some college educated, some not: and a small sample of non-disabled counterparts). The role that technology plays in these job-related social networks is also being studied. Phase II will investigate the roles of human capital, especially related to technology, and social capital needed for employment from an employer's perspective. Results from these two studies should inform vocational rehabilitation professionals, AAC consumers, and AAC manufacturers about skills and technology needed to improve employment outcomes for people who use AAC.

Continuing Education Questions

1. **Researchers in the area of AAC and employment are**
   a. investigating employment issues because of the low rate of employment for individuals who use AAC.
   b. primarily investigating employment issues for individuals with ALS.
   c. are developing and providing specific positions to individuals who use AAC.
   d. primarily investigating the employment of individuals with autism.
   e. none of the above.

2. **Studies related to employment issues include obtaining information from the following individuals:**
   a. Family members of individuals who use AAC
   b. Employers of individuals who use AAC
   c. Co-workers of individuals who use AAC
   d. Individuals who use AAC
   e. All of the above

Interface Design

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Several projects focus on interface design issues. Duke University has established a cooperative arrangement with the Federal Labs and is working on movement recognition and speech recognition technologies and their applications with individuals with severe communication impairments. The University of Nebraska has developed the AAC Menu interface. Researchers in Nebraska are also working on speech recognition as an interface option to AAC technologies.

Communication Enhancement Technology Watch Project

Frank DeRuyter, Duke University

Purpose: The purpose of this project is to establish and conduct an ongoing coordinated program that monitors and actively seeks out technological developments in both commercial form as well as pre-release development stages that can impact the engineering (and indirectly the clinical) aspects of the AAC field.

Target Population: AAC stakeholders including manufacturers, consumers, providers, Communication Aids Manufacturers Association (CAMA), Assistive Technology Industry Association (ATIA), Rehabilitation Engineering Research Center on Technology Transfer (T2RERC), other Rehabilitation Engineering Research Centers (RERCs), and the Federal Labs Consortium.

Problem: The rate of technology advancement is moving so rapidly that it is difficult for most professionals, let alone manufacturers, to keep abreast of new developments in a given field. Currently, there is no directed and comprehensive effort to identify those developments that have an immediate or direct relationship to the study of communication enhancement. Such information is generally transmitted via word of mouth, conferences, and "by chance" discoveries.

Progress and Key Findings: The Tech Watch Project has been vigorously pursuing the NIDRR directive to explore research and development activities within the Federal Laboratories Consortium as a way to locate appropriate leading edge technologies for the field of AAC. The AAC-RERC has established a coordinated program with this federal program to accomplish this goal. Efforts have resulted in the following:

Cooperative Research and Development Agreement (CRADA)—The CRADA was the first to be established between the Department of Defense and the RERC program within NIDRR. The Department of Defense, Navy Air Warfare Center Training Systems Division is currently working with the AAC-RERC to explore movement and automatic speech recognition technologies for use by people with dis-

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abilities. Only a year into the CRADA, there is a working prototype of a motion recognizer. This prototype is designed to be "trainable" by any individual, including a person with communicative disorders. The computer program can learn to recognize the individual's movements, and communicate the particular meaning of those movements to a person or system that can respond appropriately; that is, satisfy a request or need. The potential appears to be great for helping children with autism, anyone with cerebral palsy or a hearing impairment, or any condition that renders verbal communication difficult.

Demand Pull—The AAC-RERC partnered with the RERC on Technology Transfer (T2RERC) in a Demand-Pull Project for AAC technologies. The goal was to identify unmet needs in the AAC industry and to facilitate the transfer of technology from Federal Labs, research institutions, and other advanced technology developers to meet these identified needs. The project focused on four technology areas: input, output, processing, and wireless technology. The technology needs identified within these four areas reflect important and unmet customer concerns that may have significant business potential for manufacturers.

Microsoft® Survey—As a result of the work undertaken by the Demand Pull Stakeholder Forum on Communication Enhancement, the AAC manufacturers that participated expressed a desire to improve their working relationship with Microsoft Corporation. Working with Microsoft, the T2RERC administered a survey to 203 manufacturers nationally and worldwide and received a 20.7% response rate. Half of the respondents indicated AAC as their primary industry segment area. Because many AT products employ Microsoft operating systems/applications and, as a result of this survey, the Accessible Technology Group (ATG) at Microsoft is now creating a new AT Initiative to improve the quality of AT products in the marketplace.

Head Contact Microphone (HCM)—In collaboration with the Federal Labs Consortium, researchers discovered a skin-contact microphone, developed originally by the Navy Seals and later adapted for use by firefighters. The mike enables individuals who have difficulty using standard head or throat mounted mikes to amplify their voices, control a speech recognition system, and more. It can be placed anywhere on the head and is moisture proof. The microphone underwent preliminary clinical testing at Duke University Medical Center and Boston Children's Hospital with patients who exhibit dysarthria and vocal cord paralysis. The Head Contact Microphone has potential applications for several patient populations, including speakers with dysarthria, speakers with spinal cord injuries, and instructors of persons using auditory trainers, such as children with autism. RadioEar, an AAC manufacturer, modified the microphone making it functional to individuals with severe communication impairments. The AAC-RERC was offered the license to the microphone but has partnered instead with Luminaud (a manufacturer of voice amplification systems).

IT Standards—Researchers participated in the development of standards for Information Technology Access Interfaces (V2 Technical Group) of the National Committee for Information Technology Standards (NCITS).

Development of a Motion Recognition System Interface for People With Physical Disabilities

Kevin Caves, Duke University

Purpose: The purpose of this project was to develop a prototype of a system capable of recognizing repeatable motions made by individuals with disabilities and use these motions as inputs to AAC and other assistive technologies.

Target Population: The target populations were individuals who use AAC and have significant physical involvement.

Problem: Most individuals who use AAC and AT must have physical contact with some input device (e.g. keyboard or switch). There is a group of individuals for whom making physical contact with an input device is difficult, impractical or impossible. For example, individuals with severe physical disabilities may have a difficult time physically pressing a switch, but can reliably and repeatedly initiate a motion (such as a patterned response) in space.

Progress: This project is designed to develop an interface that will be able to record, learn and analyze discrete movements and recognize them for use as inputs to AAC and AT

The proof of concept that the system can work now exists at the Navy Air Warfare Center in Orlando, FL. The system analyzes data collected from a Polhemus FastTrack three-dimensional position recorder. The data are converted to a format suitable to the interface. Next steps include testing with other patterns and eventually testing with individuals with movement disorders at Duke University.

Key Findings: The system is able to

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recognize several experimental patterns (based on common shapes).

The Development of a "Menu-Based" AAC Interface for the Elderly and Other Persons With Recall Memory Limitations

David Beukelman, University of Nebraska-Lincoln

Purpose: The purpose of this project was to develop a menu-based interface minimizing the demands on recall memory and new learning common with fixed screen and dynamic screen interfaces.

Target Population: AAC users with memory and cognitive limitations include those with traumatic brain injury, aphasia, and other degenerative conditions—such as progressive aphasia.

Problem: Much of the current AAC technology requires extensive recall memory for users to remember the codes and cues that represented messages. Persons with cognitive, language, and memory limitations frequently struggle to operate these interfaces. There is a need for research and development with new interfaces that rely less on recall memory than current AAC interfaces.

Progress: This project is designed to develop an interface that will be useful with several types of individuals who have memory limitations. In addition, this interface will be useful for adults with acquired disabilities who do not wish to learn a complicated fixed or dynamic screen interface. These include adults with acquired disabilities who do not have the time or do not wish to learn an alternative symbol system, and adults with memory and cognitive limitations.

Specification and design phase—Design specifications were completed; the prototype was developed in three different versions: orthographic, iconic, and graphic (Chinese); design specifications were verified in the prototype; and four TBI survivors with cognitive limitations demonstrated the ability to operate the interface and compare accuracy and efficiency on AAC Menu and dynamic screen interfaces.

Error-free (reduced) studies with non-disabled adults—We completed a study on the use of AAC Menu as an error-free learning strategy to teach alpha codes for word and message retrieval. We initiated a similar study involving persons with TBI who use AAC system and formulate messages on a letter-by-letter basis (no use of encoding strategies).

Case study comparison of AAC Menu and semantic compaction strategies—We completed a single case study (9-year-old with cerebral palsy) of the use of AAC Menu (iconic version) and the Vanguard. Although he has used the Vanguard system for several years, he retrieved familiar words with similar accuracy and slightly less speed with AAC Menu as compared to Vanguard. For unfamiliar words, AAC Menu use was much more accurate and rapid than the Vanguard.

Ongoing study with persons with aphasia—We are conducting a study comparing messaging accuracy and rate using AAC Menu and DynaVox interfaces by persons with severe language disorders (aphasia) due to stroke. The digital photo stimuli are currently being prepared, and the same stimuli will be incorporated into each of the interfaces.

Key Findings:

- The prototype, designed to reduce recall learning and rely on recognition learning, can be implemented in current computer technology in both orthographic and graphic versions.
- Persons with marked cognitive impairments can learn to operate the interface.
- AAC Menu interface can support error-free learning in non-disabled adults and in participants with TBI.
- For a child with cerebral palsy who routinely uses a semantic compaction AAC strategy, AAC Menu interface can be used to communicate unfamiliar vocabulary much more quickly that a semantic compaction strategy. AAC Menu interface can be used to retrieve familiar vocabulary slightly slower than semantic compaction.

New AAC Interface Strategies—The Use of Automatic Speech Recognition as a Speech Clarifier

Kevin Caves, Duke University

Purpose: Our goal is to engineer a portable system with text and/or speech output of the clarified dysarthric speech.

Target Population: Individuals with mild, moderate, and severe speech disorders who are reliably understood by familiar communication partners, but who have difficulty communicating in noisy environments or with unfamiliar communication partners.

Problem: Automatic speech recognition (ASR) systems, such as DragonDictate®, VoiceExpress, and ViaVoice™ are being used with increasing frequency by the general population and individuals with physical disabilities. While there has been significant improvement in the area of ASR, these commercially available systems do not work well for individuals with imperfect speech.

Progress: Data collection began in

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October 2001 with several sample sets of simulated user data collected from research staff. Speech samples need to be collected in a specific way in order to be used to build models. Conditions including room noise, subject position, and microphone location all affect the quality of the sample. Staff developed data collection protocols, and pilot data was collected in February and March of 2002. Sample data sets will be sent to Navy Air Warfare Center (NAWC) in May 2002 for models to be built.

Key Findings: None to date

Partners: National Federal Labs Consortium—Naval Air Warfare Center

New AAC Interface Strategies—Speech Recognition (new initiative)-Voice Assess System

David Beukelman, University of Nebraska-Lincoln

Purpose: Focus on the development of new AAC interface strategies with an early emphasis in speech recognition.

Target Population: AAC user with severely unintelligible speech

Problem: Persons who require AAC because they are not able to meet their daily communication needs through speech are often able to produce vocalizations, vowel sounds, or clicks consistently. For some individuals, residual sound production is physically efficient for them. Therefore, this project will seek to develop and evaluate a prototype system to allow the control of assistive technology with residual sound production.

Progress: The prototype interface that has been developed supports the following access strategies: linear scanning (single sound recognition), row-column scanning (single sound recognition), direct matrix access (multiple sound recognition), and direct selection (multiple sound recognition).

A field test has been completed with three non-disabled speakers. More field tests are ongoing with two individuals with brain injury who are unable to speak to meet their daily communication needs. One participant controls the VAS Interface with a click, which is the only sound that he can produce consistently. The other participant controls the VAS Interface with two different vowel sounds, and nasal sounds (the only sounds that she can produce consistently). The SBIR proposal has been submitted, approved, and funded.

Key Findings: Results indicate that participants with vowel production only and lip click only can access the interface with 90% accuracy when engaged in a cognitive appropriate communication task.

Continuing Education Questions

1. **Projects that focus on interface design include the following:**
   a. Attitudes of AAC Users, Peers, and Intervention Professionals Toward AAC Technology
   b. Development of a Motion Recognition System Interface for People With Physical Disabilities
   c. Representation of Language From Children From Different Cultural Backgrounds
   d. The Study of Organizational Strategies for Three Groups of AAC Users
   e. None of the above
2. **The "Menu-Based" AAC Interface**
   a. was developed to minimize demands of recall memory associated with fixed and dynamic screen interfaces.
   b. was developed to be used with a target populations of AAC users with memory and cognitive limitations.
   c. has three prototypes including orthographic, iconic, and graphic.
   d. has been used in a case study with a nine year old male with cerebral palsy.
   e. all of the above.

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