation or as a byproduct of unrelated activities.

The debate about which second language style of teaching is best (implicit vs. explicit) is one of the oldest in the field (Dörnyei & Skehan 2003).

Using artificial grammar learning and ERP measures, one recent study showed the most native-like ERPs under implicit learning conditions, lending further support to implicit induction superiority for grammatical rule learning (Morgan-Short, Steinhauser et al. 2011).

Working memory

A cognitive domain, WM, discussed earlier under Aptitude, potentially can lead to improvements in performance at all three levels of language just reviewed.

This section outlines research indicating that WM can be improved through training, which in turn can improve output language proficiency as measured by the Defense Language Proficiency Test (DLPT). Further research is needed to reveal whether cognitive training of other abilities will result in the same proficiency gains.

People differ in their WM capacity, and this difference is tied closely to variations in general intellectual ability (Conway, Kane, & Engle, 2003). For example, Kyllonen et al. (1990) show high correlations between WM capacity and standard tests of reasoning ability.

Furthermore, individual differences in WM capacity have been tied to different levels of activity in the intraparietal and prefrontal areas of the cortex, with some models suggesting that the density of connections in the specific cortical areas explains capacity differences (Edin, et al., 2009).

If connections in these cortical networks could be strengthened through training, it can be hypothesized that WM capacity could be increased.

6 Training – DoD significance

While to our knowledge none of these findings has yet been imported into active DoD learning environments, they have clear relevance for improving classroom practices. For example, CASL's WM training program already has yielded promising results on tests and is being prepared for broader testing.

The finding that semantic context provides more robust learning of semantic meaning has direct implications for instructional practices, especially drills.

Unfortunately, it will be difficult for the DoD to obtain full value from such advances until it has implemented an experimental classroom setting at a facility such as DLIFLC, where new instructional techniques based on these findings could be tested in a scientifically rigorous fashion.

Some types of DoD personnel, such
as attachés, military analysts, and officers negotiating with the local authorities, require high levels of proficiency.

CNS methods have helped to clarify how members of other cultures may have different cognitive styles and make different assumptions. Incorporating these cultural insights into advanced language training could help DoD students reach these higher levels of proficiency.

7 Cultural neuroscience, the application of neuroscience methods to questions about culture, has provided crucial insights into these issues in two domains:

• effects of language on cognitive style, and
• effects of culture on the pragmatics of communication.

Effects of language and culture on cognitive style

Language is fundamentally about communication, and for individuals to communicate successfully, they must be able not only to convert words from one form to the other, but also be on the same page, so to speak, with the other communicator.

To speak a second language, one must master the cultural thinking style the language manifests, in addition to its vocabulary and grammar.

Research has demonstrated that language, while not the sole determinant of thought, can strongly influence cognitive style (Carruthers, 2002).

A classic example of this is the Pormpuraaw, an aboriginal community in Australia, whose inhabitants do not use terms such as “left” and “right.”

Instead, they rely heavily on the cardinal directions (e.g., “north”) that pervade their speech (Boroditsky, 2011). Just to ask “Where are you going?” requires a response such as “a long way to the south-southwest” (Boroditsky & Gaby, 2010).

This constant practice in spatial orienting has resulted in their having substantially superior performance on dead reckoning tasks, compared to English speakers (Majid, Bowerman, Kita, Haun, & Levinson, 2004)—their language inculcates a constant awareness of their spatial orientation.

Cultural differences in cognition extend beyond the manner in which space is conceived.

The best studied area of cultural differences concerns the contrast between European-Americans and East Asians.

Researchers have suggested (Hofstede, 1980; Markus & Kitayama, 1991; Triandis, 1995) that the socioemotional style of European-Americans is predominantly individualism, emphasizing values such as competitiveness and uniqueness, whereas East Asians tend toward a socioemotional style of collectivism, highlighting values such as harmony and hierarchy (Oyserman, Coon, & Kemmelmeier, 2002).

These contrasting cultural styles in turn result in differing cognitive styles.

These cultural differences affect performance not only on perceptual tasks but on language tasks as well. For example (Chiu, 1972; Ji, Zhang, & Nisbett, 2004), given the triad (seagull-squirrel-tree) and asked to select the two words that go together, Americans (individualistic) tend to choose seagull and squirrel, as these words have individual features in common (e.g., “they’re both animals”), whereas East Asians (collectivistic) tend to choose squirrel and tree, as these words have functionally and thematically related (e.g., “the squirrel climbs the tree”).

This cognitive difference is understood as being due to the differential focus on individual features (individualism) and relationships (collectivism).

Furthermore, an fMRI study (Gutchess, Hedden, Kety, Aron, & Gabrieli, 2010) indicated that, at least under some conditions, members of the two cultural groups show different patterns of activation across both types of judgments, suggesting that they handled distracting information differently in these two tasks.

In sum, these studies show that differences in languages are embedded in differences in cognitive style.

To communicate effectively in the language of the Pormpuraaw, one must not only know their vocabulary and syntax but also effectively adopt their use of the cardinal directions to represent the environment.

Likewise, to communicate effectively at a high level in East Asian languages, it seems that the speaker must adapt to the cognitive differences that inevitably will manifest themselves in the content of communications, such as the tendency to rely on relational information.

Effects of culture on perspective-taking and communication

Behavioral data alone are subject to ambiguities due to potential confounds, such as cultural differences in communication practices (pragmatics).

Neuroscience studies thus have been crucial for providing supporting evidence that confirms the findings from such behavioral studies and clarifies the nature of their results.

A wide range of evidence (Northoff & Bemmpohl, 2004; Northoff, et al., 2006) indicates that the midline cortex along the inner surfaces of the two adjoining hemispheres, the cortical midline structures (CMS), plays a central role in perspective-taking and the related task of representing the self and others.

Studies illustrate that understanding communications from other cultures requires more than just mechanically translating the words into English. It also is necessary to understand the culture from which they originate.

Furthermore, they show that culture
is more than just a collection of quaint customs and habits. It also can involve characteristic ways of thinking.

Servicemen engaged with the locals on a daily basis need to understand these cultural differences, even if their communication needs otherwise are adequately served by translators.

8 Culture – DoD significance

The DoD has become acutely aware of the need to consider foreign languages and cultures together in fulfilling its mission. Even simple communications benefit from cultural sensitivity.

Military attaches assisting diplomatic missions, field officers negotiating with local leaders, and military analysts interpreting captured insurgent communications all require higher levels of communicative competence.

9 DoD Research Landscape

To map out the DoD research landscape, CASL conducted intensive hour-long interviews of informants, both program officers and researchers (Appendix A).

This information in turn allowed us to classify the U.S. Government funding sources into four zones:
• supporting DoD CNS of SLA research;
• supporting DoD CNS research relevant to SLA;
• potential supporters of DoD CNS research;
• non-DoD but supporting research relevant to CNS of SLA.

CNS of SLA research currently is being supported primarily by the Office of Naval Research, the Defense Advanced Research Projects Agency, and the Defense Language Institute Foreign Language Center.

Please refer to Technical Report Appendix A for a list of the individuals CASL interviewed; also refer to the DoD Research Landscape section in the Technical Report for more in-depth coverage on information provided by participants.

Zone 1: Supporting DoD CNS of SLA research

The Defense Advanced Research Projects Agency (DARPA) is located under the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics.

DARPA serves the needs of the entire DoD. The focus is on high-risk, high pay-off research that spans 6.1 to 6.5 funding to allow an idea to take shape through basic research, apply the findings to a DoD context, and develop and produce prototypes or technology.

DARPA is a lean organization in which its director provides strategic interest areas and the project managers field incoming proposals and pitch original ideas that require Broad Agency Announcements requesting proposals. DARPA accepts high-risk projects; some are fast-burning one-year contracts, but most operate within two- to five-year funding streams. Examples of projects include the Accelerated Learning program (see Research Highlight 4. Learning Arabic in Half the Time).

The Defense Language Institute (DLI) is a major player in DoD’s language arena. A directorate under the U.S. Army Training and Doctrine Command (TRADOC), DLI is the primary provider for foreign language training to all of the service branches.

Particularly relevant to this report is the Defense Language Institute Foreign Language School (DLIFLC), which offers courses ranging between 26 and 64 weeks in 23 languages, taught mostly by native speakers. Its central school, located in Monterey, CA, can house 3,500 students from each branch of the military and other DoD departments.1 For example, DLI currently is funding work on the DLAB (see Research Highlight 1. Predicting Language Potential) and brain fitness training (see Research Highlight 8. Brain Fitness Training to Grow Attentional Control).

CASL, in College Park, MD, is a University affiliated Research Center (UARC), supported by various DoD sources and charged with conducting language and culture research to support the language readiness and capabilities of both DoD and the Intelligence Community.

CASL is conducting a number of research programs relevant to SLA. It has a diverse portfolio of aptitude work, including DLAB2, an update to DoD’s primary language aptitude test; Hi-Lab, a test designed to select high-proficiency learners; and the Afghan Language Aptitude Battery (ALAB), a test designed to predict English learning aptitude in Afghan nationals learning English. CASL also is developing cognitive training methods designed to speed up language acquisition and improve the performance of language intelligence analysts.

Current work includes delivering scientifically valid WM and creativity training programs. Its aptitude and training work draws from a variety of scientific disciplines and makes a particular connection to the latest advances in neuroscience (see Research Highlight 1. Predicting Language Potential; Research Highlight 2. Measuring High-Level Language Aptitude; Research Highlight 3. Different Scripts for Different Folks; and Research Highlight 7. Enhancing Working Memory to Improve Language Skills).

The Office of Naval Research (ONR) provides technological guidance for the Navy and the Marine Corps.

It appears to be the biggest funding agency for CNS work throughout DoD. As noted earlier in the CNS orientation section, ONR was an early supporter of neuroscience research
and funded a number of the seminal studies.

ONR typically solicits high-risk, high-payoff research ideas. The most directly relevant work it currently supports is Dr. Catherine Poulsen’s study on using a virtual environment to teach language and cultural practices while monitoring the results using electroencephalography (EEG) (see Technical Report Research Highlight 5. Tracking Language Learning by Listening to the Brain).

Zone 2: Supporting DoD CNS research relevant to SLA

The Applied Physics Laboratory at Johns Hopkins University (APL) is a UARC supported by the Navy. The Applied Neuroscience program at APL uses novel neuroscience applications to support the mission of the services and the Intelligence Community, including the interface between the human brain and computers, the neural bases of human performance, and enhancing prosthetics using neuroscience. The four main thrust areas for neuroscience at APL are:

• brain computing interfaces
• neuromimetic algorithms
• the neural basis of human performance
• neural prosthetics

The Army Research Laboratory (ARL) is located under the U.S. Army Material Command. The ARL mission focuses on the interface between Army warfighters and technology. Specifically, the Translational Neuroscience Branch of ARL’s Human Research and Engineering Directorate is relevant to this report. While the Translational Neuroscience Branch conducts a significant amount of in-house research (6.1 and 6.2 funding), it also supports external research through the Cognition and Neuroergonomics Collaborative Technology Alliance (CAN CTA). The CAN CTA is a consortium that encourages collaboration between the Army, academia, and industry. ARL tends to focus on research with short-term payoff. 

Examples of research currently underway include a project aimed at understanding the dynamics of attentional shifting and another examining how individual differences in brain structures relate to differences in cognitive functions.

The Army Research Office (ARO) is the division of the ARL responsible for extramural research, specifically concerning soldier performance through life sciences. ARO program managers seek matches between academic and industry capabilities that fit the research requirements for an application to Army needs. Funding awards come in many forms, including small single-investigator grants with add-on possibilities; larger 6.1 Multiuniversity Research Initiative (MURI) research awards; and industry Small Business Innovation Research grants (SBIR) that functionally and theoretically seek to bridge 6.1 to 6.3 categories of research funding.

ARO also uses Cooperative Research and Development Agreements (CRADA) as mechanisms for allocating funds. CRADAs encourage an Army and a university laboratory each to contribute capital to enable collaboration on a single project. Project managers at ARO have the flexibility to fund long-term research projects that may develop Army relevant applications in 10 to 20 years.

The Institute for Collaborative Biotechnologies (ICB) at the University of California in Santa Barbara is a UARC supported by the Army. The Action Lab (West) is a component of the Institute, whose overall mission is to use cognitive neuroscience (i.e., fMRI, EEG, and Transcranial Magnetic Stimulation (TMS) methods) to enhance the human performance of Army personnel. ICB is a lab that uses cognitive neuroscience to enhance human performance in support of ARO’s mission. Current research projects involve working with a collaborator to investigate the neural substrates of stuttering using fMRI as a feedback tool, and developing methods to explain individual differences in performance using EEG, eventually contributing to the creation of a predictive model of an individual’s future learning.

Sandia National Laboratories is a national laboratory, supported by the Department of Energy, which conducts technology research to support national security. The Cognitive Science and Applications group in the Basic Science Department of Sandia National Laboratories focuses on the human dimension of engineering systems developed by its engineers. The group’s main objective is to study and model human decision making. Using EEG and ERP methods, researchers examine WM as it relates to language, as well as memory strategies to enhance language retrieval. The lab’s current work also includes observation of individual differences in brain markers associated with memory strategies for language (see Research Highlight 6. Learning to Read on the Brain’s Best Schedule).

Zone 3: Potential supporters of DoD CNS research

The Air Force Research Laboratory’s (AFRL) mission is to discover, develop, and integrate technology relevant to Air Force warfighting efforts. The major focus of the AFRL is on basic and applied science and engineering research related to air, space, and cyberspace.

The Army Research Institute for the Behavioral and Social Sciences (ARI) is a field operating agency of Army G-1, which is tasked with managing all aspects of manpower and personnel needs for the U.S. Army. ARI is responsible for science and technology investment related to the selection, training, and development of soldiers and leaders.

The Defense Intelligence Agency (DIA) is the central producer and manager of all source defense intelligence for DoD. The Language, Regional Expertise and Culture Portfolio within DIA (LREC-DIA) does not address
neuroscience methods directly, but funded projects potentially can utilize them. LREC-DIA funding includes a combination of proposed and internally generated projects and is committed to cross-agency and inter-agency integration and collaboration. LREC-DIA does leverage the capabilities of universities and colleges with flagship and university-level language programs to ensure that SLA opportunities are available while the DoD progresses toward its goal of Interagency Language Roundtable (ILR) level 3 language expertise.

The Institute for Creative Technologies (ICT) at the University of Southern California is a UARC supported by the Army. Its primary focus is on virtual gaming to improve training and education. The multidisciplinary workforce at ICT is particularly concerned with such human aspects as emotion, facial expressions, and human interaction.

Zone 4: Non-DoD but supporting research relevant to CNS of SLA
The Institute of Education Sciences (IES) is the research arm of the U.S. Department of Education (ED) charged with providing rigorous and relevant evidence on which to ground education practice and policy and sharing this information broadly. By identifying what works, what doesn’t, and why, the Institute aims to improve educational outcomes for all students, particularly those at risk of failure.

Because education research is focused on the classroom, IES-funded research is applied in nature and researchers interested in basic research often are encouraged to seek funding from the National Institutes of Health or the National Science Foundation.

The National Institutes of Health (NIH) are charged with supporting research related to human diseases, human growth and development, environmental contaminants, and mental and physical disorders. The National Institute for Child Health and Development (NICHD) is the component of NIH most concerned with SLA issues.

The National Science Foundation’s (NSF) primary mission is to fund basic research; thus, proposals wholly applied and product-driven in nature are not appropriate for NSF support. The Neuroscience Program is concerned with projects that state questions in terms of brain functions and mechanisms while employing CNS techniques. The Linguistics Program also is housed within the Division of Behavioral and Cognitive Sciences. This program includes CNS methodologies in supporting roles for L2, language acquisition, and bilingualism research.

**Gap assessments**
Civilian funding agencies are not addressing DoD training needs in the areas of adult students, intensive training, aptitude, retention, pressure, and cross training.

1. The scope of DoD neuroscience research on second language issues currently is quite limited. While the team did hear about a number of such projects potentially being started in the near future, at present only a handful were identified as underway. It became evident that the DoD is only just beginning to take advantage of this approach to advance the science of second language research.

2. Interviews revealed some serious gaps in funding from the perspective of DoD needs especially regarding those using CNS approaches. The great majority of research is funded by civilian sources (NIH, NSF, and ED); however these largely ignore the domain of CNS of SLA research. ED research funding on SLA is primarily focused on understanding how to support students learning English as a second language and rarely supports research utilizing neuroscience methods because of its application-focused mission. NSF is strongly interested in neuroscience research but has been mandated by Congress to exclude foreign languages from its purview. The NICHD branch of NIH supports a substantial amount of bilingualism research (including neuroscience); however, it focuses more on children and ESL. Finally, DoD program officers are doing what they can to supplement civilian research, but agree that CNS work—let alone CNS SLA work—is underfunded.

3. There are important differences between teaching adults a foreign language and teaching children, including motivational strategies, adults’ greater life experience, and their age-related decrements in basic cognitive abilities. Because adults develop bilingual capabilities differently than children, continued work in foreign language training is needed for both children and adults.

4. DoD language training typically is very intensive compared to that in conventional classroom settings. Some issues include how to minimize dropout rates due to motivational burnout, optimize memory consolidation despite the closely spaced nature of the instruction, and accommodate differential learning trajectories.

5. Unlike conventional school settings, in which students self-select their course of study and bear the cost of failure, DoD invests a considerable sum in training...
students, so there is a potentially large benefit in improving success rates. DoD and civilian program managers recommended that DoD support research on the ability of some people to pick up multiple languages easily as adults, although it also was noted that meeting recruitment goals is already an issue at facilities like DLIFLC, so increasing selectivity has limited benefits. What is crucial is to get more from those who are selected.

6. Whereas research on conventional educational settings is concerned with the acquisition of language skills in the classroom, the DoD also must be concerned with the retention of these skills once the student leaves the classroom. It is of little use for its employees to gain high levels of proficiency if these subsequently decay due to disuse. Thus, there is a need to develop methods for minimizing such deterioration in skills.

7. An issue largely irrelevant in the civilian setting but of great concern to DoD is the ability to utilize second language skills in high-pressure situations, such as the battlefield. Likewise, there is a need to ensure that using a second language does not require so much attention from the warfighter that situational awareness suffers, putting him or her at risk from undetected threats.

8. A final issue unique to DoD is how best to transfer language skills from one foreign language to another (e.g., due to changes in the geopolitical status quo or in theaters of war). Some issues include predicting which foreign languages lend themselves to cross-training and minimizing interference between languages with similar characteristics.

### Recommendations

CASL makes the following recommendations:

1. CASL obtained feedback from the interviewees on what features would be needed for a proposed R-Space website that would help facilitate communication among DoD program officers and researchers working on the CNS of SLA. To develop the best tool, interviewees and the CASL team recommended supporting a dedicated staff to populate and maintain it, ensuring that it has a critical mass of users, and making it user-friendly and timely for program managers and researchers looking for individuals and groups who are interested in a particular topic. Interviewees cautioned against a tool that presents too much irrelevant information to sift through, and are wary of a function that generates another layer of reporting. They also expressed concern that there are too many similar tools already in existence, and that they have too many passwords to remember. An efficient R-Space would provide an introduction to key contributors and current research, allow for networking and collaboration, and exhibit and promote funding opportunities.

2. While as yet there is only a very limited amount of CNS research being conducted on the topic of SLA, a variety of DoD research on related topics exists that could be leveraged to great advantage. For example, the ARL research on EEG-mediated cybernetic communication involves decoding language-related neural patterns. Findings from this line of research potentially could be repurposed to second language applications, as in monitoring student comprehension during instruction. It could be helpful to implement a program to discover such potential synergies and facilitate knowledge transfer in such cases.

3. A recurrent theme in our interviews with program officers was that communication between civilian and DoD program offices is limited. Interviewees often remarked that when a proposal might be more appropriate for the other side of the civilian-DoD divide, the program officer was not sure where to direct it. Likewise, the potential for duplication of effort and missed opportunities for productive synergies could be foreseen more easily with better communication. Interviewees noted that a useful application for the R-Space tool would be to help civilian program officers to connect better with their DoD counterparts, allowing them to determine more easily whom to contact about issues of shared interest, and vice versa.

4. To focus interest on DoD second language issues, it could be helpful to institute an annual forum at which scientists and program managers could discuss ongoing issues and exchange their latest findings, comparable to the HSCB FOCUS meetings. Such a forum also could provide another avenue through which civilian and DoD program managers could develop better lines of communication.

5. Advances in research need to be translated to the classroom before they can make a difference. School teachers and administrators expressed concern that they did not know how to frame their challenges in terms that researchers could investigate; researchers in turn found it difficult to find the time to translate existing scientific findings into a form that could be applied in the classroom. CASL
currently provides the primary channel for such translational work for the DoD, but it must be given direction and support by a funding source before it can take action. Of the schools, only DLIFLC appears to have the resources to commission studies directly to obtain scientific solutions, and even it is constrained by a lack of the type of funds appropriate for long-term research. Also, other language schools may have needs not relevant to DLIFLC and hence those would not be addressed. Finally, the pedagogy component has received less attention from policy makers than other aspects of language needs. Stronger support is needed for improving training methods at the policy level.

6. An ongoing concern expressed by the researchers is the uneven support for balancing short- versus long-term research needs. The scientific process requires long-term investments to provide the foundation for scientific advances as well as short-term funding to develop the techniques and technologies that give immediate payoffs. DARPA and IARPA provide some facilities for long-term research but their explicit philosophy of sun setting programs after five years precludes long-term support for any language research initiatives. It might be helpful to emulate the Army’s approach of categorizing research according to a range of time-scales and providing funding across this spectrum to ensure a balanced approach.

7. While not raised by interviewees, an issue that became apparent is a gap between language and culture efforts. While there are a range of culture initiatives and a variety of language initiatives, there do not appear to be any organized efforts to integrate the two. Dr. Catherine Poulsen’s project, funded by ONR, is an example of how fruitful synergies might be achieved in this domain. While it makes sense to treat language and culture as distinct domains, it also would be advisable to support their integration explicitly. For example, language projects might be directed to include a culture component and vice versa, or programs might be established with a direct focus on “cultural linguistics” projects.

RELEVANCE

The DoD’s research in Cognitive Neuroscience of Second Language Acquisition is directed by many independent initiatives.

Identifying, synthesizing, and coordinating this work is important. Providing the DoD’s research communities with better knowledge of their mutual activities and needs as well as their research networking capacity will facilitate knowledge sharing to improve research coordination and outcomes.

Projecting into the future, potential benefits of CNS for DoD second language needs can be seen in four directions:

• Improving development of training and educational techniques by providing researchers with tools that enable them to directly observe their effects on brain activity, providing richer and more sensitive measures of learning, much as the microscope greatly benefitted development of new disease treatments;
• Enhancing individualized learning experiences through the classroom deployment of inexpensive technologies like EEG to provide instant feedback on learning progress, either for remedial interventions or for general use;
• Increasing the power of language aptitude batteries to select language trainees by providing new neurally based predictors, thus saving the DoD money;
• Eventually it might even be possible to provide safe pharmacological methods and/or brain stimulation methods for improving language performance, both during training and in the field.

ENDNOTE

1 For more information about DLIFLC’s foreign language programs, see www.dliﬂc.edu/about.html.

REFERENCES


