

Report from the Interagency Working Group on Language & Communication

Office of Science and Technology Policy
Executive Office of the President



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The Interagency Working Group on Language and Communication (IWGLC) serves as part of the internal deliberative process of the NSTC. The IWGLC's purpose is to coordinate and make recommendations about the range of S&T programs and activities related to key topics of language and communication that are supported across the Federal agencies. Representatives from over fifteen agencies and departments participate in the IWGLC. The IWGLC serves as a forum for exchanging and leveraging information and ideas among the participating agencies in an effort to improve coordination and collaboration of research and development agendas related to language and communication.

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About this Document

This document is an inventory of current programmatic activities across Federal agencies and departments that relate to the scientific and technological aspects of language and communication. The inventory informs this document's assessment of the state of basic and applied research in language and communication in the Federal research agencies and departments. The document provides programmatic recommendations for key areas for investment in language and communication research to support a broad range of government functions such as environmental protection, education, national security, law enforcement, and public health.

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Executive Summary

Human interaction in society depends upon language and communication. Across the Federal Government, agencies support research and development (R&D) activities focused on furthering the understanding of and supporting better language and communication. To date, however, there has been no systematic accounting or description of the range of R&D being supported by the Federal Government. In this report, the Interagency Working Group on Language and Communication (IWGLC) took on the challenge of creating an inventory and summarizing current and recent investments in this area. Representing 20 agencies and departments, the members of the IWGLC followed a three-step process to complete this task. First, all member agencies and departments were asked to brief the IWGLC on current R&D in language and communication. Building upon these briefings, the group created a Language & Communication Taxonomy in order to effectively categorize the wide range of ongoing activities. Finally, the group prepared a survey based upon the Taxonomy, which was distributed to all member agencies and departments. This report provides a synthesis of what the IWGLC learned through this process.

The Taxonomy identified four broad topics of R&D in language and communication:

- Knowledge and Processes Underlying Language and Communication
- Language and Communication Abilities and Skills
- Using Language and Communication to Influence Behavior and Share Information
- Language and Communication Technologies.

Within each of these topics, four different types of R&D activities could be supported: (1) basic/foundational; (2) translational; (3) applied; and (4) implementation.

Responses to the survey indicated that the range of R&D in language and communication supported across the Federal Government is wide, but targeted to the needs of the sponsoring agency or department. R&D investments at the Department of Defense (DoD), for example, are focused on addressing critical language training needs of military personnel; investments at the Department of Education (ED) are focused on improving educational outcomes and closing academic achievement gaps, which depend upon language skills and abilities; and investments at the Department of Transportation (DOT) are focused on mitigating risk for operators. The survey also indicated that agencies and departments that do not support R&D in language and communication, such as the Department of State and the Food and Drug Administration (FDA), have fundamental questions about how to communicate given their unique missions.

Responses to the survey also highlighted that monetary investment is not the best indicator of the extent to which the Federal Government is addressing critical issues in language and communication R&D. Each department or agency conducts or supports research for its own needs and mission, and, in some cases, inexpensive projects can be as impactful for a particular department or agency as expensive ones. It is also the case that different types of research will require smaller versus larger investments, but research across the spectrum, from basic to implementation research, is critical for having a comprehensive understanding of language and communication.

The IWGLC activities surfaced a set of ongoing needs and future opportunities for language and communication R&D. There are ongoing needs related to: the processes through which the linguistic characteristics of languages are documented, catalogued and made available for other uses; the manner in which public health and safety concerns and guidance are communicated; the availability and effectiveness of foreign language learning in the U.S.; and the explosion of activities

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leading to advanced language training and translation technologies as well as those leading to new communication media. Satisfying these needs naturally generates large amounts of data which could be made available to the wider language and community (L&C) R&D Community. The group also identified a series of potential opportunities that emerge from ongoing work occurring at different departments and agencies. For example, DoD benefits when R&D supported by ED and the Department of Health and Human Services (HHS) is drawn upon to strengthen students' language and communication abilities and skills. By laying the foundation for language and communication proficiency during the K-12 years, the DoD can anticipate a certain level of linguistic competence and tailor its specialized workforce training curricula accordingly. One of the main findings from this report, derived through the application of the Taxonomy, is that there are many such cross – agency leveraging opportunities. One of the main recommendations of this report is that such opportunities should be further identified and developed in order to optimize the available Language and Communication R&D Funds.

In order to move forward with the ongoing needs and opportunities, the IWGLC recommends that future efforts focus on: extending the Taxonomy to provide deeper insight into the types of collaborations that could be established; enabling top-down approaches to ease policy, regulatory and programmatic challenges to collaborations; and supporting bottom-up approaches that enable researchers from different agencies and departments to more easily communicate their research interests and gaps, and to more effectively coordinate collaborative efforts. Specific recommendations include:

- Periodically updating the Taxonomy;
- Extending the Taxonomy to include commercial industry language and communication R&D;
- Holding cross-agency workshops on specific R&D questions;
- Producing cross-agency publications;
- Developing social-media elaborated “collaboratories”;
- Harmonizing R&D policies across departments and agencies to facilitate collaboration;
- Releasing joint R&D program announcements, including requests for information (RFI), requests for proposals (RFP), and related activities; and
- Rechartering the IWGLC to support these ongoing efforts.

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1. Introduction

Language and communication touch on human experience and action at virtually every level relating to individuals, communities, societies, and governments. At the level of the individual, language and communication are essential to the uniquely human capacity to acquire a massive body of knowledge beyond the scope of one's own personal experience. They also form the basis for one's ability to engage in complex interactions with others. This ability is critical not just for individuals as they navigate the personal, social, and natural world, but also for societies as they seek to exist with mutual accord. Language and communication enable science, technology and collective learning to advance, and they enable governments and their agents to effectively engage with their citizens, formulate just policies and laws, and employ diplomatic solutions to avoid state conflicts.

This report describes the range of research and development (R&D) activities related to language and communication supported across the Federal agencies and departments and provides recommendations for future efforts. In doing so, this report clarifies why the U.S. Government, U.S. society, and the American people all benefit from investments in R&D activities relating to language and communication. These activities include, but are not limited to: developing and improving our understanding of human language and communication; maximizing our ability to apply that understanding to create and enhance language instruction and language assessment; developing innovative language technologies; employing effective communication strategies; and maintaining and expanding the nation's resources in languages other than English. A key product from this report is the Language and Communication R&D Taxonomy, which provides a common framework for developing a Language and Communication R&D Inventory Survey for collecting, cataloguing and classifying the various R&D efforts across the Federal Government. Going forward, this Taxonomy may be used as a tool for facilitating Language and Communication R&D collaborations across Federal agencies and departments. Using this Taxonomy, a survey was developed and administered to the National Science and Technology Council's (NSTC) member agencies and departments to inventory the Federal Government's investments in language and communication R&D. Based on this inventory, analyses were conducted and the results were used to offer recommendations for improving coordination amongst agencies and departments that produce and/or consume language and communication R&D.

2. Background: Language & Communication Research

2.1 The Importance of Language & Communication Research at the National Level

2.1.1 *Why Invest in Language and Communication R&D?*

Communication refers to the myriad of acts one can perform through the use of language and associated facial expressions and gestures (e.g., to convey information, issue a command or request, offer encouragement, take an oath, or tell a lie). Improving the ways individuals and organizations communicate with others can help build and strengthen connections with others. The Federal Government invests substantial resources in R&D programs that address how information is produced and consumed. The goal of these activities is to improve individuals' access to, comprehension of, and retention of information, as well as their participation in society. These programs can help organizations, including the Federal Government, improve awareness of their audiences, culture, and informal communication mechanisms, and develop effective approaches to communicating critical information, such as weather, health, and food safety risks, to the public in a way that is accurate, timely, and easily understood. They can also improve the quality of

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individuals' interactions in social settings with friends and family, as well as more formal settings such as school and work.

2.1.2 Language and Communication Today

Today, we live in an age of heightened connectivity. Recent developments in science and technology have broken down social, cultural, and geographical limitations. Relatively easy and affordable access to transportation – ships, trains, cars and planes – enables travel for both social and business purposes. Even those who are unable to leave their local communities can enjoy increased interaction with peoples of other cultures, as the last 250 years have brought us the invention of a number of communication technologies, including: the telegraph (1792); the telephone (1890); the radio (1891); email (1966); the internet (first ARPANET 1969); Wikipedia (2001); Facebook (2003); YouTube (2005); and Twitter (2006)¹. In fact, it is commonly argued that in the age of globalization and increased connectivity, the world is growing increasingly smaller. Family members separated by hundreds or thousands of miles can speak to one another for minimal cost using web-based mobile phone applications; people can conduct business with their counterparts around the world via real-time video-teleconferences; and students can attend degree-granting universities that use remote-learning technologies, enabling them to earn their degrees without ever setting foot on a campus.

Building on decades of investment by the Federal Government and the private sector, there has been a surge of new research and development to support increased connectivity. For example, use of the web to find information is powered by advanced capabilities in human language technology, which blends advances in computer science, mathematics, artificial intelligence and related fields to enable more effective: information querying, information retrieval; and information summarization (ability to summarize information); and automated question answering (ability to search multiple websites to answer questions of interest). Furthermore, global communication is increasingly necessary for the competitiveness and success of a business; as the pervasiveness of social media, and online news and information increases, organizations that want to remain competitive must learn to communicate with individuals and businesses around the world. To communicate globally, automated technical capabilities such as those listed above as well as automated language translation capabilities are critical. In 2012, “the language services industry, which encompasses interpretation, translation, localization, and the accompanying technologies, [was] worth \$33 billion globally”². Additionally, the fields of sentiment detection and opinion monitoring to understand attitudes towards products and political events are increasingly used and have become necessary for success in fields like business and politics.

These R&D driven enhancements, which can occur on a timescale of months, represent an alternative approach through which human language and communication capabilities can evolve – not through biological, social, or cultural change, but through R&D investment. Against this backdrop of rapidly changing language and communication capabilities, the Federal Government faces a list of growing requirements for R&D in language and communication to meet requirements in national security, global competitiveness, diplomacy, and the needs of a multilingual citizenry at home. At the same time, R&D in language and communication is needed to improve the ability to support the language and communication of individuals in the U.S. who struggle to communicate

¹ "Timelines in Journalism: A Closer Look." Teaching Online Journalism. N.p., n.d. Web. 4 May 2014.

² Jacobs, Deborah L. "Lydia Callis and the Biggest Industry You've Never Heard Of." Forbes. Forbes Magazine, 13 Nov. 2012. Web. 10 Oct. 2014.

due to disability or injury, low literacy skills, limited ability in English, or limited access to technologies.

2.1.3 Language & Communication: Stakeholders

The benefits and needs of R&D in language and communication are distributed across a wide range of national stakeholders. Success in school depends upon mastery of the English language, success in diplomatic relationships depends upon mastery of foreign languages, and success in military operations depends upon both verbal and non-verbal communication in languages other than a soldier's native language. Training in all world languages is useful for diplomatic, defense, and international trade purposes, among others. For special populations, like individuals with disabilities and English learners (i.e., non-native speakers of English), the basic aims to facilitate and enhance individuals' language and communication capacities through R&D are the same as for the general population. However, the approach to meeting these basic needs, through access to effective education programs, therapies, technologies, or other means for all modes of communication (e.g., written, oral, nonverbal communication, signs, gestures) may vary widely based on a person's culture, language proficiency, and language goals. In addition, critical national needs include effective risk communication in contexts as varied as food safety, transportation safety, and prescription medication. In this section, we highlight the unique needs of a few critical stakeholders.

Each year, about 48 million people in the U.S. (1 in 6) get sick from food. U.S. Department of Agriculture (USDA) agencies play a central role in developing and evaluating education and communication materials designed to share information on issues such as food safety. Recent findings from a study conducted at the Tennessee State University and Kansas State University found that including graphics is a critical element of written food safety communication. Ongoing research is examining whether the use of jingles, short statements rather like a tag-line in a commercial, can be effective.³

Military personnel often need to acquire a basic understanding of second languages in short periods of time prior to deploying. The Defense Language and National Security Education Office (part of the Department of Defense [DoD]) is actively exploring how to leverage technology to build a training solution to blend adaptive learning technology with foreign language instruction curricula to accelerate basic second language acquisition.

Diplomats and Military Personnel

A significant aspect of the need to develop foreign language skills involves high-end levels of proficiency and performance. Diplomats and senior military personnel interact with counterparts in situations – such as international trade negotiations or negotiations in a wartime environment – where complete understanding of communication in a foreign language, including nuanced and nonverbal messaging, is required. Heavy reliance on

³ Doan, A., Chambers, D., Chambers E. IV., Godwin, S., Cates, S., and Kosa, K. 2007. Development of a consumer Message for Storage Time of Ready-to-Eat Foods. International Association of Food Protection European Conference Abstract Book P12, Pg. 7.

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interpreters puts one at a disadvantage. This level of proficiency comes via significant investment of time and resources. Additionally, many professionals require advanced language skills to perform their roles—oftentimes when lives are in the balance. Medical personnel, pilots, and air traffic controllers working in international situations hold lives in their hands on a daily basis. Language skills allow communication of very vital information. In all cases, advanced concepts and specialized vocabularies must be acquired, mastered, and maintained.

English Learners

The U.S. Census estimates that over 300 languages are spoken in the United States, and over 60 million people speak languages other than English at home.⁴ Approximately 4.4 million students in the United States are English learners⁵, and the percentage of these students has increased over the last ten years in all but ten states. Understanding English is critical for success in school and life in the United States. However, persistent academic gaps exist between English learners and their native English-speaking peers. Some English learners may have limited oral, written, or receptive skills in their primary language, as well as limited opportunities to develop more advanced skills in their primary language and/or in English. Many struggle as they learn a new language and new content, particularly the academic language and content necessary to be successful in school.

Second Language Learners

Foreign language learning has not historically been a major focus for students in the United States enrolled in K-12 or postsecondary institutions. Limited foreign language learning opportunities exist in the K-12 sector, and in 2009, only 8.2% of postsecondary students at degree-granting institutions enrolled in foreign languages courses. Approximately 1% of Bachelor's degrees and less than 1% of Master's degrees or Doctorates were conferred in foreign languages, literatures, and linguistics in 2011. In addition, students who do take foreign language courses are most likely to take Spanish in both high school and postsecondary settings. However, this limited investment in foreign language learning in the United States runs counter to research findings which indicate that adults who learn additional languages in childhood retain remarkable language processing abilities throughout their lives.^{6,7,8} Learning multiple languages has the potential to improve Americans' health and well-being over the life course, increasing cross-cultural understanding across the United States's increasingly multicultural population, and increasing U.S. competitiveness, security, and relations with other countries.⁹

Individuals with Disabilities

⁴ U.S. Department of Education (2015). *English Language Learners*. Washington, DC: National Center for Education Statistics, Institute of Education Sciences. Accessible at:
http://nces.ed.gov/programs/coe/indicator_cgf.asp

⁵ http://nces.ed.gov/programs/coe/indicator_cgf.asp

⁶ Bradley, KA, King, KE, & Hernandez, AE. (2013). Language experience differentiates prefrontal and subcortical activation of the cognitive control network in novel word learning. *Neuroimage*, 67, 101-110.

⁷ Marian, V, Chabal, S, Bartolotti, J, Bradley, K, & Hernandez, AE. (2014). Differential recruitment of executive control regions during phonological competition in monolinguals and bilinguals. *Brain and Language*, 139, 108-117.

⁸ Archila-Suerte, P, Zevin, J, & Hernandez, AE. (2015). The effect of age of acquisition, socioeducational status, and proficiency on the neural processing of second language speech sounds. *Brain and Language*, 141, 35-49.

⁹ Abbott, M., et al. (2014). Languages for All? Final Report. *The Language Enterprise*.
http://www.casl.umd.edu/sites/default/files/LFA2013_FinalReport.pdf

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The U.S. Census reports that about 6.2% of adults¹⁰ in the U.S. experience some level of difficulty with seeing, hearing, or having their speech understood. It also reports that 6.3% experience difficulty with cognitive, mental, or emotional functioning. These figures include adults with learning disabilities, intellectual disabilities, and other developmental disabilities. Some individuals were born with a disability; others have developed disabilities later in life often through events such as a stroke or injury. The Department of Education (ED) reports 8.2% of elementary, middle, and high school students¹¹ received special education services in school in 2011. In general,

Children with autism spectrum disorder (ASD) develop and interpret speech and social sounds differently from children without ASD. Researchers have identified joint attention, or the ability to share a common focus on something (e.g., people, objects) with someone else, as a precursor to language, communication, and social understanding. A study funded by the National Institute of Child Health and Human Development (part of the National Institutes of Health, Department of Health and Human Services) is following ASD and typically developing children from 12 to 36 months to examine the development of joint attention for speech, music, and environmental sounds over time. The results of this work will clarify aspects of the development of communication and may contribute to the development or refinement of early interventions for children with ASD.

individuals with disabilities, compared to their peers, tend to show lower academic performance and are less likely to live independently, interact successfully with others, and maintain employment.^{12,13} Many of these struggles are intimately linked to challenges with language and communication. For example, children must be exposed to language in order to learn a language. However, children with disabilities often lack sufficient exposure to rich language.

2.1.4 Benefits of Improved Language and Communication

While the needs of specific stakeholders vary, all benefit from language and communication R&D. Examples of research findings are included throughout this document to

highlight the ways this investment is changing the lives of these and other stakeholders. Rapid advances in technology have transformed the ways that we communicate with each other, and have enabled individuals to participate in global civic life. Our shrinking world has also placed increasing demands on our ability to communicate across language and geographic boundaries, and R&D has supported novel instructional and technological innovations to address these challenges.

¹⁰ U.S. Census Bureau (2012). Americans with Disabilities: 2010. *Household Economic Studies: Current Population Reports*. <http://www.census.gov/prod/2012pubs/p70-131.pdf>

¹¹ U.S. Department of Education (2013). 35th annual report to congress on the implementation of the Individuals with Disabilities Act, 2013. *Office of Special Education and Rehabilitative Services*. <http://www2.ed.gov/about/reports/annual/osep/2013/parts-b-c/35th-idea-arc.pdf>

¹² Council for Exceptional Children (2013). NAEP results show wide achievement gaps between students with, without disabilities. *Policy Insider*. <http://www.policyinsider.org/2013/11/naep-results-show-wide-achievement-gaps-between-students-with-without-disabilities.html>

¹³ U.S. Census Bureau (2012). Americans with Disabilities: 2010. *Household Economic Studies: Current Population Reports*. <http://www.census.gov/prod/2012pubs/p70-131.pdf>

2.2 Understanding the Role of Language & Communication R&D within the Federal Government

Departments and agencies throughout the Federal Government must not only understand the importance of language and communication in day-to-day activities, but also ensure that effective language and communication techniques are used to accomplish many important national missions. These missions span the entirety of U.S. domestic and foreign policy, as different departments and agencies have different relationships to language and communication research. For example, basic science in language and communication is supported at the National Science Foundation (NSF), the National Institutes of Health (NIH), the National Endowment for the Humanities (NEH), and ED, without a direct line to implementation, whereas the Department of Defense (DoD) supports R&D with a specific mission focus that is rapidly translated into practice. Others, such as the State Department, look to language and communication R&D to support their mission, but do not support R&D. Accordingly, these Federal departments and agencies sponsor different types of R&D and look for different solutions to their language and communication-based requirements and gaps.

To increase safety, efficiency, and capacity in the National Airspace, the U.S. Department of Transportation, Federal Aviation Administration is expanding the use of Data Communications (Data Comm), between pilots and air traffic controllers. With Data Comm, pilots and controllers communicate using a series of digital, written messages. Now, pilots are able to receive their departure clearance via Data Comm. Soon, pilots and controllers in the domestic en route airspace will communicate with Data Comm. Relative to voice communications, written messages reduce the likelihood of miscommunication. To support this effort, the DOT has engaged in and continues to support R&D activities to help ensure that this communication mode minimizes the probability of pilot and controller error.

In order to better understand the breadth and scope of these R&D efforts, it was necessary to place them into a common framework – a taxonomy. There were two main requirements placed on this taxonomy. First, the taxonomy should account for different departments’ and agencies’ hierarchies of R&D activities along a nominal scale. Four different levels of R&D activity were identified: 1) Basic/foundational; 2) Translational; 3) Applied; and, 4) Implementation. Second, it should broadly

The Departments of Agriculture, Commerce, and State have foreign service staff located at U.S. Embassies around the world. These foreign-service officers are required to learn the local language before starting work in the Embassy or if they rotate to different Embassies during their career. Language learning is a central task of these staff. Research and technologies that improve the teaching and learning of languages are needed to facilitate the work of these and other Federal agencies and departments.

capture the different domains within which these R&D efforts are executed. Four broad R&D domains were identified that were common to all IWGLC member departments and agencies: 1) Knowledge & Processes Underlying Language & Communication; 2) Language & Communication Abilities/Skills; 3) Using Language & Communication to Influence Behavior and Share Information; and, 4) Language & Communication Technologies.

Because these departments and agencies use the science, knowledge, and technology produced by R&D activities to support vastly different goals and missions, sub-domains under each domain were developed to capture specific

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areas at a higher resolution. Details on the development of this Language and Communication R&D Taxonomy are provided in Section 3. The complete Taxonomy is provided in Annex II.

2.3 Consumers of Language & Communication R&D

The pervasive nature of language and communication means that the potential consumers of R&D carried out at the Federal level are varied and numerous. Respondents to the inventory survey indicated that the varied missions of the Federal agencies and departments shape the potential reach of these efforts and make it more likely that there will be an explicit match between consumer need and R&D. However, R&D carried out initially to meet a specific mission often has future, but unknown, benefits for a wide range of consumers/stakeholders, as was seen in the development of the Internet (see Table 2 for survey responses regarding stakeholders of language and communication R&D). For example, within a department or agency such as the Department of Transportation (DOT), R&D on language and communication completed by DOT scientists has direct links and applications to pilots seeking to communicate using a shared language of commands. Some agencies and departments, such as ED, USDA, and the Department of Health and Human Services (HHS) share their findings from R&D investments with offices within their agencies and departments responsible for implementing programmatic efforts to improve education and health outcomes across the nation. Other agencies and departments, such as the NSF, support a wide range of basic scientific activities that often underlie the applied R&D of other Federal agencies and departments. Still other departments and agencies, such as the Food and Drug Administration (FDA, part of HHS), have limited investments in R&D, but benefit indirectly from the investments made by other agencies and departments as they carry out their missions. Consumers of the wide spectrum of language and communication R&D investments described in the following sections include not only Federal departments and agencies, the scientific community, and the general public, but also policymakers, the private sector, and other entities across the world; all will benefit from the findings of this research.

3. Language & Communication R&D Activities within the Federal Government: The Language and Communication R&D Taxonomy

In order to capture language and communication R&D activities within the Federal Government and to provide organization and structure to the information that would be collected, the IWGLC developed a Language and Communication R&D Taxonomy. The purpose of the taxonomy was to begin to develop a framework within which Federal policymakers and stakeholders can analyze and compare the different types of investments made across a wide range of Federal agencies and departments.

3.1 Methodology: Taxonomy

Approximately 25 IWGLC members representing 20 agencies and departments across the Federal Government that are sponsors and consumers of language and communication R&D participated in the development of a taxonomy. The goal was to develop a taxonomy that: (a) captured all potential content related to language and communication R&D activities; (b) included all potential types of research related to language and communication R&D; and (c) could guide the development of an inventory survey. The inventory survey was intended to capture all language and communication R&D activities across the Federal Government (see Section 4 below). The development of the taxonomy proceeded in three steps: (1) briefings by IWGLC members; (2) development of an initial draft of the taxonomy; and (3) review and revisions.

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First, representatives from each department or agency in the IWGLC were invited to give a briefing that provided an overview of their agency's or department's mission as well as examples of language and communication R&D activities that their agency or department supports. If the agency or department was a consumer of language and communication R&D, as opposed to a funder or sponsor, the briefing highlighted the types of issues language and communication R&D activities could address (e.g., risk communication). There were 16 briefings presented to IWGLC members.

Second, the taxonomy and inventory subcommittee, made up of eight IWGLC members, constructed the first draft of the taxonomy based on the briefings. The subcommittee considered multiple factors in the taxonomy construction process. First, it considered which dimensions of the R&D activities should be reflected in the taxonomy (e.g., topic, content, type of research, etc.). It also considered the level of detail that should be captured, keeping in mind that each category should be sufficiently broad such that multiple agencies' and departments' work would fit under a category, but also sufficiently detailed to capture the central focus of a particular R&D activity. The subcommittee settled on a taxonomy that included two dimensions of categorization: one that focused on type of research (e.g., basic/foundational, applied evaluation) and one that focused on the content or topic of the research (e.g., Knowledge and Processes Underlying Language and Communication). The goal was for each language and communication R&D activity across the Federal Government to fall into both a type of research and a content topic. In addition, the content-based topics were developed with a hierarchical structure, which included four main content topics and numerous subtopics (e.g., Language and Communication Technologies includes the subtopic machine translation, which includes other, more specific subtopics).

Third, after a draft of the taxonomy was complete, the subcommittee generated examples of activities and attempted to place them within the taxonomy. If an example did not fit under any of the content topics or subtopics, the topics were expanded or a new subtopic was added. Additionally, terminology was revised to clarify the scope of topics and subtopics and to ensure the terminology would be clear to representatives from departments and agencies across the Federal Government who might use different terms to refer to similar activities or topics.

Individual subcommittee members provided comments and suggestions on the first draft. All IWGLC members had an opportunity to comment on and suggest revisions to the final draft of the taxonomy. Additionally, experts in language and communication, both inside and outside the Federal Government, were given the opportunity to provide feedback on the taxonomy.

3.2 Types of Language & Communication R&D

Annex II displays the full Taxonomy. The Taxonomy categorizes language and communication R&D activities into four major types of research: (1) Basic/foundational; (2) Translational; (3) Applied; and (4) Implementation. In addition, the Taxonomy organizes these R&D activities into four broad content topics of research: (1) Knowledge and Processes Underlying Language and Communication; (2) Language Abilities/Skills; (3) Using Language and Communication to Influence Behavior and Share Information; and (4) Language and Communication Technologies. A brief summary of these two dimensions is provided here.

3.2.1 Types of Research

Through our review of participating departments' and agencies' research activities, four distinct types of research categories were identified. These included:

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- Basic/foundational research, that focuses on identifying new principles or phenomena that may then be expanded upon through other types of research;
- Translational research, that integrates findings from basic science into a framework that is oriented toward more applied research questions and that serves as the foundation for developing, evaluating, and implementing products, tools, interventions, and program;
- Applied research, that either results in the development of products, tools, interventions, or programs, or that leads to the evaluation of products, tools, interventions, or programs; and
- Implementation research/science, that focuses on the research and development on the implementation of products, tools, interventions, and programs or that focuses on sustainability research

3.2.2 Content Topics of Research

Similarly, based on the initial reviews of each department and agency's language and communication R&D efforts, combined with follow-on discussions, four distinct areas of language and communication R&D were identified. These include:

- Knowledge and Processes Underlying Language and Communication, which focuses on the overall structure, properties and rules of language; the processes through which language and communication skills are learned and applied; and, the processes leading to language deficits or impairments and their impact on language and communication.
- Language and Communication Abilities/Skills, which focuses on tools, methods and techniques for enabling and enhancing language and communication skills and approaches for assessing performance towards specific proficiency goals;
- Using Language and Communication to Influence Behavior and Share Information, which focuses on modifying/influencing behavior to manage risk, enhance information exchange, enhance cross cultural interaction and facilitate the sharing of information in social contexts;
- Language and Communication Technologies, which focuses on enhancing user interface / human – machine interaction technologies for the general population, including accessibility for people with disabilities or in special environments as well as technologies to support and facilitate human-to-human communication, through machine-based translation tools for spoken and written language and technology-based language education.

4. Language & Communication R&D Activities within the Federal Government: The Inventory Survey

4.1 Methodology: Survey and Data Analysis

The Taxonomy was used as a guide for the inventory survey. The process for developing the survey included three steps: (1) IWGLC members decided on the information that needed to be included in the survey; (2) the taxonomy and survey subcommittee drafted the survey; and (3) IWGLC members reviewed and revised the survey.

The first step in developing the inventory survey was deciding which characteristics of the language and communication R&D activities were important to capture in the survey, what level of reporting was possible across government departments and agencies, and which details would be easily accessible at that level of reporting.

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Second, the taxonomy and survey subcommittee created the first draft of the inventory survey. The inventory survey structure was developed using the content topics of the Taxonomy. The same sets of questions were asked for each of the four top-level topics of R&D activities (e.g., Knowledge and Processes Underlying Language and Communication). This set of questions asked for: identification of the subtopics on which R&D activities are based; type of research on that topic (e.g., basic/foundational); participants/subjects of the research activity or activities in that topic; and the funding status of the activity or activities in that topic (e.g., current activity with funds currently being expended, target of future R&D). General questions about language and communication R&D activities were also included, such as questions about types of funding for these activities (e.g., grants, contracts), identification of stakeholders, and identification of current agency or department language and communication research needs. IWGLC members had an opportunity to comment and suggest revisions before the inventory survey was finalized. IWGLC members attempted to complete the survey using their own agencies' and departments' activities to see whether they could answer all of the questions easily and accurately. If a particular question was too detailed or not meaningful for the majority of agencies and departments, it was removed from the survey. If the definition of a term used in the survey differed drastically by agency or department (e.g., the term 'program'), efforts were made to remove the term to ensure that all departments and agencies interpreted questions in a similar way.

The final version of the inventory survey included 61 questions (see the complete survey in Annex V). The IWGLC developed both a pdf and an online version of the survey. The online survey was hosted on the survey engine from the Institute of Education Sciences at ED. The IWGLC also developed a cover letter and a set of definitions of important terms used throughout the inventory survey, and these were included in the email to the survey respondents.

The inventory survey was distributed to agencies and departments through the NSTC's subcommittee on Social, Behavioral, and Economic sciences (SBE subcommittee) on October 7, 2014. Representatives on the SBE subcommittee were charged with forwarding the information to the appropriate contact(s) within their agencies and departments.

4.2 Survey Results

Of those contacted through the SBE subcommittee, the IWGLC received 27 survey responses, collected between October 7, 2014 and February 15, 2015. These responses varied in their level of reporting, so there were instances of multiple responses within the same agency or department. Responses presented below are aggregated to the agency or department level.

Of those who responded, six indicated through email or through the initial survey question that their agency or department did not conduct or support language and communication R&D. They are the Department of Energy, the Environmental Protection Agency, Department of State, the Networking and Information Technology Research and Development Program (multi-agency research initiative), the Centers for Disease Control and Prevention (HHS), and the Office of the Assistant Secretary for Health (HHS). The remaining 20 respondents all indicated that their department, agency, or office conducts or supports/funds/manages language and communication R&D. See Table 1 for a list of departments, offices, and agencies that participated in the survey.

The results reported here are intended to demonstrate the breadth of language and communication activities that the Federal Government has supported or is currently supporting across departments and agencies. Agencies' and departments' responses to these survey items are presented by topic in sections 4.2.1, 4.2.2, 4.2.3, and 4.2.4.

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It is important to note that these results do not provide information about monetary investments nor do they provide enough information to compare the financial contributions of different agencies and departments. In fact, while the IWGLC survey included a question about monetary investments in language and communication R&D, the majority of survey respondents chose to omit this information from their survey response. Lacking this information did not prevent us from

Building on decades of basic research supported by several Federal agencies and departments on the development of language and reading, and the underlying causes of language and reading disabilities, the Institute of Education Sciences (Department of Education) launched the Reading for Understanding Research Initiative in 2010. Intended to support an interdisciplinary and longitudinal approach to the vexing problem of struggling readers, six large research teams are carrying out programs of research which promise to reshape our understanding of the best ways to support reading outcomes from prekindergarten through twelfth grade. The projects include studies exploring the foundations of poor reading outcomes, the development of interventions and assessments building on those basic findings, and tests of the efficacy of those interventions and demonstrate the value of engaging in R&D activities across the spectrum of research types.

continuing our analyses, since monetary investment is not the only, nor necessarily the best, indicator of the extent to which the Federal Government is addressing critical issues in language and communication R&D.

Table 1 shows which agencies and departments conduct or support/fund/manage R&D under each of the four topics (Knowledge and Processes Underlying Language and Communication, Language and Communication Abilities and Skills, Using Language and Communication to Influence Behavior and Share Information, and Language and Communication Technologies) and identifies the type(s) of research the department or agency uses to address each topic. While this table suggests that agencies and

departments overlap in many areas, it is important to keep in mind that these topics are quite broad. The following sections will provide more fine-grained analyses of each topic and will show that while there is some overlap in R&D across departments and agencies, it is clear that each agency or department has unique contributions to language and communication R&D, largely due to the differences in their missions.

4.2.1 Knowledge and Processes Underlying Language and Communication

4.2.1.1 Background

The R&D activities relating to the topic Knowledge and Processes Underlying Language and Communication fall into one or more of the following three taxonomic headings: Language Structure; Language and Communication Processes; and Language Deficits and Impairments. Research on language structure is comprised of basic studies of grammatical structure at a variety of descriptive levels (e.g., phonological) of spoken, written and signed languages, research on how language is used and processed, studies of the computational properties of language, and research on linguistic variation and change. Language and communication processes refers to a broad range of research activities, including research on: the neurobiological and cognitive basis of the human language faculty; the cognitive resources normally enlisted in the performance of language production and comprehension; non-verbal components of language-based communication; and language acquisition (defined, for the purpose of the Taxonomy, as implicit attainment of language without formal instruction). Research on language deficits and/or impairments includes studies of disorders or delays in language development and acquired deficits resulting from injury, illness or disease.

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Basic R&D in these areas provides a deeper understanding of the uniquely human capacity to acquire and use a rich system to convey spoken, written, and signed messages to one another. This understanding, in turn, serves as the basis for efforts to develop, evaluate, and improve approaches to the instruction of language skills (e.g., reading, writing) and foreign languages, to diagnose and intervene on developmental and acquired language deficits, and to approach the task of analyzing, documenting, and teaching unfamiliar or understudied languages. It provides the theoretical foundation for developments in technologies for automated systems for speech recognition, meaning extraction, and machine translation, and it acts as a valuable starting point for developing approaches to influencing behavior through language and communication across government agencies and departments.

Are IQ scores related to developmental dyslexia? Research funded by the National Institute of Child Health and Development (part of the National Institutes of Health, Department of Health and Human Services) examined the role of IQ scores in developmental dyslexia using functional magnetic resonance imaging (fMRI). Researchers looked for differences in brain activation for children with poor reading ability but high IQ scores, relative to those with low IQ scores, as they engaged in a phonological processing task. Results showed that all students who struggle with phonological processing that is characteristic of developmental dyslexia, regardless of IQ scores, show similar brain activation, suggesting that IQ scores and developmental dyslexia are not linked.

4.2.1.2 Results

Tables 3 and 4 show the investment in R&D on the Knowledge and Processes Underlying Language and Communication by department. Of the nine reporting departments and agencies, only two (the Department of Justice and DOT) did not report support for or engagement in activities relating to this topic. ED and the NSF cover the majority of the subtopics under Knowledge and Processes Underlying Language and Communication, while other departments and agencies focus on only a subset of the subtopics. There is variation in the categories of R&D activities (i.e., basic,

Many languages around the world, including all the Chinese languages, use tone or pitch to distinguish between otherwise identical words. An estimated 1.66 billion people speak tone languages. However, an estimated 5% of the world's population has difficulty perceiving musical pitch, a difficulty called amusia or musical tone deafness. National Science Foundation (NSF)-funded researchers are investigating whether native speakers of tone languages who have musical tone deafness also show deficits in perceiving and producing linguistic tones. This research on pitch perception and its communicative consequences provides a unique opportunity for examining the connection between two major complex auditory phenomena in our auditory system, namely music and speech.

translational, applied, etc.) across the remaining seven departments and agencies that do report such activities, which is largely a reflection of the goals and missions of those entities. For example, five of those seven (HHS, the National Aeronautics and Space Administration [NASA], NSF, and the DoD and ED) report that they support or engage in basic/foundational research in this area. As shown in Table 4, of the seven departments and agencies reporting activities in this

area, there are three (ED, HHS, and NSF) that report that the participants of the research include people and/or students across the lifespan (infants through adults). The remaining departments and agencies have a more narrow focus on specific populations.

Approximately one million people in the U.S. are currently diagnosed with aphasia, an impairment in language processing commonly associated with stroke, estimates the National Institute of Neurological Disorders and Stroke (part of the National Institutes of Health, Department of Health and Human Services).¹⁴ Many individuals with aphasia have difficulty naming objects or people, and while some can improve with special naming therapy, treatment is not always effective. A research team funded by the National Institute on Deafness and Other Communication Disorders (part of the National Institutes of Health, Department of Health and Human Services) is developing mapping techniques to examine neural connectivity. The hope is that by understanding cortical necrosis and disconnection in patients who have chronic naming problems, effective therapies and other treatments for stroke patients will be developed to reverse aphasia's effects.

Focusing on the subtopics in the area of Knowledge and Processes Underlying Language and Communication, the survey results summarized in Table 3 indicate that the DoD, ED, HHS, and NSF have the broadest coverage, although this form of accounting does not simultaneously make distinctions among the types of R&D activities. For example, both the Department of Commerce and the NSF report activities relating to linguistics, characteristics of spoken/written language, and human language processing; but from the department and agency responses tallied in Table 1 it can be inferred that the types of R&D activities the two departments/agencies engage in do not overlap with regard to those subtopics. The Department of Commerce supports work on translational and applied R&D, whereas the activities supported by NSF relating to these subtopics fall under the

category of basic/foundational R&D. Other instances of apparent overlap across departments and agencies for specific subtopics within the domain heading Knowledge and Processes turn out, in most cases, to fall into different types of R&D.

4.2.1.3 Discussion

Department and agency investments that are relevant to Knowledge and Processes Underlying Language and Communication clearly reflect their respective missions. For example, the mission of the National Institute of Standards and Technology (NIST; part of the Department of Commerce) is “to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life;” whereas in its charter, NSF is “authorized and directed ... to initiate and support basic scientific research and research fundamental to the engineering process; [and] programs to strengthen scientific and engineering research potential; ...” NIST primarily supports work on translational and applied R&D, which reflects its specific, applied mission, while NSF supports basic/foundational R&D, which is aligned to its mission to strengthen the basic scientific research base. On the other hand, the efforts of HHS and ED on developmental disorders and acquired deficits of language and communication represent their complementary missions relating to identifying effective diagnostic tools and approaches to improving developmental outcomes for youth with or at risk for disabilities. However, even though both departments share interests in these topics and study similar populations, their missions are quite different. ED’s mission is “to promote student

¹⁴ U.S. Department of Health and Human Services (n.d.). *NINDS Aphasia Information Page*. Washington, DC: National Institute of Neurological Disorders and Stroke, National Institutes of Health, U.S. Department of Health and Human Services. <http://www.ninds.nih.gov/disorders/aphasia/aphasia.htm>

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achievement and preparation for global competitiveness by fostering educational excellence and ensuring equal access,” while HHS’s mission is “to enhance the health and well-being of Americans by providing for effective health and human services and by fostering sound, sustained advances in the sciences underlying medicine, public health, and social services.” Consequently, the specific R&D activities that HHS and ED support under these topics are likely to be substantively different from each other given that they reflect the specific missions and goals of each department.

4.2.2 Language & Communication Abilities/Skills

4.2.2.1 Background

The topic Language and Communication Abilities and Skills encompasses R&D focused on learning, teaching, and assessing language abilities and skills. The IWGLC Taxonomy defines learning language skills as the acquisition of language and communication skills through explicit or formal instruction, as opposed to implicit attainment of language. Under learning language skills, the Taxonomy and inventory include learning of primary and foreign languages, learning of English as a second language¹⁵, and language and communication disorders and delays as they relate to language learning. Under teaching and assessing language abilities and skills, the Taxonomy and inventory include teacher preparation, instruction of language, and policy related to teaching and assessing language and communication abilities and skills. R&D in these areas is critical for many reasons, including developing and identifying effective foreign language programs, improving instruction of language, reading, and writing skills in classrooms (including for students with disabilities), and creating assessments that validly and reliably capture an individual’s language skill level, among others.

In 2013, only 35% of fourth graders and 36% of eighth graders could read proficiently. The Institute of Education Sciences (Department of Education) has funded multiple research teams to develop interventions to improve students’ reading outcomes. These include vocabulary interventions that teach students how to use word roots to infer the meaning of unknown words, curricula that use interesting social studies topics to increase reading engagement, and intelligent tutoring systems that help students understand complex informational text. These interventions and programs often include the development of classroom materials, teacher professional development materials, and assessments.

¹⁵ English Learners may come from multilingual families so they may be learning English as a third or fourth language.

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4.2.2.2 Results

Tables 5 and 6 show the investment in R&D on Language and Communication Abilities and Skills by department. Interestingly, few departments and agencies in the Federal Government engage in R&D

A key stumbling block in language learning is fluent pronunciation. In collaboration with MIT Lincoln Lab researchers, DLIFLC has produced NetProF, Networked Pronunciation Feedback program, a system that gives visual feedback on each sound pronounced in foreign language words and phrases and also gives a context sentence example showing how the word or phrase in question is pronounced in context. Similar systems have been developed with ED support at Carnegie Mellon University, SRI, and elsewhere.

activities related to this topic. The Department of Commerce, Department of Justice, and NSF report no R&D activities in this area. DOT reported that the department supports evaluation R&D on reading level for consent forms (a topic that falls outside of the subtopics listed in the inventory). NASA reports translational and development research on assessments. The National Endowment for the Humanities (NEH) supports translational and applied research on the learning of foreign languages

(specifically endangered languages) of underrepresented groups.

As shown in Table 5, the majority of R&D on Language and Communication Abilities and Skills is carried out or supported by the DoD, ED, and HHS (specifically, the NIH), at least in terms of coverage of subtopics in this area. ED supports R&D across all subtopics listed under Language and Communication Abilities and Skills, and the DoD and HHS support research in a sizable proportion of the subtopics. There are three subtopics on which all three departments conduct or fund research, but there are important differences between these three departments when it comes to the participants of the research. For example, while all three report R&D activities on foreign languages, the DoD is the only department of the three that supports activities with career/workforce trainees. Both ED and HHS support R&D activities with children, while the DoD does not. Additionally, while ED and HHS cover all types of research (i.e.,

More than 7,000 languages exist worldwide, most of which are understudied and endangered, as holds for Native American, Alaskan and the Hawaiian languages. Due to small speaker populations, with sometimes two or three elderly fluent speakers remaining, the nation faces an urgent need to maintain these languages and to understand their diverse structures. Multiple agencies sponsor¹⁶ research and applications to support indigenous languages. Initiatives include scientific investigations of their linguistic structure to illuminate cross-linguistic diversity and complexity, the documentation and analysis of indigenous language oral histories, their acquisition by adults and children, and the implementation of evidence-based models for language instruction. Even highly visible U.S. indigenous languages often lack uninterrupted intergenerational transmission, a key for language survival according to UNESCO criteria.

¹⁶ These Agencies include: National Science Foundation (SBE/BCS/DEL); National Endowment for the Humanities (DEL).

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basic/foundational through implementation research) on language and communication abilities and skills, the DoD does not fund or conduct basic/foundational research on this topic. NSF supports basic/foundational research about language and communication as it relates to young children's development of mathematics and science skills and abilities, with additional investments focused on the role of language and STEM skills and abilities in children and adults from underrepresented groups, particularly individuals with disabilities and persons who are English language learners.

4.2.2.3 Discussion

The difference in population focus between the DoD, ED, and HHS is consistent with the missions of each of these departments; however it also highlights that the DoD may benefit from the R&D that ED and HHS are supporting to strengthen students' language and communication abilities and skills, as stronger skills should lead to a stronger workforce that would need less language skills training or could start with more advanced training. For example, R&D funded by ED and HHS intended to improve foreign language instruction has the potential to lead to substantial improvements in the foreign language skills of K-12 students, reducing the DoD's burden to teach foreign languages to young adults and adults who need these skills to perform their mission-critical jobs. This would free up resources for the DoD to invest in other types of training. It is also possible that DOD-supported R&D on foreign language learning at the adult level could be useful for informing future research at ED around foreign language learning in K-12 classrooms.

The Centers for Disease Control and the Office of Homeland Security have identified radiological exposure from a terror event as a potential threat for which the nation should prepare. In research funded by the National Institute of Biomedical Imaging and Bioengineering (National Institutes of Health, Health and Human Services), scientists are studying new ways to develop communication materials that would reach low literate adults based on modeling the low literate individuals' conceptualization of a dangerous radiological situation. The team is assessing the effectiveness of risk communication messages using psychophysiological measures such as heart rate and eye-tracking. The results of this research may inform the design of risk communication aids for various types of risk and may help reduce or eliminate disparities in disaster response.

4.2.3 Using Language & Communication to Influence Behavior and Share Information

4.2.3.1 Background

The topic Using Language and Communication to Influence Behavior and Share Information includes R&D focused on modifying and influencing behavior and sharing information in social contexts. Under modifying/influencing behavior, the Taxonomy and inventory include managing risk and safety through better communication, diplomacy, negotiation and persuasion, and behavioral economics. Sharing information in social context focuses on language and communication in social networks, group dynamics, cross cultural communication, specialized language, outreach and transfer of research finding, and social media. R&D in this area is important for many reasons, including: finding the best ways to communicate critical information about health, safety, and transportation to the public; understanding the role of language and communication in culture and social settings; and improving negotiation skills.

4.2.3.2 Results

Tables 7 and 8 show the investment in R&D on Using Language and Communication to Influence Behavior and Share Information. There are only a few departments and agencies that reported engaging in R&D on this topic, and those that did report activities in this area only report covering a

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small number of the subtopics. For example, while the DoD and ED both report R&D in this area, they only conduct or support R&D on cross-cultural communication and social media or Internet communication. DOT reports R&D on managing environment and transportation risk and safety, as well as social media, and outreach of research findings. USDA reports that education messages for food safety and nutrition are based on research to determine their effectiveness. Interestingly, the only departments and agencies that support or conduct R&D on modifying behavior other than managing risk and safety are HHS and NSF. No departments or agencies report activities related to diplomacy.

Published in 2011, the FDA report Communicating Risks and Benefits: An Evidence-Based User's Guide, highlights what we know from R&D about strategies to improve communication in the context of risk.

NSF reports only supporting or conducting basic/foundational research on Using Language and Communication to Influence Behavior and Share Information, while HHS and the DoD conduct or support activities across all research

types (i.e., basic/foundational through implementation research). ED supports activities across all research types within this topic except for basic/foundational research.

HHS is the only department that reports including all participant groups in their activities related to Using Language and Communication to Influence Behavior and Share Information. NSF only includes adults as participants in this topic's activities. The DoD and DOT also include adults as participants as well as operators and users. ED is the only other department besides HHS that includes students of various ages as participants in research on this topic.

4.2.3.3 Discussion

DOT's mission is to provide fast, safe, efficient, accessible, and convenient transportation. Certainly, then, the communication of risk and safety information regarding transportation is important for producing safe and convenient transportation for the American people. Many different agencies and offices at the DoD who provided responses to the inventory survey highlight the role of R&D related to Using Language and Communication to Influence Behavior and Share Information in achieving the mission. For example, the Defense Language Institute Foreign Language Center's mission is to provide culturally-based foreign language education and training, so R&D on cross-cultural communication and other aspects of language and communication in social interactions may be especially important for its work. The NIH (part of HHS) conducts science in the pursuit of knowledge about the nature of behavior as part of its mission, which includes research on sharing information in social settings and managing risk and safety. Additionally, one of the broader goals of HHS is "to enhance the health and well-being of Americans by providing for effective health and human services..." Addressing this goal requires an understanding of how to use language and communication to influence behavior and share information.

4.2.4 Language & Communication Technologies

4.2.4.1 Background

The topic Language and Communication Technologies encompasses R&D focused on user interface and interaction technologies, human-to-human communication, machine translation, language education support using human language technologies, automated analysis/recognition of spoken language, and automated analysis/recognition of written language. Under user interface and interaction technologies, the IWGLC Taxonomy and inventory include hardware and software capabilities to support interaction between the user and the technology, accessibility for people

Human-computer interactions are becoming increasingly pervasive. The Office of Naval Research (part of the Department of Defense) engages in multiple programs intended to leverage those opportunities. For example, programs have been developed that allow robots to take commands from sailors and even learn behaviors from humans. There are programs working on machine understanding of natural language so that Intelligent Systems can interact with people, primarily for training and education (e.g., tutoring systems). Other programs search social media (analyze text) and compile behavioral trends of social communities (e.g., scan texts sent out after a natural disaster and inform first responders to locations in need). Finally, another program uses role playing with robotic avatars to train Marines to communicate with local people.

with disabilities or in special environments, and non-linguistic communication. Under technology to support human-to-human communication, the Taxonomy and inventory include collaborative tools, social media, and crowd sourcing. Machine translation includes parallel text development and automated language translation technologies. Language education support using human language technologies includes pronunciation feedback programs, text-complexity/readability/text leveling analysis, assessing

language proficiency of individuals, and computer-based tutoring and testing. Automated analysis/recognition of spoken language includes speech analysis/recognition, language and dialect information, and speaker and language analysis/recognition. Finally, automated analysis/recognition of written language includes text analysis/recognition, and natural language processing.

R&D in these areas is critical for many reasons, including developing mechanisms that quickly and effectively translate one language into another, automatically synthesize big data into meaningful summaries, and create human level interactions with computer systems, just to name a few. These tools are important for a variety of populations. For example, diplomats and soldiers overseas may find that real-time translation tools facilitate their interactions with local groups. Likewise, pilots and air traffic controllers may see improvements in efficiency and performance when working with enhanced

The Army Research Lab performs complementary research focused on land forces. Research in human-robot interaction develops methods for deep comprehension of language and its relation to the world so that robots understand better. Research in machine understanding of natural language focuses on soldier requests to networks of systems for information critical to the place and time of a mission (“what is the terrain like after the earthquake?”). Research on social media seeks to appreciate sentiment and opinion and to track unfolding events such as epidemics in humanitarian relief operations

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human-computer interaction technologies.

4.2.4.2 Results

Tables 9 and 10 show the investment in R&D on Language and Communication Technologies, by department. Every department or agency in the Federal Government that responded to the inventory survey is engaged in R&D activities related to this topic, though there is variation in the number of subtopics covered by each department or agency. The DoD and HHS support and/or conduct R&D on almost all of the subtopics, while the Department of Justice and DOT tend to focus their efforts on far fewer subtopics, with no R&D from either department falling under human-to-human communication, machine translation, or language education support using human language technologies. Interestingly, all departments and agencies report R&D activities in natural language processing, which includes tasks such as extraction, summarization, search, filtering, and knowledge base creation.

In terms of types of research, the DoD, ED, HHS, and NASA report all research types related to R&D on Language and Communication Technologies. The Department of Justice reports only evaluation research on Language and Communication Technologies. In fact, evaluation of Language and Communication Technologies is the only language and communication R&D reported by the Department of Justice across all topics. The Department of Commerce and NEH report translational, development, and evaluation R&D related to Language and Communication Technologies.

Adults are included as participants in all departments' and agencies' Language and Communication Technologies R&D. Career and workforce trainees are included in the Language and Communication Technologies R&D only at HHS. Students of various ages and infants, children, and young adults are included in R&D on this topic in numerous departments and agencies.

4.2.4.3 Discussion

The missions of those departments and agencies that report Language and Communication Technologies R&D align with the subtopics of activities reported by them. The two departments with a more narrowly-focused set of R&D activities in this area (Department of Justice and DOT) use language and communication for targeted reasons (i.e., for law enforcement and to ensure safe and reliable transportation respectively), and only a subset of Language and Communication Technologies R&D activities are necessary in order to address their needs. For example, neither department includes language education in its mission, so neither supports nor conducts language and communication R&D on using human language technologies to support language education. On the other hand, different agencies within the DoD have different missions and agency needs (e.g., Army, Air Force, Navy), so a diverse set of language and communication technologies are necessary to support the broad range of tasks in which these agencies are engaged. In addition, many of the DoD agencies that responded to the inventory survey stress a focus on innovative solutions to allow the armed forces to be ready and able to communicate with individuals around the world. The missions of innovation and worldwide communication align well with language and communication technologies, which use state-of-the-art hardware and software to allow interaction between people who speak different languages.

4.3 General Conclusions

The results reported here demonstrate the breadth of the Federal Government's investment in language and communication R&D. The departments and agencies that indicated that they conduct and/or support or fund R&D activities in language and communication overlap in their broad research interests across a number of subtopics within the four broad topics of language and communication research (see Taxonomy in Annex II); however, the types of research each

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department or agency engages in within these topics are substantively different due to the unique missions of each. It is important to note that while many of the topics and types are covered by more than one department or agency, there is actually little overlap in the actual R&D being supported or conducted. The unique missions of the departments and agencies require R&D that is suited to their aims and the populations they serve.

For example, many departments and agencies report conducting or funding R&D under the Knowledge and Processes Underlying Language and Communication topic, but the population focus differs. ED, NSF, and HHS all report including participants from across the lifespan, including a focus on students. This is appropriate given the missions of supporting basic science on language and communication, and of supporting work to increase students' academic performance. On the other hand, NASA and the DoD focus on specific populations such as career/workforce trainees and operators/users. For the DoD, this is likely to include soldiers, as the missions of the DoD agencies are to support the military both in the United States and overseas. The needs of students and soldiers may be similar in some respects (e.g., the cognitive basis of language may be similar), but different in others (e.g., second language acquisition processes have been shown to differ between young children and adults).

Similarly, under the topic Language and Communication Abilities and Skills, ED supports R&D under all subtopics, which is appropriate given the department's mission of improving academic outcomes for all students. On the other hand, DoD focuses on foreign languages and strategies for teaching languages to adults, which matches their needs of preparing military forces to interact effectively with individuals around the world. The NEH also focuses its R&D on foreign languages with a particular focus on supporting the study, documentation, and preservation of historical and

minority languages, which matches its mission of supporting work in the humanities. The work of the DoD and the NEH may appear to overlap, but the DoD has specific needs related to training and preparing military personnel to use foreign languages in the field, while NEH support for research on endangered languages, including a priority for Native American languages, helps to capture valuable knowledge and to ensure that the unique cultural

U.S. Soldiers have an increasing need to communicate with different individuals around the world. While verbal language education is essential to Soldier capabilities, they are also trained to understand cultural nuances of nonverbal communication. The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) developed training for Soldiers to interpret nonverbal behavior in a variety of situations: credibility assessment, detecting aggression, and interpreting nonverbal cues at a distance.¹⁷ Three nonverbal decoding skills appear especially important: detecting emotion, reading emblematic gestures, and change detection. The most reliable nonverbal "channel" is the face; thus, significant training is oriented toward detecting specific emotions expressed in the face. Gestures also convey significant information. Finally, change detection training allows the Soldier to attune their ability to discern facial and gestural cues to specific settings.

¹⁷ Rosenthal, D.B., et al. (2009). Training soldiers to decode nonverbal cues in cross-cultural interactions. *ARI Research Note 2009-12*. Washington, DC: U.S. Army Research Institute for the Behavioral and Social Sciences,

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and linguistic heritage of our country is sustained, for the benefit of all Americans.

Under the topic of Using Language and Communication to Influence Behavior and Share Information, the DOT, USDA, and NSF all report work on risk management through better communication, but the NSF includes general adults as participants while the DOT and USDA includes the more specific subgroups of operators/users and individuals from underrepresented populations. Because the DOT has the need to manage risk for operators, for example, its R&D needs are slightly different. Knowledge gained through R&D at NSF might be applicable to the needs of the DOT, but because of the DOT's specific needs, it is important that they support and conduct their own R&D.

Finally, the topic Language and Communication Technologies had the most department and agency representation and strong coverage across the subtopics, with all respondents indicating at least some work in the area. This topic seems to be the one with the most overlap, but still, this work is complementary and is not a reflection of redundant investments. For example, many different departments and agencies report work on speech analysis and recognition, but for different purposes. R&D at ED uses speech recognition technology to develop intelligent tutoring systems and tools for students that can listen to them speak and correct their responses as a human tutor could. DoD develops and tests speech analysis and recognition tools to aid military personnel in correcting pronunciation so as to become more fluent in foreign languages. Finally, the DOT supports research on speech recognition and analysis in order to aid technologies that utilize spoken commands while in vehicles. All of these tasks require R&D in the subtopic of speech analysis/recognition, but because of their different purposes and different populations (i.e., children, military personnel, operators), different R&D activities are required.

In addition to the fact that existing R&D illustrates a great breadth and depth of knowledge in the domain of Language and Communication, Departments and Agencies across the Government

Since 1992, the National Institute of Standards and Technology (NIST; Department of Commerce) Text Retrieval Conference (TREC) and its spinoffs have lowered the barriers of entry to engage thousands of researchers on hard problems in Information Retrieval (IR). TREC provides researchers with challenge problems, datasets, metrics, ground truth, evaluation tools, and a world class venue to compare their approaches and exchange knowledge. TREC has made significant impacts in promoting research and accelerating the state-of-the-art in IR and has had direct impacts to the legal, chemistry, genomics, and Health IT fields. An economic analysis conducted by RTI International in 2010 showed that for every \$1 NIST and its partners invested in TREC, \$3 to \$5 in benefits accrued to researchers.

recognize the importance their work has on developing standards for the domain. For example, the NIST Information Technology Laboratory fosters the creation of multi-sector/multi-disciplinary technical communities of interest in emerging information access technologies and develops rigorous measurement science to inform, gauge, and accelerate the state of the art. In the language and communication area, these technologies include speech recognition, speaker recognition, language recognition, textual and multimedia search and understanding, machine translation, natural language processing, and information extraction. The

specifications, best practices, metrics, datasets, and tools created in this process ultimately make their way into standards which improve our nation's information technology systems.

The results of the inventory survey show that most areas of language and communication R&D are being funded or supported by the Federal Government; yet, there are still language and communication needs that have somewhat sparse coverage across departments and agencies. For

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example, the topic Using Language and Communication to Influence Behavior and Share Information is only addressed by a small number of departments and agencies, and there are some subtopics where very few departments or agencies indicated that they do work in that area (e.g., diplomacy, managing risk/safety around health and existential threats). This inventory survey is useful for identifying these areas. However, it is also important to keep in mind when interpreting these results that there is R&D being conducted that is not necessarily categorized as “language and communication” by a particular department or agency, but that may actually be relevant for language and communication R&D. For example, NIH funds translational and applied intervention research that strives to influence human thought and behavior to improve and maintain health and wellbeing, ensuring adherence/compliance to treatments, and enhancing/improving the provision of health care services. Such interventions include strategically designed curricula that must be performed precisely and repeatedly over time. Yet NIH would not necessarily code such projects as language and communication as the agency’s reporting system uses different labels for projects that strive to evoke healthier attitudes and behaviors in others.

For example, the National Institute of Diabetes and Digestive and Kidney Disease’s (NIH/HHS) Diabetes Prevention Program (DPP) was a multicenter clinical research study aimed at discovering whether an intensive lifestyle intervention designed to result in modest weight loss through dietary changes and increased physical activity or treatment with the oral diabetes drug metformin (Glucophage) could prevent or delay the onset of type 2 diabetes in study participants. The DPP found that participants in the intensive lifestyle intervention who lost a modest amount of weight through dietary changes and increased physical activity sharply reduced their chances of developing diabetes. Taking metformin also reduced risk, although less dramatically. These results were so profound that the DPP’s external monitoring board recommended halting the study before its original stop date to disseminate this intervention to a broader population. Reviewing the description¹⁸ of the lifestyle intervention, which relied on case managers delivering a core set of information, one can surmise that language and communication played a critical role in the success of this intervention. However, the “project terms” NIH uses to catalog these grants include: “behavior modification; behavioral /social science research; body physical activity; clinical trials; cost effectiveness; diabetes mellitus therapy; diabetes risk; diet therapy; disease /disorder prevention /control; exercise; glucose tolerance; health behavior; human subject; human therapy evaluation; hyperinsulinism; lifestyle; longitudinal human study; metformin; noninsulin dependent diabetes mellitus; nutrition related tag; obesity; patient oriented research; weight control.” Though these terms certainly apply, they do not account for the words and mediums used to convey the efficacious intervention.^{19,20}

There are also departments and agencies that indicated they do not conduct or support language and communication R&D, yet language and communication activities are central to their work. For example, State has department needs related to language and communication (e.g., risk communication, foreign language training), but responded that they do not conduct or support/fund R&D on language and communication. Departments and agencies like these need to

¹⁸ The Diabetes Prevention Program Research Group (1999). The Diabetes Prevention Program: Design and methods for a clinical trial in the prevention of type 2 diabetes. *Diabetes Care*, 22, 623–634.

¹⁹ Diabetes Prevention Program Research Group. (2002). Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *New England Journal of Medicine*, 346, 393-403.

²⁰ Knowler, W.C. *Prevention of type 2 diabetes mellitus*. NIH grant 1Z01DK060951. Retrieved 19 May 2015, http://projectreporter.nih.gov/project_info_description.cfm?aid=6984162&icde=24702388

leverage the work of other departments and agencies. The IWGLC's Taxonomy and this inventory analysis will be useful for identifying potentially relevant sources of information that these departments can draw upon.

5. Language & Communication (R&D) Activities within the Federal Government: Opportunities and Ongoing Needs

As this report illustrates, R&D investments in language and communication are spread across multiple Federal departments and agencies. As the committee heard from Federal staff representing this breadth, it became clear that there are opportunities for building a community of practice within the Federal Government that would enable scientists and practitioners to leverage the wide range of extant research. In addition, it is clear that there remain areas of critical need where the research foundation is thin.

Identifying opportunities and ongoing needs across the Federal investment is constrained by the methods that were used to gather the data reported here. The combination of briefings to the committee and survey responses allowed the IWGLC to identify the breadth of Federal investment, but did not provide information as to the depth of that investment. Readers should remain mindful that four broad areas of opportunities and ongoing needs identified here reflect questions of breadth, and do not speak to whether the depth of the Federal investment is sufficient to tackle all the possible areas of need in language and communication R&D.

One set of opportunities and ongoing needs, understood as gaps between current R&D investments and needs identified by departments and agencies charged with practice missions, focused on the area of risk communication. While the DoD and the intelligence community have a deep investment in this area, their focus on national security potentially limits the range of application. At the same time, both the FDA and the USDA identified clear needs – how to communicate health information, including directions and instructions on products used daily (e.g., correct use of prescription medicines) – for which the Federal R&D investment was limited. Another set of opportunities and ongoing needs reflected the need to invest in R&D to leverage the rapid explosion of language technologies to support critical national needs.

In addition to providing a clearer picture of the investments that the Federal Government has made in language and communication R&D, the efforts of this working group have also helped to identify opportunities and (both unmet and ongoing) needs for additional R&D efforts to better serve our national priorities in the economy, technology, security, education and health.

5.1 Language Documentation

Accurate and efficient cross-linguistic communication may be easily frustrated by differences across languages, and the challenges that arise from these differences become especially important when effective cross-linguistic communication is required to address the national interests, as in contexts involving foreign conflict or governmental humanitarian relief efforts. What resources can be deployed to serve the nation's needs when the number of available U.S. speakers of a language alone is inadequate to meet those needs? Depending on the foreign language, our ability to create adequate pedagogical materials and/or language-specific communication aids will depend on our ability to leverage existing linguistic assets (e.g., dictionaries and grammars of the spoken and/or written language, language skills that adult immigrants and English learners possess) and cultural analyses (e.g., the results of anthropological and sociolinguistic studies of language use by culturally and linguistically identifiable communities). Research supported by NSF, NEH, and other Federal departments and agencies plays a central role in developing these resources for languages and language communities that currently are understudied and/or endangered. Federal departments

and agencies (including DoD, NSF, NEH, and NIST) also engage in and/or support the development and evaluation of new tools and automated technologies that can augment human efforts to create resources for meeting the nation's need to communicate, disseminate and collect information on the world's languages. In some instances, resources may not yet exist in forms that can adequately serve specific language and communication needs when they are first identified; this remains a major challenge for the nation—a challenge that requires investments in training, in basic and applied language research, and in the development of new language technologies. Investments in the analysis and documentation of understudied and endangered languages spoken within the borders of the U.S. can produce other societal benefits as well. For example, the ability of any indigenous group to reclaim its cultural and linguistic heritage has implications for education²¹, health²², and economic participation; the documentation of Native American languages leads to development of appropriate pedagogical materials for Native American language education, which in turn contributes to higher graduation rates, social health and well-being, and greater economic competitiveness in the spheres of science and technology.

5.2 Language and Communication Regarding Health and Safety

It is in the best interests of the nation and society for all of its members to engage in best practices regarding health and safety. However, Federal and state governments increasingly face the challenge of educating and communicating with multiple communities of non-English (and non-Spanish) speaking U.S. citizens and residents. For example, NIH, DHS, USDA, and other Federal departments and agencies have made substantial investments in how to use language to influence behavior to manage risks to health and safety, but the majority of these efforts have been based on English and (to a lesser extent) Spanish as the medium of communication. The increasingly diverse range of minority languages used as the primary and/or (in the case of more recent waves of immigration) sole means of communication poses a host of problems. What investments will improve, across both majority and minority language groups, our efforts to mitigate risks and educate such communities about the health and safety benefits of specific actions or behaviors? Investments that will have a positive impact include: supporting basic and applied research on the nuances across cultures and languages that modulate the success of efforts to communicate and educate our citizens about how to improve their health and safety; and developing language technologies that will enable the portage of previous and ongoing Federal investments (based on the use of English and Spanish) to such smaller language communities in the U.S.

In addition, the U.S. faces a rapidly aging population, many of whom will be facing a variety of impairments including, for example, cognitive or visual/hearing impairment. In this instance, there is a critical need to determine how best to communicate basic health information (e.g. on nutrition or prescription drug timing and potential negative effects of drug interactions). Challenges with communicating basic health and safety risks and precautions are ongoing issues in an environment

²¹ McCarthy, T. (2014). Teaching the Whole Child: Language Immersion and Student Achievement. *Indian Country Media Network* (<http://indiancountrytodaymedianetwork.com/2014/09/01/teaching-whole-child-language-immersion-and-student-achievement-156685>).

²² Hallett D., Chandler M.J., Lalonde C.E. (2007). Aboriginal language knowledge and youth suicide. *Cognitive Development*. 22:392–399.); Oster, R.T., Grier, A., Lightning, R., Mayan, M.J., & Toth, E.L. (2014). Cultural continuity, traditional Indigenous language, and diabetes in Alberta First Nations: a mixed methods study. *International Journal for Equity in Health*, 13:92 (<http://www.equityhealthj.com/content/13/1/92>); McIvor, O., Napoleon, A., Dickie, K.M. (2009). Language and culture as protective factors for at-risk communities. *Journal of Aboriginal Health*. 5: 6-25.

where 11% of our adult population is identified as having low literacy skills.

5.3 Language Learning in the U.S.

The growth of the globalized economy poses a host of challenges to the competitiveness of U.S. citizens and U.S. industries, and some of those challenges relate directly to our ability to communicate with members and representatives of emerging foreign markets. One vehicle for developing a competitive edge in these markets is to provide members of our own workforce with opportunities that enable them to

communicate in the language(s) of those markets. Current practice in this area falls short along a number of dimensions. For example, foreign language instruction is typically made available too late (learning a second language becomes more difficult with age, which makes problematic the common practice of beginning such instruction in high school) and in too few languages. Foreign language instruction in German, French, Spanish and other Western European languages is valuable, but our workforce will also benefit from opportunities to learn languages of emerging markets in

Tools that have been created for modern standard dialects of a language often fail when applied to regional dialects of the same language. Additionally, machine translation that works on news articles does not adapt automatically to informal foreign language media content. To address the challenges posed by the volume and variety of informal content emerging in social media and to improve automated translation of Twitter content, the Combating Terrorism Technical Support Office, Department of Defense, is developing an operational software engine that can be inserted into various existing media understanding systems and will enable users to understand the content of foreign language tweets, extract overall trends, and make sense of specific content.

places like China, Indonesia, Africa, and Eastern Europe. Although the number of languages spoken in these marketplaces renders traditional approaches to language instruction unfeasible as a general approach to serving this need, improving our competitiveness in the global economy will require investments in basic research on how to maximize the success of second language instruction, in the development of technologies to assist in second language learning, and in providing incentives and opportunities for our young citizens to engage in learning or maintaining their fluency in the languages of the global marketplace. At the same time, schools are required to provide English language instruction for the growing number of students participating in the U.S. school system for whom English is not their first language. Current R&D indicates that current instructional practice is not supporting the rapid acquisition of English for many of these students.

5.4 Language Technologies

The explosion of language technologies across multiple sectors requires a nimble and coordinated effort in basic and applied research to ensure that these powerful tools are meeting the needs of the security and commercial sector. Many domains of critical national importance rely on the development of language and communication technologies. These include (a) public safety and the public safety communication network; (b) aging in place; (c) learning and education; (d) healthcare and interaction with health information technologies; (e) usable security and privacy; (f) mobile communications; and (g) improved access to Federal data and information. In order to tackle many of the critical domains, there is a pressing need to extend existing R&D to address the application of language technologies to groups not typically represented in existing research efforts and data collections (children, elderly, individuals with disabilities). To address public safety, national security, education, and other national priorities requiring automated analysis and understanding of multi-lingual/multi-cultural language information, there is a need to develop R&D, data

resources, and evaluation tools to support the development of language technologies, that are robust to languages spoken and written, cultural variability, regional dialect variability, and environmental conditions.

There are needs within the research community as well as critical needs within the United States that need to be addressed. In order to leverage current investments, there is a need to develop methods and repositories of data and tools to port language technologies across domains. The speed of R&D in this area has meant that there is a need for a research infrastructure to support breakthroughs in language and communication technologies that will: (a) reduce the barriers of entry and increase the availability of research tools and data to enable research on hard problems; (b) increase the pool of experts in language and communication technologies within academia and industry; (c) reduce research-to-implementation cycles; (d) support future standards; and (e) measurably increase Federal return on investment. And there remain fundamental unanswered research questions as well, such as the need to understand the semantics of language and communication so that meaning can be accurately represented in language technologies.

6. Moving Forward with these Recommendations: Engaging Within and Across Government, Industry, and Academia

Based on the survey analyses, Section 5 identified a series of recommendations which, combined, could significantly enhance Federal-wide language and communication R&D activities. These recommendations provide a clear indication that significantly more work remains to be done in terms of supporting wider and more varied types of research (e.g., basic/foundational, applied evaluation) that focus on broader content areas (e.g., Knowledge and Processes Underlying Language and Communication) applied to a larger sampling of participants of the research (e.g., older adults). Within an agency or department, it is neither possible, nor desirable, to address every R&D 'cell' identified in Table 1 (Annex I). Yet collectively, across agencies and departments, and within the larger Federal Government, closing R&D gaps would significantly enhance our Nation's academic, economic, security and diplomatic competencies. This speaks to the need for enhanced collaborations across these departments and agencies. Section 6 focuses on different approaches to moving forward with these recommendations and proposes several engagement activities that may be undertaken to facilitate the cross-agency coordination necessary for effective collaboration. Three main activities are discussed: 1) extending the Taxonomy developed for this study to provide deeper insight into the types of collaborations that could be established; 2) supporting bottom-up approaches that enable researchers from different departments and agencies to more easily communicate their research interests and gaps, and to more effectively coordinate collaborative efforts; and 3) enabling top-down approaches to ease policy, regulatory and programmatic challenges to collaborations.

6.1 Extending the Taxonomy

Each department or agency values language and communication in accordance with its mission. This valuation in turn drives each department or agency to support specific types of language and communication R&D, to focus on specific content areas, and to do so for specific participant populations. The Taxonomy provides a common framework into which departments and agencies may align their language and communication R&D efforts to make them more easily understood across the Federal Government. For example, using the Taxonomy-based survey, the IWGLC's work found agency- and department-specific projects that can benefit other agencies and departments, yet of which the other departments and agencies were – until now – unaware. The Taxonomy allowed these agencies and departments to better understand how to map these R&D efforts onto their own gaps and future plans. For instance, the Taxonomy highlighted that the FDA and USDA

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have a shared interest in better understanding the best ways to deliver health communications to a wide range of different audiences. Similarly both agencies seek R&D to help them understand how individuals and groups make decisions regarding food and drug consumption based on these health communications. The Taxonomy also allowed Federal organizations that do not fund language and communication research to identify specific areas on which they would like guidance to inform their communication practices. For example, the Department of State does not fund language and communication R&D, yet it seeks guidance from R&D on communication strategies that are best suited to a specific need within a diplomatic context. Additionally, using the Taxonomy-based survey, the IWGLC identified R&D efforts across departments and agencies that involve language and communication, but that were not formally designated as such, making it difficult to share findings and/or best practices across the Federal Government.

In order to fully realize the value of this Taxonomy, it should be further refined to provide a more complete framework for capturing the varied nature of language and communication R&D across the Federal Government. Potential extensions include:

- *Periodically Updating the Taxonomy:* Language and communication research is in a constant state of flux, both as a result of new discoveries that are made through various research activities as well as through emerging challenges that are identified as requiring further investigation. This is due both to new discoveries identified through the research activities, emerging needs that inform the types of research that are to be undertaken, and other factors that influence the degree to which a certain research topic. Consequently, the Taxonomy should be updated to ensure that it captures the breadth and scope of language and communication research.
- *Regularly Gather Data Using Surveys Built on Current Versions of the Taxonomy.* The information presented in this report is of great initial value to understanding where current Federal R&D investment in language and communication resides. However, given that new investments are made annually across the Federal government, and given that needs will shift over time, the IWGLC recommends periodic surveys of the Federal R&D investment in language and communication based upon the Taxonomy.
- *Extend the Taxonomy to Include Commercial Industry Language and Communication R&D.* Each of the R&D types, content areas and participant populations represented by the Taxonomy reflect areas of active interest by Federal departments and agencies. Commercial Industry has a significant stake in language and communication, and may approach their R&D investments from perspectives that are distinct, yet complementary, to those of the Government. Reaching out to Industry to capture these alternate perspectives could significantly enhance the scope and value of the Taxonomy.

6.2 Bottom-up Approaches

The Taxonomy provides a formal structure for capturing cross-agency language and communication R&D, which can provide the foundation for one agency or department to reach out to another. Facilitating these cross-agency interactions requires a different set of approaches. One such set of approaches relies on “Bottom-up Approaches”, in which individual investigators from different agencies and departments, using the Taxonomy, the survey results and other information sources, naturally reach out to their colleagues to share information, and to develop collaborations. In order to facilitate these working-level collaborations, the following approaches are suggested.

- *Workshops:* Workshops with focused goals and objectives provide an important venue for facilitating cross-agency collaborations. As one example, the DoD hosted the first, of what is expected to be an annually recurring series, “Symposium on Science & Technology for Blended Adaptive Language & Culture Training.” This Symposium focused on identifying the

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challenges and opportunities attendant with integrating adaptive language training technologies into traditional schoolhouse settings, with the goal of developing a comprehensive R&D roadmap to address these challenges and to realize these opportunities. Realizing that expertise in these areas resides across the Federal Government, the DoD invited representatives from NSF and ED to share their insights and to participate in developing the roadmap. Workshops can serve to identify new Challenge problems in emerging areas, or they can be focused around already-identified challenge problems. In both cases Workshops would then serve to foster the formation of diverse interdisciplinary research communities in a common discussion while enabling the exploration of a broad variety of ideas and approaches.

- *Shared Publications*: Joint publications, particularly edited books and special issues of peer-reviewed journals, provide a unique forum within which representatives from different Federal departments and agencies collectively pose far-reaching questions, address specific R&D concerns and seek insight on solutions to unique challenges from their colleagues. Importantly, these media provide an enduring, and public, record of these R&D discussions which may in turn, enhance overall recognition of the challenges, solutions and applications of language and communication R&D across different strata of our Nation.
- *Social-Media Enabled “Collaboratories”*: Similarly, digitally-based spaces allow for real-time collaboration between colleagues. This interconnectedness enables researchers, analysts, programmers, and policy makers to gain insight into what their counterparts across Government and Industry are currently involved, where they may be able to leverage their colleagues’ R&D, and to ensure that R&D efforts across the Government are complimentary, rather than duplicative. Already, the DoD has created such “*collaboratories*”, both internally and externally facing (e.g. Techipedia and the DoD Innovation Marketplace, respectively). A potential application for this type of space lies in facilitating collaborations. For instance, one agency or department might want to do a certain type of research but lacks the necessary funds, while another agency or department has the ability to do this research but might not currently be focusing on this research area. By sharing their interests, needs, and capabilities, the two agencies or departments may be able to arrive at an approach that benefits both.

6.3 Top-down Approaches

“Top-down approaches” are a second way through which to move forward with the recommendations proposed in Section 5. Here, senior leadership would take an active role in driving the formation of collaborations. In order to facilitate these types of collaborations, the following approaches are suggested.

- *Harmonized R&D Policies*: While not captured explicitly in the Taxonomy, a common theme underlying efforts to develop the Taxonomy was the recognition that different departments and agencies have vastly different policies concerning funding language and communication R&D. This includes: how R&D funds are obtained, how they are expended and how they are tracked. In order for cross-agency collaborations to be effective (or, in many cases, possible) harmonization of policies underlying these processes should take place.
- *Joint R&D Program Announcements*: A natural follow-on to harmonizing R&D policies is the potential for establishing cross-agency or Joint R&D program announcements. These announcements could be tailored in a way that optimizes each department’s or agency’s

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R&D strengths, leverages each department's or agency's past R&D successes, and focuses on a combined set of R&D gaps that together address multiple needs across multiple departments and agencies. As an example, the DoD has developed an overarching framework, called Reliance 21²³, for a Science & Technology (S&T) joint planning and coordination process that brings together experts in the Department's technical domains from across the Services and Agencies "to coordinate and align S&T efforts against capability gaps, and jointly communicate their responses, exploiting synergies and potentially developing new opportunities"²⁴. The establishment of similar intra- and/or inter-Agency harmonization processes would enable success, across the Government, through increased information sharing and collaboration related to R&D efforts, ultimately leading to an increased value of investment for each participating Department or Agency.

- *Recharter the Inter-agency Language and Communication Working Group (IWGLC):* Rechartering the IWGLC would enable the implementation and tracking of these recommendations. The IWGLC would work with the Subcommittee on Social, Behavioral and Economic Sciences to establish a regular cycle for reporting its progress.

7. Summary

With its charter in September 2013, the IWGLC was tasked with coordinating and making recommendations about the range of R&D programs and activities related to key topics of language and communication that are supported across the Federal agencies. In order to carry out that task the IWGLC charter specified five broad activities, including coordination and collaboration across agencies, providing an inventory of current programmatic activities related to S&T of language and communication, assessing the state of basic and applied research in this area based upon the information collected via the inventory, sharing those findings through a report, and providing programmatic recommendations of key areas of investment in R&D related to language and communication.

Beginning with its chartering in Fall 2013, the IWGLC has worked across twenty departments and agencies to describe the current Federal investment in language and communication research and development. As a group, the IWGLC invited briefings from all participating departments and agencies of the NSTC-SBE Subcommittee of the Committee on Science. Building on the knowledge gleaned from those briefings, the group developed a Taxonomy of Language and Communication R&D to provide a framework within which to summarize the Federal investment. Described in detail in Section 3.0, this unique Taxonomy identified four different content topics of research:

- Knowledge and Processes Underlying Language and Communication,
- Language Abilities/Skills,
- Using Language and Communication to Influence Behavior and Share Information, and
- Language and Communication Technologies.

In addition, the Taxonomy categorized these R&D activities into four major types of research:

²³ For more information on the Reliance 21 process, please see the [Reliance 21 Operating Principles](#) document.

²⁴ "Reliance 21 Operating Principles." (2014): 1. *Department of Defense Research & Engineering Enterprise: Reliance 21 an Operational Framework*. Assistant Secretary of Defense (Research & Engineering), Jan. 2014. Web. <<http://www.acq.osd.mil/chieftechnologist/publications/docs/Reliance21OpPrinciples-Jan2014.pdf>>.

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- Basic/foundational,
- Translational,
- Applied, and
- Implementation.

Using this Taxonomy, the IWGLC developed and administered a Language and Communication Inventory Survey to departments and agencies, to systematically collect information about current and ongoing R&D. Section 4.0 summarizes the results from the inventory survey, which illustrates the types of R&D that are being pursued by the various departments and agencies, across the range of foci and types of research. The analyses of the survey data also highlight the degree to which R&D activities are tightly linked to the specific missions of departments and agencies. Section 5.0 summarizes ongoing R&D needs in the areas of language documentation, language and communication regarding health and safety, language learning in the U.S., and language technologies. Section 6.0 provides a series of recommendations that, collectively, the IWGLC believes will further enhance the U.S.'s Language and Communication R&D efforts,

In brief, convening the IWGLC and carrying out the subsequent activities brought into sharp relief the broad scope of R&D related to language and communication, and highlighted the breadth of R&D investments across the Federal government. Members of the IWGLC noted the degree to which R&D efforts were delimited by mission-specific foci and indicated that there are forward-looking opportunities for the Federal community to build on the work being supported by their sister departments and agencies. The report concludes with several recommendations and strategies that allow the departments and agencies represented on the IWGLC to collectively address these critical ongoing needs and to leverage collaboration opportunities to build on ongoing and completed R&D. Implementing these recommendations and strategies will enhance our understanding of how to extend and apply Language and Communication R&D to improve individuals' quality of life; to facilitate more effective interactions between federal agencies and individual citizens; and to facilitate our Nation's role on the global stage.

LANGUAGE & COMMUNICATION

Annex I: Tables

Table 1. Overview of Language and Communication R&D by Department, Topic, and Type

		Knowledge and Processes	Abilities and Skills	Influence Behavior and Share Information	Technologies
Department of Commerce ¹	Basic/Foundational				
	Translational				
	Applied: Development				
	Applied: Evaluation				
	Implementation				
Department of Defense ²	Basic/Foundational				
	Translational				
	Applied: Development				
	Applied: Evaluation				
	Implementation				
Department of Education ³	Basic/Foundational				
	Translational				
	Applied: Development				
	Applied: Evaluation				
	Implementation				
Department of Justice ⁴	Basic/Foundational				
	Translational				
	Applied: Development				
	Applied: Evaluation				
	Implementation				
Department of Transportation	Basic/Foundational				
	Translational				
	Applied: Development				
	Applied: Evaluation				
	Implementation				
Health and Human Services ⁵	Basic/Foundational				
	Translational				
	Applied: Development				
	Applied: Evaluation				
	Implementation				
Nat'l Aeronautics and Space Administration	Basic/Foundational				
	Translational				
	Applied: Development				
	Applied: Evaluation				
	Implementation				
Nat'l Endowment for the Humanities	Basic/Foundational				
	Translational				
	Applied: Development				
	Applied: Evaluation				
	Implementation				
National Science Foundation	Basic/Foundational				
	Translational				
	Applied: Development				
	Applied: Evaluation				
	Implementation				
Department of Agriculture	Basic/Foundational				
	Translational				
	Applied: Development				
	Applied: Evaluation				
	Implementation				

Note: Shading represents a positive response from the Department/Agency.

¹NIST

²U.S. Air Force/AFRL, U.S. Army/ARI, U.S. Army/ARL, DARPA, DLIFLC,DLNSEO, U.S. Navy/ONR

³IES, OELA, OII, OSERS

⁴FBI, National Institute of Justice and Office of Juvenile Justice and Delinquency Prevention

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Table 2. Stakeholders of the Language and Communication Research and Development

	Your agency	Other federal agencies	Policymakers	Scientific community/researchers	Private sector	General public	Specific groups	Individuals or entities from other countries	Other
Department of Commerce ¹									
Department of Defense ²									
Department of Education ³									
Department of Justice ⁴									
Department of Transportation									
Health and Human Services ⁵									
Nat'l Aeronautics and Space Administration									
Nat'l Endowment for the Humanities									
National Science Foundation									
Department of Agriculture									

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Table 3. Knowledge and Processes Underlying Language and Communication: Subtopics

	Linguistics	Characteristics of spoken/ written language	Characteristics of signed languages	Language variation and change	Biological, neurobiological, and cognitive basis of language	Human language processing	Gesture, visual cues, other non-verbals	Language acquisition: Primary language	Language acquisition: Secondary language	Simultaneous language acquisition	Developmental disorders/ delays	Acquired deficits
Department of Commerce ¹												
Department of Defense ²												
Department of Education ³												
Department of Justice ⁴												
Department of Transportation												
Health and Human Services ⁵												
Nat'l Aeronautics and Space Administration												
Nat'l Endowment for the Humanities												
National Science Foundation												
Department of Agriculture												

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Table 4. Knowledge and Processes Underlying Language and Communication: Participants of the Research

	Birth - pre-K students	K-12 students	Undergraduate students	Graduate students	Adult education students	Career/workforce trainees	Operators/users	Infants	Children	Young Adults	Adults	Older Adults	Individuals from underrepresented groups	General public	Other
Department of Commerce ¹															
Department of Defense ²															
Department of Education ³															
Department of Justice ⁴															
Department of Transportation															
Health and Human Services ⁵															
Nat'l Aeronautics and Space Administration															
Nat'l Endowment for the Humanities															
National Science Foundation															
Department of Agriculture															

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Table 5. Language and Communication Abilities and Skills: Subtopics

	Reading and Writing	Oral/verbal skills	Aural/listening skills	Disorders and delays	English as a second language	Foreign languages: Low/no-resource languages	Foreign languages: Major world languages	Foreign languages: Endangered languages	Teacher preparation and professional development	Assessments	Strategies for initial instruction of language	Strategies for maintenance of language	Instructional tools, materials, curricula, etc.	Bilingual and English as a second language policy	Educational opportunities for children with disabilities
Department of Commerce ¹															
Department of Defense ²															
Department of Education ³															
Department of Justice ⁴															
Department of Transportation															
Health and Human Services ⁵															
Nat'l Aeronautics and Space Administration															
Nat'l Endowment for the Humanities															
National Science Foundation															
Department of Agriculture															

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Table 6. Language and Communication Abilities and Skills: Participants of the Research

	Birth - pre-K students	K-12 students	Undergraduate students	Graduate students	Adult education students	Career/workforce trainees	Operators/users	Infants	Children	Young Adults	Adults	Older Adults	Individuals from underrepresented groups	General public	Other
Department of Commerce ¹															
Department of Defense ²															
Department of Education ³															
Department of Justice ⁴															
Department of Transportation															
Health and Human Services ⁵															
Nat'l Aeronautics and Space Administration															
Nat'l Endowment for the Humanities															
National Science Foundation															
Department of Agriculture															

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**Table 7. Using Language and Communication to Influence Behavior and Share Information:
Subtopics**

	Managing risk/safety: Health	Managing risk/safety: Environment	Managing risk/safety: Transportation	Managing risk/safety: Existential threats	Diplomacy	Negotiation, persuasion, influence	Language and the law	Behavioral economics	Language/communication aspects of social networks, group dynamics	Cross-cultural communication	Specialized language (e.g., veterinary care, battlefield medicine)	Outreach and transfer of research findings	Social media and internet communication/new literacies
Department of Commerce ¹													
Department of Defense ²													
Department of Education ³													
Department of Justice ⁴													
Department of Transportation													
Health and Human Services ⁵													
Nat'l Aeronautics and Space Administration													
Nat'l Endowment for the Humanities													
National Science Foundation													
Department of Agriculture													

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Table 8. Using Language and Communication to Influence Behavior and Share Information: Participants of the Research

	Birth - pre-K students	K-12 students	Undergraduate students	Graduate students	Adult education students	Career/workforce trainees	Operators/users	Infants	Children	Young Adults	Adults	Older Adults	Individuals from underrepresented groups	General public	Other
Department of Commerce ¹															
Department of Defense ²															
Department of Education ³															
Department of Justice ⁴															
Department of Transportation															
Health and Human Services ⁵															
Nat'l Aeronautics and Space Administration															
Nat'l Endowment for the Humanities															
National Science Foundation															
Department of Agriculture															

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Table 9. Language and Communication Technologies: Subtopics

	Hardware	Interaction including user input and output to the user	Supporting accessibility for people with disabilities	Non-linguistic communication	Collaborative tools, computer-supported cooperative work	Social media	Crowd sourcing	Parallel text development	Automated language translation technologies	Pronunciation feedback programs	Text-complexity/readability/text leveling analysis	Assessing language proficiency of individuals	Computer-based tutoring and testing	Speech analysis/recognition	Language and dialect information	Speaker and language analysis/recognition	Handwriting and text recognition	Natural language processing
Department of Commerce ¹																		
Department of Defense ²																		
Department of Education ³																		
Department of Justice ⁴																		
Department of Transportation																		
Health and Human Services ⁵																		
Nat'l Aeronautics and Space Administration																		
Nat'l Endowment for the Humanities																		
National Science Foundation																		
Department of Agriculture																		

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Table 10. Language and Communication Technologies: Participants of the Research

	Birth - pre-K students	K-12 students	Undergraduate students	Graduate students	Adult education students	Career/workforce trainees	Operators/users	Infants	Children	Young Adults	Adults	Older Adults	Individuals from underrepresented groups	General public	Other
Department of Commerce ¹															
Department of Defense ²															
Department of Education ³															
Department of Justice ⁴															
Department of Transportation															
Health and Human Services ⁵															
Nat'l Aeronautics and Space Administration															
Nat'l Endowment for the Humanities															
National Science Foundation															
Department of Agriculture															

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Annex II: Taxonomy

*The Inventory should cover all research on language and communication investments throughout the Federal Government (including both extramural and intramural funding programs). There are multiple **levels/types** of research and development, so the top level of the Taxonomy for the inventory should include:*

Research on Language and Communication

- Types of research
 - Basic/foundational research
 - Research that focuses on identifying new principles or phenomena that may then be expanded upon through other types of research
 - Translational
 - Research that bridges gap between basic/foundational and applied research; integrates findings from basic science into a theoretical framework that is oriented toward more applied research questions and is meant to serve as the foundation for the development, evaluation, and implementation of tools, programs, etc.
 - Applied research
 - Development of products, tools, interventions, programs, assessments, etc.
 - Evaluation of products, tools, interventions, programs, assessments, etc.
 - Implementation research/science
 - Research and development on the implementation of products, programs, etc.
 - Sustainability research

*Within each type of research (and likely spanning multiple types of research) are four broad **domains** of research, which are expanded below: (1) research on knowledge and processes underlying language and communication; (2) research on language abilities/skills; (3) research on using language and communication to influence behavior and share information; and (4) research on language and communication technologies.*

- Research and development on: Knowledge and Processes Underlying Language and Communication
 - Language structure
 - Linguistics (socio-, psycho-, and computational linguistics)
 - Characteristics of spoken/written languages (e.g. syntax, morphology, semantics)
 - Characteristics of signed languages (e.g. syntax, morphology, semantics)
 - Language variation and change (including as influenced by social or technological factors)
 - Language and communication processes
 - Biological, neuro-biological, and cognitive basis of language
 - Human language processing
 - Gesture, visual cues, other non-verbals in language-based communication

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- Language acquisition (defined as implicit attainment of language without formal instruction)
 - Primary language
 - Secondary language
 - Simultaneous language acquisition (AKA bilingual language acquisition)
- Language deficits or impairments
 - Developmental disorders or delays
 - Acquired deficits
- Research and development on: Language and Communication Abilities/Skills
 - Learning language skills (defined as the acquisition of these skills through explicit instruction)
 - Primary language
 - Reading and writing
 - Oral/verbal skills
 - Aural/listening skills
 - Language and communication disorders and delays
 - English as a second language
 - Foreign language
 - Low/No-resource languages
 - Major world languages
 - Endangered languages
 - Teaching and assessing language skills
 - Teacher preparation and professional development
 - Assessments
 - Instruction
 - Strategies for initial instruction of language
 - Strategies for maintenance of language
 - Instructional tools, materials, curricula, etc.
 - Policy
 - Bilingual and English as a second language policy
 - Educational opportunities for children with disabilities (IDEA/special education policy)
- Research and development on: Research on Using Language and Communication to Influence Behavior and Share Information
 - Modifying/influencing behavior
 - Managing risk/safety through better communication
 - Health
 - Environment
 - Transportation
 - Existential threats
 - Diplomacy
 - Negotiation, persuasion, influence
 - Language and the law
 - Behavioral economics

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- Sharing of information in social contexts
 - Language/communication aspects of social networks, group dynamics
 - Cross cultural communication
 - Specialized language (e.g. veterinary care, battlefield medicine)
 - Outreach and transfer of research findings
 - Social media and internet communication/new literacies
- Research and development on: Language and Communication Technologies
 - User interface/interaction technology
 - Hardware
 - Interaction including both user input and output to the user
 - Supporting accessibility for people with disabilities or in special environments
 - Technology to support human-to-human communication
 - Collaborative tools, computer-supported cooperative work
 - Social media
 - Crowd sourcing
 - Non-linguistic communication (gesture, visual-based cues, etc.)
 - Machine translation
 - Parallel text development
 - Automated language translation technologies
 - Language education support using Human Language Technologies
 - Pronunciation feedback programs
 - Text-complexity/readability/text leveling analysis
 - Assessing language proficiency of individuals (including spoken, written, etc. language proficiency)
 - Computer-based tutoring and testing
 - Automated analysis/recognition of spoken language
 - Speech analysis/recognition (speech recognition/transcription, prosodic analysis, emotion analysis)
 - Language and dialect information
 - Speaker and language analysis/recognition
 - Automated analysis/recognition of written language
 - Text analysis/recognition: Handwriting and text recognition (USPS Zip Code readers, etc.)
 - Natural Language Processing (extraction, summarization, search, filtering, clustering, knowledgebase creation, etc.)

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Annex III: Briefings Presented to the IWGLC

Representatives of the following offices/agencies/departments presented briefings to the IWGLC on the language and communication R&D activities and needs of their office/agency/department:

Food and Drug Administration

National Institutes of Health

Institute of Education Sciences, Department of Education

Office of Naval Research, U.S. Navy

National Science Foundation

U.S. Army Research Laboratory, U.S. Army

National Institute of Standards and Technology, Department of Commerce

Department of Agriculture

Defense Language Institute Foreign Language Center, Department of Defense

Department of Homeland Security

Defense Advanced Research Projects Agency, Department of Defense

Intelligence Advanced Research Projects Activity

Defense Intelligence Agency

National Endowment for the Humanities

Department of State

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

Defense Language and National Security Education Office

Annex IV: Language and Communication Resources

Institute of Education Sciences, U.S. Department of Education (<http://ies.ed.gov>)

The Institute's mission is to provide rigorous and relevant evidence on which to ground education practice and policy and share this information broadly. By identifying what works, what doesn't, and why, we aim to improve educational outcomes for all students, particularly those at risk of failure.

- Funding Opportunities (<http://ies.ed.gov/funding>)
- Database of Funded Projects (<http://ies.ed.gov/funding/grantsearch/index.asp>)
- What Works Clearinghouse (<http://ies.ed.gov/ncee/wwc/>)

National Science Foundation (<http://www.nsf.gov/>)

NSF's mission and purpose is to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes.

NSF is authorized and directed (by Public Law 81-507) to initiate and support: (1) basic and applied scientific research and research fundamental to the engineering process; (2) programs to strengthen scientific and engineering research potential; (3) science and engineering education programs at all levels and in all the various fields of science and engineering; and (4) programs that provide a source of information for policy formulation, and other activities to promote these ends.

National Endowment for the Humanities (<http://www.neh.gov/>)

Because democracy demands wisdom, NEH serves and strengthens our republic by promoting excellence in the humanities and conveying the lessons of history to all Americans.

- NEH Grant Opportunities (<http://www.neh.gov/grants>)
- NEH Database of Funded Projects (<https://securegrants.neh.gov/publicquery/main.aspx>)

National Institutes of Health, Department of Health and Human Services (<http://www.nih.gov/>)

NIH's mission is to seek fundamental knowledge about the nature and behavior of living systems and the application of that knowledge to enhance health, lengthen life, and reduce illness and disability.

- List of NIH Institutes and Centers (<http://www.nih.gov/about/almanac/organization/index.htm>)
- MEDLINE/PubMed (<http://www.ncbi.nlm.nih.gov/pubmed/>)
- NIH Plain Language Overview (<http://www.nih.gov/clearcommunication/plainlanguage/index.htm>)
- NIH Plain Language Training (<http://plainlanguage.nih.gov/CBTs/PlainLanguage/login.asp> and <http://www.nih.gov/clearcommunication/plainlanguage/gettingstarted/index.htm>)
- NIH Senior Health (<https://nihseniorhealth.gov/>)
- OppNet Basic Behavioral & Social Science Opportunity Network (<http://oppnet.nih.gov/>)

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- NIH Office of Behavioral and Social Sciences Research (<https://obssr.od.nih.gov/index.aspx>)

Office of Director of National Intelligence (<http://www.dni.gov/>)

- Foreign Language Program Office (<http://www.dni.gov/index.php/about/organization/foreign-language>)

The mission of the intelligence community (IC) foreign language organization is to improve the foreign language capability of the IC workforce. The Foreign Language Program Office (FLPO) promotes higher foreign language proficiency, deepens cultural understanding among workforce professionals who use language in their work, and works to integrate language technology and document translation techniques to maximize effectiveness. FLPO defines, measures, and tracks IC foreign language capabilities and readiness against mission objectives across the IC.

- Government Catalog of Language Resources (<https://www.intelink.gov/gclr/>)

The GCLR is a catalog of resources to improve the language capabilities of humans and machines. Includes language data, dictionaries, glossaries, translation memories – resources especially useful in building automated language processing and translation systems. (Requires CAC or Federal PIV access)

- National Foreign Language Center (<http://www.nflc.umd.edu/>)

The National Foreign Language Center (NFLC) is dedicated to promoting a language-competent society by developing and disseminating information that informs policy makers. The mission of the NFLC is to improve the capacity of the U.S. to communicate in languages other than English. We implement that mission through intensive and innovative strategic planning and development with globalized institutions, organizations, and enterprises throughout the U.S..

- LangSource (<http://www.langsource.umd.edu/>)

Sponsored by The National Foreign Language Center, LangSource is a searchable, annotated bibliographic database of language and culture resources. LangSource can be used by both teachers and learners at all levels in a variety of languages. The LangSource catalogue offers resources in Arabic, Chinese, German, Hausa, Hindi, Japanese, Korean, Quechua, Spanish, Tamil, and Yoruba.

U.S. Department of Defense (www.defense.gov)

- Defense Language Institute Foreign Language Center (<http://dliflc.edu/>)

The DLIFLC provides language training and has robust research and evaluation component charged in part with designing, conducting, coordinating, and reporting on applied research in foreign language learning.

- Publishes academic journals: Applied Language Learning; Dialog on Language Instruction, etc.: <http://dliflc.edu/dliflc-publications/>
- DLIFLC Language Schools (<http://dliflc.edu/language-schools/>)
- Continuing Education Directorate (<http://dliflc.edu/continuing-education/>)
- Basic Skills - Language and Culture (<http://dliflc.edu/products/>)

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- Language Proficiency Assessment Directorate (<http://dliflc.edu/evaluation-standardization/>)
- DLIFLC Resources (<http://dliflc.edu/resources/>)
- Defense Language and National Security Education Office (<http://www.cultureready.org>)

The Defense Language and National Security Education Office leads the nation in recruiting, training, sustaining, and enhancing language and culture capabilities to ensure national security and defense readiness by:

 - Building a highly-qualified pool of U.S. citizens with foreign language and international expertise committed to public service through programs and policies,
 - Leading the Department's strategic policy planning regarding foreign language, culture, and regional expertise for Department of Defense personnel,
 - Providing oversight of high-value training and education Department of Defense initiatives, and
 - Ensuring national and Departmental governance through the Defense Language Steering Committee, the National Security Education Board, and other organizational and professional bodies.
- Center for Advanced Study of Language (<http://www.casl.umd.edu/>)

The Center for Advanced Study of Language (CASL), a DoD University Affiliated Research Center (UARC), It is the first and only national resource dedicated to addressing the language needs of the Intelligence Community (IC). CASL's overarching mission is to defend and protect our country by improving our language readiness and capabilities through research in languages, linguistics, psychology, computer science, and second language acquisition.

U.S. Department of State (www.state.gov)

The Mission of State is to create a more secure, democratic, and prosperous world for the benefit of the American people and the international community.

- Embassy Science Fellows Program, 2014 (<https://max.omb.gov/community/display/STATE/2014+Embassy+Science+Fellows>)
- Embassy Science Fellows Program, 2013 (<https://max.omb.gov/community/display/STATE/2013+Embassy+Science+Fellows+Program>)

U.S. Department of Transportation (<http://www.dot.gov/>)

- Volpe Center (<http://www.volpe.dot.gov/>)

Part of the U.S. Department of Transportation, Volpe is a unique federal agency that is 100 percent funded by sponsor projects. Volpe partners with public and private organizations to assess the needs of the transportation community, evaluate research and development endeavors, assist in the deployment of state-of-the-art transportation technologies, and inform decision and policy making through our comprehensive analyses.
- US DOT Research Hub (<http://ntlsearch.bts.gov/researchhub/index.do>)

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A searchable database of the latest USDOT-sponsored research, development and technology projects.

National Institute of Standards and Technology, U.S. Department of Commerce
(<http://www.commerce.gov>)

NIST's mission is to To promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life.

- Information Access Technology Division (<http://www.nist.gov/itl/iad/>)

LANGUAGE & COMMUNICATION

Annex V: Inventory Survey

Inventory of Federal Language and Communication Research and Development

Introduction

The Interagency Working Group on Language and Communication (IWGLC) was established by the President's National Science and Technology Council's (NSTC) Committee on Science (CoS). The IWGLC is chartered to coordinate, inventory, and make recommendations about the range of research and development (R&D) efforts related to language and communication that are supported across the Federal Government.

The purpose of this survey is to identify the range of activities supported across the Federal agencies and departments that relate to the intersecting domains of language and communication. From this survey we hope to learn:

- What research your agency supports with regard to language and communication
- How these activities fit with your agency's mission and goals
- What benefits these activities will provide for society and the nation
- What additional research and/or technology development relating to language and communication is needed for your agency to achieve its goals

Please complete the survey by November 7, 2014.

You should feel free to send this survey to as many individuals in your organization or agency that you feel can contribute to the survey. Each respondent can submit their responses individually, and the IWGLC will aggregate responses to the Department or agency level. You may distribute this fillable PDF to offices within your agency if it is necessary to aggregate or approve offices' responses to the survey before submitting them to the IWGLC. Please return the completed survey to Erin Higgins at Erin.Higgins@ed.gov.

The second page of this document is a list of definitions to which you should refer when completing the survey.

Contact

If you have questions or difficulties completing the questionnaire, please contact Erin Higgins at Erin.Higgins@ed.gov.

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LANGUAGE & COMMUNICATION

Definitions

Before you begin, please read the following definitions carefully to determine whether you need to complete the survey.

Language and Communication: For the purpose of this survey, we take the term **language** to refer, most generally, to a system that enables humans to encode an unbounded range of meanings and concepts in spoken, written, or signed expressions. Please consider both English and other languages (e.g. French, Arabic, and non-verbal languages such as American Sign Language).

Communication refers to the myriad acts one can perform through the use of language and associated facial expressions and gestures: to convey information; to issue a command or request; to make a promise, offer encouragement, take an oath, or tell a lie. Language is used to communicate with other humans, but human natural language may also be used to engage in a variety of human-computer interactions (such as those involving user interface technology, machine translation, and automated analysis of speech, to name just a few). Communication can also be accomplished through the use of symbols, icons, graphics, and other semiotic elements.

Language and Communication Research and Development (LCRD): For the purposes of this inventory, Language and Communication Research and Development (LCRD) refers to: (1) a systematic study directed toward fuller scientific knowledge or understanding of language and/or communication; and (2) the systematic use of knowledge and understanding of language and communication gained from research directed toward the production of useful materials, devices, systems, or methods.

Examples include:

- Studying the properties of human language and communication
- Understanding language and communication disorders
- Developing adaptive language training technologies

Types of efforts in which the IWGLC is not interested include:

- Non-human language and communication (e.g. radio/satellite transmission, animal communication etc.)
- Biological signaling and communication (e.g. neurotransmission, cell-based signal transduction pathways)
- Delivery of language instruction or programs
- Classified research and development activities

We recognize that organizations, agencies, and departments may have different definitions of a program. For the purposes of this survey, we ask you to use the definition that makes the most sense for your agency. Please note, however, that we'd like you to consider those research and development activities that are

Currently funded: efforts for which the programmed funding is being spent now

- **AND/OR**

Recently completed: going as far back as 2009, efforts for which associated funding is entirely expended (spent)

- **AND/OR**

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Targets of anticipated future funding: efforts for which funding is programmed in FY14 or beyond, but that have not yet started spending money

[PAGE BREAK]

Section 1: Language and Communication Research and Development (LCRD) Background Information

Please provide the requested background information on the language and communication research and development (LCRD activities).

1. Agency: _____
2. Sub Agency: _____
3. Does your agency conduct or support/fund/manage research and development activities that relate to language and communication (please refer to the definitions in your email invitation)?
 - Yes
 - No

→ If you answered “Yes”, continue to question 4

→ If you answered “No”, skip to the top of page 21.

4. How does your agency label R&D activities in general (e.g. 6.1, 6.2, etc.; CFDA, program names)?

5. Given your answer to the previous item, what label does your agency use to refer to its LCRD activities?

6. If your response to the previous question does not sufficiently describe the LCRD activities of your agency, please give a brief description of the LCRD and its objectives.

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Please provide the name and contact information for the person submitting this survey on behalf of your agency.

7. Name: _____
8. Email: _____
9. Office phone: _____

[PAGE BREAK]

Section 2: Language and Communication Research and Development Activities

10. Does your agency conduct or support/fund/manage LCRD? (check all that apply)

- My agency conducts LCRD
- My agency supports/funds/manages LCRD
- Neither

→ If you answered “Neither”, skip to the top of page 21. Otherwise, continue to next page.

[PAGE BREAK]

On the following pages, you will have the opportunity to indicate the domains or topics of LCRD which your agency conducts or supports/funds/manages. There are four domains: (1) research on knowledge and processes underlying language and communication; (2) research on language abilities/skills; (3) research on using language and communication to influence behavior and share information; and (4) research on language and communication technologies. You will also be asked a series of follow-up questions under each domain regarding the type or level of research, the participants in the research, and whether the research is completed, ongoing, or the target of future research.

[PAGE BREAK]

Does your agency conduct or support/fund/manage research and development on any of the following topics related to **knowledge and processes underlying language and communication**? (check all that apply on this page)

11. Language structure

- Linguistics (including socio-, psycho-, and computational linguistics)
- Characteristics of spoken/written languages (e.g. syntax, morphology, semantics)
- Characteristics of signed languages (e.g. syntax, morphology, semantics)

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- Language variation and change (including as influenced by social or technological factors)

12. Language and communication processes

- Biological, neuro-biological, and cognitive basis of language
- Human language processing
- Gesture, visual cues, other non-verbals in language-based communication
- Language acquisition: Primary language
- Language acquisition: Secondary language
- Language acquisition: Simultaneous language acquisition (AKA bilingual language acquisition)

13. Language deficits or impairments

- Developmental disorders or delays
- Acquired deficits

14. If there are other LCRD activities your agency conducts or supports/funds/manages that relate to knowledge and processes underlying language and communication but which are not captured above, please provide a brief description of those activities.

15. If your agency does not conduct or support/fund/manage research and development on any of the above, please check here:

- None of the above

→ If you checked the box above, “None of the above”, skip to the top of page 9.

[PAGE BREAK]

The following are questions regarding your agency’s research and development activities on topics related to **knowledge and processes underlying language and communication**.

16. What types of research and development objectives are the focus of your agency’s language and communication activities related to **knowledge and processes underlying language and communication**? (check all that apply)

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- Basic/foundational research (Research that focuses on identifying new principles or phenomena that may then be expanded upon through other types of research)
- Translational research (Research that bridges the gap between basic/foundational and applied research; integrates findings from basic science into a theoretical framework that is oriented toward more applied research questions and is meant to serve as the foundation for the development, evaluation, and implementation of tools, programs, etc.)
- Applied research: Development of products, tools, interventions, programs, assessments, etc.
- Applied research: Evaluation of products, tools, interventions, programs, assessments, etc.
- Implementation research/science: Research and development on the implementation of products, programs, etc., and sustainability research

17. Is this research currently funded, recently completed, or the target of anticipated future funding?

- Currently funded: efforts for which the programmed funding is being spent now
- Recently completed: going as far back as 2009, efforts for which associated funding is entirely expended (spent)
- Anticipated future funding: efforts for which funding is programmed in FY14 or beyond, but that have not yet started spending money

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18. Who are the participants/subjects in the research and development activities on knowledge and processes underlying language and communication? (check all that apply)

- Birth through pre-kindergarten students
- K-12 students
- Undergraduate students
- Graduate students (Masters or above)
- Adult education students
- Career/Workforce trainees
- Operators/users (e.g. pilots, air traffic controllers, soldiers)
- Infants
- Children
- Young adults
- Adults
- Older adults
- Individuals from underrepresented groups (i.e. individuals from underrepresented racial or ethnic groups; individuals with disabilities; and

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individuals from economically, socially, culturally, or educationally disadvantaged backgrounds)

- General public
- Other

19. If you answered "Career/Workforce trainees" or "Operators/users" to the question above, please specify the role of the individuals (e.g. soldiers, health practitioners, air traffic controllers).

20. If you answered "Other" to the question above, please indicate what groups are the target of your agency's LCRD.

[PAGE BREAK]

Does your agency conduct or support/fund/manage research and development on any of the following topics related to **language and communication abilities/skills**? (check all that apply on this page)

21. Learning language skills (defined as the acquisition of these skills through explicit instruction)

- Primary language: Reading and writing
- Primary language: Oral/verbal skills
- Primary language: Aural/listening skills
- Language and communication disorders and delays
- English as a second language
- Foreign language: Low/No-resource languages
- Foreign language: Major world languages
- Foreign language: Endangered languages

22. Teaching and assessing language skills

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- Teacher preparation and professional development
- Assessments
- Instruction: Strategies for initial instruction of language
- Instruction: Strategies for maintenance of language
- Instruction: Instructional tools, materials, curricula, etc.
- Policy: Bilingual and English as a second language policy
- Policy: Educational opportunities for children with disabilities (IDEA/special education policy)

23. If there are other LCRD activities your agency conducts or supports/funds/manages that relate to language and communication abilities/skills but which are not captured above, please provide a brief description of those activities.

24. If your agency does not conduct or support/fund/manage research and development on any of the above, please check here:

- None of the above

→ If you checked the box above, “None of the above”, skip to the top of page 12.

[PAGE BREAK]

The following are questions regarding your agency’s research and development activities on topics related to **language and communication abilities/skills**.

25. What types of research and development objectives are the focus of your agency’s language and communication activities related to **language and communication abilities/skills**? (check all that apply)

- Basic/foundational research (Research that focuses on identifying new principles or phenomena that may then be expanded upon through other types of research)
- Translational research (Research that bridges the gap between basic/foundational and applied research; integrates findings from basic science into a theoretical framework that is oriented toward more applied research questions and is meant to serve as the foundation for the development, evaluation, and implementation of tools, programs, etc.)

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- Applied research: Development of products, tools, interventions, programs, assessments, etc.
- Applied research: Evaluation of products, tools, interventions, programs, assessments, etc.
- Implementation research/science: Research and development on the implementation of products, programs, etc., and sustainability research

26. Is this research currently funded, recently completed, or the target of anticipated future funding?

- Currently funded: efforts for which the programmed funding is being spent now
- Recently completed: going as far back as 2009, efforts for which associated funding is entirely expended (spent)
- Anticipated future funding: efforts for which funding is programmed in FY14 or beyond, but that have not yet started spending money

27. Who are the participants/subjects in the research and development activities on language and communication abilities/skills? (check all that apply)

- Birth through pre-kindergarten students
- K-12 students
- Undergraduate students
- Graduate students (Masters or above)
- Adult education students
- Career/Workforce trainees
- Operators/users (e.g. pilots, air traffic controllers, soldiers)
- Infants
- Children
- Young adults
- Adults
- Older adults
- Individuals from underrepresented groups (i.e. individuals from underrepresented racial or ethnic groups; individuals with disabilities; and individuals from economically, socially, culturally, or educationally disadvantaged backgrounds)
- General public
- Other

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28. If you answered “Career/Workforce trainees” or “Operators/users” to the question above, please specify the role of the individuals (e.g. soldiers, health practitioners, air traffic controllers).

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29. If you answered “Other” to the question above, please indicate what groups are the target of your agency’s LCRD.

[PAGE BREAK]

Does your agency conduct or support/fund/manage research and development on any of the following topics related to **using language and communication to influence behavior and share information**? (check all that apply on this page)

30. Modifying/influencing behavior

- Managing risk/safety through better communication: Health
- Managing risk/safety through better communication: Environment
- Managing risk/safety through better communication: Transportation
- Managing risk/safety through better communication: Existential threats
- Diplomacy
- Negotiation, persuasion, influence
- Language and the law
- Behavioral economics

31. Sharing of information in social contexts

- Language/communication aspects of social networks, group dynamics
- Cross cultural communication
- Specialized language (e.g. veterinary care, battlefield medicine)
- Outreach and transfer of research findings
- Social media and internet communication/new literacies

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32. If there are other LCRD activities your agency conducts or supports/funds/manages that relate to using language and communication to influence behavior and share information but which are not captured above, please provide a brief description of those activities.

33. If your agency does not conduct or support/fund/manage research and development on any of the above, please check here:

- None of the above

→ If you checked the box above, “None of the above”, skip to the top of page 15.

[PAGE BREAK]

The following are questions regarding your agency’s research and development activities on topics related to **using language and communication to influence behavior and share information**.

34. What types of research and development objectives are the focus of your agency’s language and communication activities related to **using language and communication to influence behavior and share information**? (check all that apply)

- Basic/foundational research (Research that focuses on identifying new principles or phenomena that may then be expanded upon through other types of research)
- Translational research (Research that bridges the gap between basic/foundational and applied research; integrates findings from basic science into a theoretical framework that is oriented toward more applied research questions and is meant to serve as the foundation for the development, evaluation, and implementation of tools, programs, etc.)
- Applied research: Development of products, tools, interventions, programs, assessments, etc.
- Applied research: Evaluation of products, tools, interventions, programs, assessments, etc.
- Implementation research/science: Research and development on the implementation of products, programs, etc., and sustainability research

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35. Is this research currently funded, recently completed, or the target of anticipated future funding?

- Currently funded: efforts for which the programmed funding is being spent now
- Recently completed: going as far back as 2009, efforts for which associated funding is entirely expended (spent)
- Anticipated future funding: efforts for which funding is programmed in FY14 or beyond, but that have not yet started spending money

36. Who are the participants/subjects in the research and development activities on using language and communication to influence behavior and share information? (check all that apply)

- Birth through pre-kindergarten students
- K-12 students
- Undergraduate students
- Graduate students (Masters or above)
- Adult education students
- Career/Workforce trainees
- Operators/users (e.g. pilots, air traffic controllers, soldiers)
- Infants
- Children
- Young adults
- Adults
- Older adults
- Individuals from underrepresented groups (i.e. individuals from underrepresented racial or ethnic groups; individuals with disabilities; and individuals from economically, socially, culturally, or educationally disadvantaged backgrounds)
- General public
- Other

37. If you answered "Career/Workforce trainees" or "Operators/users" to the question above, please specify the role of the individuals (e.g. soldiers, health practitioners, air traffic controllers).

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38. If you answered "Other" to the question above, please indicate what groups are the target of your agency's LCRD.

[PAGE BREAK]

Does your agency conduct or support/fund/manage research and development on any of the following topics related to **language and communication technologies**? (check all that apply on this page)

39. User interface/interaction technology

- Hardware
- Interaction including both user input and output to the user
- Supporting accessibility for people with disabilities or in special environments
- Non-linguistic communication (gesture, visual-based cues, etc.)

40. Technology to support human-to-human communication

- Collaborative tools, computer-supported cooperative work
- Social media
- Crowd sourcing

41. Machine translation

- Parallel text development
- Automated language translation technologies

42. Language education support using Human Language Technologies

- Pronunciation feedback programs
- Text-complexity/readability/text leveling analysis
- Assessing language proficiency of individuals (including spoken, written, language proficiency)
- Computer-based tutoring and testing

43. Automated analysis/recognition of spoken language

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- Speech analysis/recognition (speech recognition/transcription, prosodic analysis, emotion analysis)
- Language and dialect information
- Speaker and language analysis/recognition

44. Automated analysis/recognition of written language

- Text analysis/recognition: Handwriting and text recognition (USPS Zip Code readers, etc.)
- Natural Language Processing (extraction, summarization, search, filtering, clustering, knowledgebase creation, etc.)

45. If there are other LCRD activities your agency conducts or supports/funds/manages that relate to language and communication technologies but which are not captured above, please provide a brief description of those activities.

•
46. If your agency does not conduct or support/fund/manage research and development on any of the above, please check here:

- None of the above

→ If you checked the box above, “None of the above”, skip to the top of page 19.

[PAGE BREAK]

The following are questions regarding your agency’s research and development activities on topics related to **language and communication technologies**.

47. What types of research and development objectives are the focus of your agency’s language and communication activities related to **language and communication technologies**? (check all that apply)

- Basic/foundational research (Research that focuses on identifying new principles or phenomena that may then be expanded upon through other types of research)
- Translational research (Research that bridges the gap between basic/foundational and applied research; integrates findings from basic science into a theoretical framework that is oriented toward more applied research)

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questions and is meant to serve as the foundation for the development, evaluation, and implementation of tools, programs, etc.)

- Applied research: Development of products, tools, interventions, programs, assessments, etc.
- Applied research: Evaluation of products, tools, interventions, programs, assessments, etc.
- Implementation research/science: Research and development on the implementation of products, programs, etc., and sustainability research

48. Is this research currently funded, recently completed, or the target of anticipated future funding?

- Currently funded: efforts for which the programmed funding is being spent now
- Recently completed: going as far back as 2009, efforts for which associated funding is entirely expended (spent)
- Anticipated future funding: efforts for which funding is programmed in FY14 or beyond, but that have not yet started spending money

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49. Who are the participants/subjects in the research and development activities on language technologies? (check all that apply)

- Birth through pre-kindergarten students
- K-12 students
- Undergraduate students
- Graduate students (Masters or above)
- Adult education students
- Career/Workforce trainees
- Operators/users (e.g. pilots, air traffic controllers, soldiers)
- Infants
- Children
- Young adults
- Adults
- Older adults
- Individuals from underrepresented groups (i.e. individuals from underrepresented racial or ethnic groups; individuals with disabilities; and individuals from economically, socially, culturally, or educationally disadvantaged backgrounds)
- General public
- Other

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50. If you answered "Career/Workforce trainees" or "Operators/users" to the question above, please specify the role of the individuals (e.g. soldiers, health practitioners, air traffic controllers).

51. If you answered "Other" to the question above, please indicate what groups are the target of your agency's LCRD.

[PAGE BREAK]

Section 3: General Information about LCRD Activities

The following questions pertain to all of your agency's research and development on language and communication, regardless of topic or type.

52. What types of institutions, organizations, or individuals are eligible for funding to implement LCRD activities? (check all that apply)

- Federally funded government laboratories and research centers
- Individuals
- Institutions of higher education
- Non-academic research organizations or institutions
- State, local, and tribal systems, agencies, and governments
- Non-profit and philanthropic institutions or organizations
- For-profit entities
- Small businesses
- Other government agencies
- Other
- Not applicable (including if your agency only conducts intramural LCRD)

53. If you answered "Other" to the question above, please specify what types of institutions, organizations, or individuals are eligible for funding.

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54. How is external funding allocated? (check all that apply)

- Formula (to government entities)
- Competitive (grants or contracts)
- Other
- Not applicable

55. If you answered "Other" to the question above, please specify how external funding is allocated.

56. Please provide an estimate of the amount Federal funding allocated to LCRD for the following time frames, if possible

Currently funded: efforts for which the programmed funding is being spent now

Recently completed: going as far back as 2009, efforts for which associated funding is entirely expended (spent) _____

Anticipated future funding: efforts for which funding is programmed in FY14 or beyond, but that have not yet started spending money _____

57. Who are the stakeholders of the language and communication research and development? (check all that apply)

- Your agency
- Other Federal agencies
- Policymakers
- Scientific community/researchers
- Private sector
- General public
- Specific group(s) (e.g. students, soldiers, health practitioners)
- Individuals or entities in other countries
- Other

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58. If you answered "Specific group(s)" to the question above, please identify the stakeholders of your agency's LRCD.

59. If you answered "Other" to the question above, please identify the stakeholders of your agency's LRCD.

[PAGE BREAK]

60. Please identify any gaps in LCRD that, if filled, would be critical for your agency.

61. Please identify any gaps in LCRD that, if filled, would be critical at the national level.

Thank you for the time and effort it took to complete this inventory survey. The IWGLC anticipates submitting the final report to the NSTC, including the results of this inventory survey, no later than October 31, 2015. You may contact Erin Higgins (Erin.Higgins@ed.gov) for more information.

Annex VI: Abbreviations

ARI	U.S. Army Research Institute for the Behavioral and Social Sciences
ARL	Army Research Laboratory
DARPA	Defense Advanced Research Projects Agency
DHS	Department of Homeland Security
DLIFLC	Defense Language Institute Foreign Language Center
DLNSEO	Defense Language and National Security Education Office
DoD	Department of Defense
DOT	Department of Transportation
ED	Department of Education
FBI	Federal Bureau of Investigation
FDA	Food and Drug Administration
HHS	Department of Health and Human Services
IWGLC	Interagency Working Group on Language and Communication
NASA	National Aeronautics and Space Administration
NEH	National Endowment for the Humanities
NIH	The National Institutes of Health
NIJ	National Institute of Justice
NIST	National Institute of Standards and Technology
NSF	National Science Foundation
NSTC	National Science and Technology Council
OII	Office of Innovation and Improvement
OJJDP	Office of Juvenile Justice and Delinquency Prevention
ONR	Office of Naval Research
OSERS	Office of Special Education and Rehabilitative Services
OSTP	Office of Science and Technology Policy
R&D	Research and Development
SBE	Social, Behavioral, and Economic sciences
State	Department of State
USDA	United States Department of Agriculture