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**Principal Investigator:** Cole, Ronald A.

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**Submitted By:**

Cole, Ronald - Principal Investigator

**Title:**

Virtual Therapist - U.S.-France Workshop May 2-3, 2007 in Bordeaux, France

### Project Participants

#### Senior Personnel

**Name:** Cole, Ronald

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

#### Post-doc

#### Graduate Student

#### Undergraduate Student

#### Technician, Programmer

#### Other Participant

#### Research Experience for Undergraduates

### Organizational Partners

#### Universit  Victor Segalen

The Virtual Therapist U.S.-France Workshop was held in Bordeaux France on May 2-3, 2007. The workshop was hosted by Professor Jean-Michel Madaux, M.D., at Universit  Victor Segalen. The Universit  Victor Segalen provided all of the facilities for the two day meeting, and paid for lunch and dinner for all of the U.S. participants from the evening before the workshop through lunch the second day of the workshop. Moreover, Dr. Madaux worked closely with Dr. Cole to organize the workshop and secure support from French national organizations that serve individuals with disabilities.

### Other Collaborators or Contacts

### Activities and Findings

**Research and Education Activities:** (See PDF version submitted by PI at the end of the report)

#### Findings:

The workshop produced great interest and excitement among the French research community and resulted in subsequent collaboration between U.S. and French researchers, as described below.

#### Training and Development:

The project has led to training of speech and language pathologists in both the United States and France in clinical development, administration and assessment of virtual speech and language therapy programs.

#### **Outreach Activities:**

The workshop brought together approximately sixty individuals in Bordeaux France, including researchers, practitioners and graduate students who learned about and shared experiences using virtual tutoring systems.

#### **Journal Publications**

#### **Books or Other One-time Publications**

#### **Web/Internet Site**

#### **Other Specific Products**

#### **Contributions**

##### **Contributions within Discipline:**

The workshop generated an increased awareness of the current capabilities and future potential of computer-based programs to provide effective clinical treatments for individuals with neurological disorders. It was clear that researchers in France were not aware of the virtual tutoring and therapy programs developed in the United States, that they were greatly impressed by this work and eager to initiate both independent and collaborative efforts to develop their own systems.

The intense interest and excitement produced by the presentations at the Bordeaux workshop has made several important contributions to both computer science and speech and language pathology.

These contributions include:

1. A clear demonstration that human language and character animation technologies can be integrated into engaging and effective treatment programs that incorporate spoken dialogs with virtual therapists. Researchers in computer science and engineering and speech and language pathology are now aware that speech, language and character animation technologies can be combined to produce engaging and effective clinical treatments.
2. The tools and technologies developed at the Center for Spoken Language Research under the direction of Ron Cole and Wayne Ward have been integrated into a Virtual Human Toolkit that will be distributed to the research community. The VHT, originally funded by an NSF ITR grant, is now being used at Boulder Language Technologies to develop My Science Tutor, a program funded by the NSF and IES to improve science learning of elementary school students through natural spoken dialogs with a virtual tutor.

##### **Contributions to Other Disciplines:**

The development and integration of human language and character animation technologies within intelligent tutoring and therapy systems is making a significant contribution to cognitive psychology, educational research and health related disciplines.

The Perceptive Animated Agents and software design tools developed during the NSF ITR grant were subsequently used to develop literacy programs, science tutors and four virtual therapy programs, three for individuals with aphasia and one for individuals with Parkinson disease. Each of these programs was funded by research programs in specific disciplines outside of computer science, including the IES reading and writing program, the IES cognition and student learning program, the IES NIDRR program, the NIH NICHD and the NIH NIDCD. These federal research programs serve a diverse community of researchers in other disciplines that have benefitted from development of computer programs that incorporate virtual humans capable of emulating the behaviors of sensitive and effective tutors and therapists.

The research funded by the NSF has therefore led to contributions to other disciplines including speech and language pathology, educational research in reading and science, neurology, and cognitive neuroscience. The workshop in France enlightened significant numbers of individuals in these research communities to the work conducted in the U.S. supported initially by the NSF and subsequently by the NIH and NIDRR.

### **Contributions to Human Resource Development:**

#### **Contributions to Resources for Research and Education:**

An explicit and much desired outcome of the the 2007 Bordeaux Workshop was the initiation of collaboration between researchers at the Rehabilitation Institute of Chicago and the University of Bordeaux. This collaboration led to a French version of the AphasiaScripts virtual therapy program that has been demonstrated to improve the (English) speech and language skills of individuals with aphasia. The extensions to the AphasiaScript program to enable speech and language therapy in French, and other languages in the future, provides a resource that is now supporting research at the University of Bordeaux and contributing to research training and professional development of speech and language therapists. This collaboration recently culminated in a second workshop in Bordeaux.

#### Second Bordeaux Workshop (June 9-11, 2009)

The AphasiaScripts<sup>TM</sup> program presented at the Bordeaux Workshop, developed at the Rehabilitation Institute of Chicago (RIC) and University of Colorado Boulder under the direction of Leora Cherney and Ron Cole, stimulated great interest among Jean-Michel Mazaux (the co-organizer of the workshop) and his colleagues at the University of Bordeaux.

As noted, AphasiaScripts<sup>TM</sup> provides a software platform for an individual with aphasia and a speech-language pathologist to design personal individualized monologues and conversations that they can use in everyday life. The program allows the individual with aphasia to practice the script by repeatedly reading aloud the sentences at the same time as the words are produced by a virtual therapist (avatar), and then to practice the conversation independently with the virtual therapist.

As a direct result of the presentations and discussions at the 2007 workshop in Bordeaux and subsequent email discussions between Leora Cherney, Jean-Michel Mazaux and the University of Colorado Technology Transfer Office, a long-term research collaboration was established between the Rehabilitation Institute of Chicago's Center for Aphasia Research and Treatment, the University of Colorado, and the University of Bordeaux.

This collaboration included:

1. Contractual agreement between the University of Colorado the University of Bordeaux for the use of the AphasiaScripts <sup>TM</sup> for research purposes.
2. Development of a French prototype of AphasiaScripts <sup>TM</sup> which included presenting in French both the written instructions that appear on the screen as well as the verbal instructions spoken by the virtual therapist. Additionally, a method was developed for producing accurate visual speech of French words spoken by the virtual tutor by mapping English phonetic transcriptions of each utterance to the corresponding phonetic symbols in the French words. These enhancements to the program were supported by the remote online support of Mr. Wattanut Ngampatipingpong at the University of Colorado who developed the AphasiaScripts <sup>TM</sup> program under the direction of Ron Cole and Leora Cherney.
3. Creation of an instruction manual for each component of the software û authoring, player interface and data collection.
4. Organization of a new three day workshop sponsored by the University of Bordeaux during June of 2009 to initiate a joint research project to develop virtual therapy programs for individuals with aphasia using the AphasiaScripts <sup>TM</sup> program.

The workshop attendees from RIC included:

1. Leora Cherney, PhD (Director, Center for Aphasia Research and Treatment)
2. Jaime B. Lee, MA, CCC-SLP (Research Speech-Language Pathologist)

The workshop attendees from the University of Bordeaux included:

1. Jean-Michel Mazaux, (Medical Director)
2. Bernard Nkaoua, (Director û Cognitive Science Laboratory)
3. Ms B Darrigrand, (Speech and Language Pathologist)

4. G BÚnichou, (Speech and Language Pathologist)
5. G Gordon, (Speech and Language Pathologist)
6. M Despagne, (Speech and Language Pathologist)
7. F PÚlage (Speech-language Pathologists)
8. J Berthomieu (Computer Engineer)

The 3-day workshop included:

1. Reviewing and modifying the French translations of all commands and informations for the French-speaking user of AphasiaScripts™ and recording them.
2. Training the speech therapists how to design a script, to implement it in the software, to modify the lips movements when they were not accurate, and to review data collection procedures.
3. Planning a clinical study to develop and assess the benefits of the French AphasiaScripts™ program and a discussion of future research directions in France using AphasiaScripts™.

At the conclusion of the workshop, plans were made to:

1. Provide the University of Bordeaux with a final French version of :
2. Develop formal research plan for assessing efficacy of French AphasiaScripts™
3. Identify funding sources and seek research funding for a large-scale trial.

There has been additional interest in Paris from Professor Pradat-Diehl who would like to use AphasiaScripts™ under the licensing agreement with Bordeaux in a series of single-case studies prior to a larger cross-over or randomized control trial.

#### **Contributions Beyond Science and Engineering:**

The computer programs enabled by research and development efforts funded by the NSF and reviewed at the Bordeaux workshop have led to several commercialization efforts.

Ron Cole and Wayne Ward, the founders of the Center for Spoken Language Research at CU in 1998, established Mentor Interactive in 2004 to develop a commercial version of the Foundations to Literacy reading program. Mentor Interactive has just released its first product line, a set of reading games for use on the Nintendo DS that are designed to teach preschool, kindergarten and first grade children to read. The product can be viewed at Amazon.com by searching for 'My Virtual Tutor.'

The success of the NSF ITR grant also led Ron Cole and Wayne Ward to establish Boulder Language Technologies (BLT) in 2007, where they now work, to develop science tutors under support from NSF and IES. Recently, Delta Education, the publisher of the FOSS science program (developed under NSF support by the Lawrence Hall of Science at UC Berkeley) awarded a contract to BLT to develop a set of tutorials that will be distributed with the 2011 release of the FOSS program. These tutorials incorporate spoken dialog with a virtual science tutor. successful speech and language therapy programs developed in collaboration with distinguished speech and language pathologists from the United States. The FOSS science program is used in all 50 states by over 2 million children in 100,000 classrooms. We have high hopes that the virtual tutoring programs distributed with the FOSS program in the future will produce significant contributions to science education in the U.S.

The Bordeaux workshop was an opportunity to both educate and engage computer scientists and speech and language pathologists in France on the remarkable potential of computer programs that use human language and character animation technologies to provide accessible, inexpensive and highly effective treatments to individuals with aphasia and Parkinson disease. It appears likely that at least some of the virtual therapy programs presented at the Bordeaux workshop will be commercialized in this decade. We view the Bordeaux workshop as the 'coming out' party that demonstrated both the reality and potential of virtual therapy programs.

#### **Conference Proceedings**

#### **Categories for which nothing is reported:**

- Any Journal
- Any Book
- Any Web/Internet Site
- Any Product

Contributions: To Any Human Resource Development  
Any Conference

# **Bordeaux Workshop on Virtual Tutors and Therapists**

## **Historical Background and Context for the Bordeaux Workshop**

Lifelike computer characters used in tutoring, training and therapy programs are known by a variety of names including perceptive animated agents, intelligent animated agents, embodied conversational agents, pedagogical agents and virtual tutors. Just a few years ago, the idea of highly effective virtual tutors was science fiction. In 2003, in a special issue of the IEEE Proceedings on animated agents, Cole et al. (2003) wrote:

*“We envision a new generation of human computer interfaces that interact with people like people interact with each other. These interfaces will use intelligent and embodied animated agents to engage users in natural face-to-face conversational interaction to accomplish a wide variety of tasks. An intelligent agent is one that mimics the behaviors of real persons and behaves intelligently in the context of a specific application or task domain. We call these interfaces of the future perceptive animated interfaces. We can begin to develop perceptive animated interfaces today that will produce more effective and desirable communication experiences than existing systems. The advent of perceptive animated interfaces will revolutionize human computer interaction by enabling users to communicate with machines using their natural communication skills, and by enabling system developers to design interactive experiences that are more personal, emotional, meaningful, enjoyable and effective” (p. 1391).*

Just six years later, this vision is becoming a reality. Lifelike pedagogical agents are being used to train soldiers to interact with individuals in Iraq in culturally appropriate and respectful ways and have been used to teach children to read, to learn science and to help individuals with aphasia and Parkinson disease re-acquire speech and/or language skills. Several of these programs have been assessed in schools, clinics or homes, with positive user experiences and statistically significant outcomes in summative assessments and clinical trials.

## **Research History**

In 1997, Ron Cole became PI of an NSF Challenge grant awarded to the Oregon Graduate Institute. The research and development activities conducted during this grant led to a computer program that used a 3-D talking head with accurate visual speech, called Baldi, to help children with profound hearing loss who had received cochlear implants improve their ability to learn and use new words. The results of this computer program, which was a dramatic success, were featured on ABC TV's Prime Time and the NSF home page. The Vocabulary Wizard used to design vocabulary applications easily and quickly, was distributed free of charge to the research community, and has been installed and used at over 30,000 sites worldwide. In 1998, Dr. Cole founded the Center for Spoken Language Research at CU Boulder with Wayne Ward, and in 2000 became PI of an NSF ITR grant at CU (Ephraim Glinnert, PM).

The objective of the ITR project was to develop tools and technologies to support natural conversational interactions with lifelike computer characters (aka: perceptive animated agents or

virtual tutors). While the NSF ITR grant contributed most directly to research and development of the perceptive animated agents used in all subsequent virtual tutoring and therapy programs developed at the Center for Spoken Language Research, three additional grants from the NSF ITR and IERI programs also supported research and development of the spoken language and character animation technologies at CU. Together, these grants totaled approximately \$13 million, and supported both basic research and system development activities between 2000 and 2007.

The following NSF and NIH grants contributed directly to development of perceptive animated agents:

NSF/ITR: IIS-0086107 - Cole, R., van Santen, J., Movellan, J., "ITR: Creating the Next Generation of Intelligent Animated Conversational Agents," \$4,000,000, NSF, 09/01/00 - 08/31/05.

NSF/ITR: REC-0115419 - Kintsch, W., Landauer T., Caccamisa, D., Cole, R., "ITR/PE: Latent Semantic Analysis Theory and Technology," \$2,400,000, NSF, 09/01/01 - 08/31/06.

NSF/IERI: EIA-0121201 - Kintsch, W., Caccamisa, D., Cole, R., Olson, R., Snyder, L., "IERI: Scalable and Sustainable Technologies for Reading Instruction and Assessment," \$5,997,404, NSF, 07/01/01 - 06/26/06.

NSF/IERI: 1R01HD-44276.01 Cole, R., Barker, L., Schwartz S., Snyder, L., Wise, B., "IERI: Scaling up Reading Tutors," \$1,000,000.00, NIH. 9/27/02 - 9/30/04.

These grants led to the development of several of the human language and character animation technologies needed to support conversational interaction with lifelike computer characters. As a result of the above grants, the Foundations to Literacy (FtL) program was developed at CSLR. FtL was used by over 2000 K-2 children in Colorado schools, and produced exceptional reviews from teachers and students and significant learning gains on standardized tests. The success of FtL motivated Ron Cole and Wayne Ward to establish a startup company to develop virtual reading tutors. Mentor Interactive is currently selling products for the Nintendo DS platform that uses a virtual tutor to teach children to read (<http://www.mentorinteractiveinc.com/>).

### **From Virtual Tutors to Virtual Speech and Language Therapists**

Perceptive animated agents have a promising role as virtual therapists. To date, PI Ron Cole has worked with three distinguished speech and language pathologists (Leora Cherney, Lorraine Ramig and Cynthia Thompson) to develop virtual therapy systems. The four systems resulting from these projects, funded by grants from the NSF, NIH and IES, use a virtual therapist that closely emulates the behaviors of a human clinician in effective behavior treatments. In each project, we worked with the speech and language pathologists who developed the clinical treatments to produce a computer version of the treatment. All four programs have undergone clinical trials, with results showing improvements in speech communication abilities similar to those achieved by trained clinicians who administered the treatment.

## 1. LSVT (Lee Silverman Voice Treatment)



LSVT, developed by Dr. Lorraine Ramig and her colleagues at the National Center for Voice and Speech (NCVS) and the University of Colorado, is a highly effective voice and speech treatment for individuals with Parkinson disease. About 90% of individuals with Parkinson disease have difficulty communicating using speech. LSVT teaches individuals with Parkinson disease to think and speak loudly in real world situations, which is difficult for them, and must be learned and practiced through a variety of activities in 16 one hour sessions over a one month period. Between March 2004 and May 2007, with support from two NIH grants, a team of researchers at CU. Mentor Interactive worked with Ms. Angela Halpern and Dr. Lorraine Ramig at NCVS to develop the LSVT virtual therapist program. Clinical trials were conducted by Angela Halpern at NCVS using a clinician oversight system that enabled Ms. Halpern to monitor and review progress of several subjects using the program and to communicate with individual subjects as needed. Results of clinical trials revealed that the LSVT virtual therapist program produced gains in speech production similar to those obtained with certified LSVT clinicians. A Polish version of the LSVT Virtual Therapy system has been developed with support from the Polish NSF and successfully implemented in speech and language therapy contexts in Poland.

The LSVT Virtual Therapist program has been presented to the scientific community through publications and conference presentations:

Cole, R., Halpern, A., Ramig, R., van Vuuren, S., Ngampatitpong, N., & Yan J. (2007). A Virtual Speech Therapist for Individuals with Parkinson's disease. *Educational Technology*, Vol. 47 (1), pp. 51-55.

Cole, R., Ramig, L., Yan, J., Halpern, A., & Van Vuuren, S. Animated Agent Enhanced LSVT Virtual therapy system. Poster presented at the Coleman Institute for Cognitive Disabilities, "Enhancing the Quality of Life for People with Cognitive Disabilities through Technology" Conference, October 4-5, 2004, Denver, Colorado.

Halpern, A. Theory, research and presentation of virtual therapy treatments for Parkinson disease. Invited oral presentation at the Virtual Reality and Cognitive Disability Conference, May 2-3, 2007, Bordeaux, France.

Halpern, A., Cole, R., Ramig, L., Yan, J., Petska, J., Van Vuuren, S., Spielman, J. Virtual Speech Therapists - Expanding the Horizons of Speech Treatment for Parkinson's disease. Oral Presentation at the 13<sup>th</sup> Biennial conference on Motor speech, March 22nd-26th, 2006, Austin, Texas.

Halpern, A., Matos, C., Ramig, L., Petska, J., Spielman, J., Cole, R., Yan, J. Technology Supported Speech Treatment for Parkinson's Disease. Poster presented at the First World Parkinson Congress, February 22-26, 2006, Washington, D.C.

Halpern, A., Matos, C., Ramig, L., Petska, J., Spielman, J., Cole, R., Yan, J., Will, L. Technology Supported Speech Treatment for Parkinson's Disease. Poster presented at the 9th International Congress of Parkinson disease and Movement disorders, March 5-8, 2005, New Orleans, Louisiana.

## 2. ORLA



ORLA is an effective speech treatment for aphasia that focuses on comprehension and production of sentences. The clinical treatment was developed by Dr. Leora Cherney, head of the Center for Aphasia Research at the Rehabilitation Institute of Chicago (RIC). During the treatment, an individual first points to each word in a printed sentence as it is read aloud by a clinician, then reads along with the clinician as she reads, and then reads the sentence independently. With support from a subcontract from RIC to CSLR (NIDRR grant H133G040269; Ron Cole, PI), Dr. Cole led an effort at CSLR with Sarel van Vuuren and Nattawut Ngampatipatpong that led to the ORLA virtual therapist program. The program was evaluated in a clinical trial in Chicago by Dr. Cherney's team and results of the study are now being analyzed.

In 2007 Mentor Interactive Inc. was awarded a subcontract from RIC from a new NIDRR grant (H133G060055) written by Leora Cherney and Ron Cole entitled "Web-Based ORLA with Clinician Oversight." Dr. Cole worked with Dr. Cherney and consultant Jariya Tuantranont to develop a clinician oversight system that enables individual clinicians to monitor progress of multiple simultaneous remote subjects via the internet and to communicate with individual subjects using the program. The clinician oversight system is now being field tested by Leora Cherney and her colleagues in Chicago with support from staff at CSLR.

Information about the ORLA virtual therapist program can be found at the BLT Web site at <http://www.bltek.com/virtual-teacher-side-menu/orla.html>. ORLA has been presented to the scientific community through presentations at scientific meetings:

Cherney, L., Babbitt, E., Cole, R., van Vuuren, S., Hurwitz, R., & Ngampatipatpong, N. "Computer Treatment for Aphasia: Efficacy and Treatment Intensity." Poster presented at the Annual Education Conference of the American Congress of Rehabilitation Medicine, Boston MA, September, 2006.

Cherney, L. R., Cole, R., Holland, A., Thompson, C., Ramig, L., Halper, A., & Halpern, A. "Virtual Therapist Technology: Application to Neurologic Communication Disorders." Seminar presented at the Annual Convention of the American Speech-Language Hearing Association, San Diego, November, 2005.

### 3. AphasiaScripts



AphasiaScripts is a virtual therapist program that uses a virtual therapist to help individuals with aphasia learn how to have conversations with other people in their daily lives. The clinical treatment was developed by Leora Cherney at the Center for Aphasia research at the Rehabilitation Institute of Chicago (RIC). The AphasiaScripts program was developed at CSLR through a subcontract from RIC (NIDRR Grant H133B031127; Ron Cole, PI) by Ron Cole, Sarel van Vuuren and Nattawut Ngampatipatpong working closely with Leora Cherney and her colleagues. AphasiaScripts enables clinicians to work with individuals with aphasia to design and practice conversations. The program has been successfully evaluated in clinical trials with excellent results; every individual improved their speech communication abilities.

Further information about the AphasiaScripts virtual therapist program can be found at the BLT Web site at <http://www.bltek.com/virtual-teacher-side-menu/aphasia-scripts.html>. The program has been presented to the scientific community in the following journal articles and conference presentations:

- Cherney, L., Halper, A., Holland, A., Cole, R. "Computerized Script Training for Aphasia: Preliminary Results." *American Journal of Speech-Language Pathology*, 2008, 17, pp. 19-34.
- Cherney, L. Halper, A., Holland, A., Lee, J., Babbitt, E., & Cole, R. "Improving Conversational Script Production in Aphasia with Virtual Therapist Computer Treatment." *Brain and Language*, 2007, Vol. 103, pp. 246-247.
- Cherney, L., Halper, A., Holland, A., Babbitt, E., Cole, R., & van Vuuren, S. Creating and "Implementing Conversational Script Training for Aphasia," Seminar presented at the Annual Conference of the American Speech-Language Hearing Association. Miami, FL, November, 2006.
- Cherney, L. R., Halper, A., Babbitt, E., Holland, A., Cole, R., van Vuuren, S. & Ngampatipatpong, N. "Learning to Converse: Script Training, Virtual Tutors, and Aphasia Therapy." Seminar presented at the Annual Convention of the American Speech-Language Hearing Association, San Diego, November, 2005.

## 4. Sentactics



Sentactics is a computer-based clinical treatment based on over twenty years of research by Dr. Cynthia Thompson, Director of the Aphasia and Neurolinguistic Research Laboratory, and her colleagues at Northwestern University. Sentactics is designed to improve sentence comprehension and production abilities of individuals with Broca's aphasia and agrammatism. Individuals with agrammatism, often resulting from lesions in Broca's area in the brain, have syntactic deficits. Research conducted by Dr. Thompson and her colleagues led to a treatment approach called "Treatment of Underlying Forms" that focuses on training patients to comprehend and produce complex, non-canonical sentence structures like "It was the woman who the man saved from drowning." With support from an NIH grant (R21 DC007377-01) Dr. Cole, Sarel van Vuuren and Nattawut Ngampatipatpong worked with Dr. Thompson and JungWon Janet Choy to develop Sentactics. The program was evaluated in a clinical trial in the Chicago area with successful outcomes; subjects improved their production and comprehension of sentences following use of the Sentactics program, with improvements very similar to those obtained with human clinicians.

Information about the Sentactics program can be found on the BLT Web site at <http://www.bltek.com/virtual-teacher-side-menu/sentactics.html>.

The Sentactics program was described in the following two conference presentations:

- Thompson, C.K. Choy, J., Holland, A., & Cole, R. Theory, research and presentation of Virtual Therapy treatments in aphasia: The program Sentactics, Workshop on Virtual Reality and Cognitive Disability, Bordeaux, France, May 2-3, 2007.
- Thompson, C., Holland, A., Cole, R., van Vuuren, S., Ngampatipatpong, N., & Choy, J. "Treatment of Sentence Deficits: Using a Virtual Therapist for Delivery of Treatment of Underlying Forms (TUF)." American Speech and Hearing Society Meeting, San Diego, CA, Nov 18, 2005.

## **From Poznan Poland to Bordeaux France**

NSF 0710706: Virtual Therapist - U.S.-France Workshop May 2-3, 2007 in Bordeaux, France. 03/15/2007 – 06/30/2008.

In 2005, the Poznan Linguistic Meeting, a highly regarded annual linguistics conference, held a special session on computers, linguistics and medicine. The meeting was organized by Professor Katarzyna Dziubalska-Kolaczyk, Head of the School of English at Adam Mickiewicz University (AMU) in Poznan, Poland. For the past six years, PI Cole has collaborated with Dr. Dziubalska-Kolaczyk to develop Polish virtual tutoring and therapy systems. Dr. Dziubalska-Kolaczyk received two grants from the Polish National Science Foundation at AMU, one to support development of a Polish Literacy Tutor, and one to support development of a Polish LSVT system. As a result of these awards, Dr. Dziubalska-Kolaczyk established the Center for Speech and Language Processing at Adam Mickiewicz University in February 2005 (<http://ifa.amu.edu.pl/cslp/>). CSLP has become a center of excellence in human language technology with active interdisciplinary projects in areas of linguistics, psycholinguistics (e.g., studies of language development, studies of gestures during communication) and virtual tutoring and therapy systems. At the special session of the Poznan Linguistic Meeting, Drs. Dziubalska-Kolaczyk, Lorraine Ramig, Ron Cole and Jean-Michel Mazaux presented their research. Following the session, these researchers explored future collaboration. Dr. Mazaux issued an invitation for Dr. Cole to visit University of Bordeaux to present his work. At this point, Dr. Cole contacted Dr. Ephraim Glinnert to explore the idea of writing a proposal to hold a workshop in Bordeaux that would feature the various systems developed under NSF support, beginning with the NSF ITR grant. These discussions led to the idea of inviting each of the speech and language pathologists to France to present their experiences and research results using virtual therapists. A proposal was submitted and the resulting award enabled us to organize the workshop with Jean-Michel Mazaux.

It is important to note that Dr. Mazaux was an awesome host. In addition to organizing the workshop, Dr. Mazaux worked with his university and outside agencies to sponsor the workshop within Bordeaux. This included a specially arranged museum tour in Bordeaux and a tour of vineyards in St-Émilion for the U.S. visitors. In addition, Dr. Mazaux arranged and paid for lunch and dinners for the visitors during the workshop.

### **The Workshop**

The workshop brought nine researchers from the U.S. together with over 50 French researchers in areas of computer science and speech and language pathology to share new developments and explore collaboration in the emerging area of virtual therapist programs. The first day of the workshop featured a presentation by Ron Cole of the speech, language and character animation technologies that underlie the virtual tutoring and therapy programs developed at CSLR under NSF support. The remainder of the first day of the workshop consisted of presentations by U.S. researchers, which included the speech and language pathology researchers who co-developed and assessed the virtual therapy programs, and a presentation by Dr. Stephen Small who presented an excellent talk on cognitive neuroscience and linguistics. The second day of the workshop consisted of presentations by French researchers in areas of virtual reality and computer-based approaches to speech and language therapy, followed by a three hour meeting

that focused on stimulating collaborations between the U.S. and French researchers. The workshop web site can be found at <http://www.bltek.com/content/blogcategory/12/18/>.

### **Dr. Jean-Michel Mazaux's Description of the Bordeaux Workshop**

The following paragraphs, slightly edited, are a summary of the workshop written by Jean-Michel Mazaux.

A workshop on Virtual Reality and Cognitive Disabilities was held at University Victor Segalen Bordeaux 2 in Bordeaux, France, on May 2<sup>nd</sup> and 3<sup>rd</sup>, 2007. The workshop was organized by Dr. Ronald Cole, President of Boulder Language Technologies (formerly at the Center for Spoken Language Research at the University of Colorado Boulder), and Pr. Jean-Michel Mazaux, of the University Victor Segalen Bordeaux 2. Participation of nine U.S. participants was supported by a grant from the U.S. National Science foundation. Several French Institutions participated in the organization of the workshop, including the University Victor Segalen Bordeaux 2 (components: EA 4136 Handicap and Nervous system, EA 487 Cognition and Human Factors, and Department of Speech Therapy), the Federative Institute of Research : Handicap Network IFR 25, the National Union for the Development of Research and Assessment in Speech Therapy UNADREO, and the Physical Medicine and Rehabilitation Association of Aquitaine.

The objective of the workshop was to explore collaboration among speech and language pathologists, clinicians, specialists in cognitive and language rehabilitation, and researchers engaged in the development of computer systems that incorporate speech, language and animation technologies and virtual reality environments in the field of health and rehabilitation. The workshop was supported in large part by the generous financial supports of the National Science Foundation, the IFR 25 and the University Victor Segalen Bordeaux 2.

The workshop was opened by a welcoming speech of Pr B Bégau, President of the University Victor Segalen Bordeaux 2. The day of May 2 was coordinated by Drs. R Cole and JM Mazaux. Presentations during the first day of the workshop by French and U.S. researchers focused mainly on descriptions and demonstrations of virtual reality systems based on effective

clinical treatments for individuals with dyslexia, aphasia and Parkinson disease. After introductory statements by Pr JM Mazaux, Pr B Claverie, Pr R Dauman, Pr PA Joseph, Dr P Pradat-Diehl and Dr T Rousseau describing the planning, organization and objectives of the workshop, Mr. Suskind of the U.S. National Science Foundation welcomed participants and shared his enthusiasm for the workshop and hoped that it would lead to significant future collaborations among U.S. and French researchers. Pr B Nkaoua, of the Institute of Cognitive of Bordeaux (EA 487) then presented the history and the current state of the development of the techniques of Virtual Reality applied to the problems of health, in particular in psychiatry for treatment of phobias and anxiety, and in neuropsychology to assess and treat disorders of memory and executive functions. Then Pr JM Mazaux, of the University Victor Segalen Bordeaux 2 and Dr. P Pradat-Diehl, of the Salpêtrière Hospital of Paris, both members of the IFR 25, emphasized the importance of aphasia, which represents approximately one third of the cases of stroke, they reviewed current speech therapy in this field, and looked at potential benefits of virtual reality programs for treating aphasia.

Pr R Cole read a message from Ms Pr A Holland, a distinguished aphasia researcher who contributed to the conceptualization and design of the virtual reality aphasia programs presented at the workshop. Dr. Holland was planning to attend the workshop but had to withdraw because of unforeseen family problems. Her message stressed the incredible potential of the programs now under development and the importance of the workshop to stimulate collaboration between researchers in the U.S. and France. Dr Cole then summarized over 10 years of research in speech, language and character animation technologies which made it possible for his group to collaborate with clinicians, initially in the field of pedagogy and teaching, then in the field of rehabilitation, to develop effective virtual reality programs for administering computer-based treatments to individuals with aphasia and Parkinson Disease. He described in detail the capabilities and limitations of current technologies, and demonstrated these technologies through videos and system demonstrations. Dr. Cole also presented a brief overview of four different clinical treatments, three for aphasia and one for Parkinson disease that would be presented by his colleagues following Pr S Small's presentation.

Pr S Small, of the University of Chicago, reviewed theory and research on the state of knowledge on activations of cerebral networks which accompany interaction with virtual humans (lifelike computer characters). His research investigated brain function differences while listening to the identical speech produced by a human face or a lifelike computer character with anatomically correct lip movements and also compared audio-visual perception and audio perception. Following Dr. Small's presentation, speech and language pathology researchers from the United States described clinical treatments they had developed for aphasia and Parkinson disease, and demonstrated computer-based versions of these programs which used a virtual therapist.

Dr. L. Cherney, of the Rehabilitation Institute of Chicago, discussed two treatments for aphasia, and demonstrated virtual therapy programs for each. The first program, ORLA, improves speech and language comprehension and production through a range of reading exercises that includes pointing to words as the virtual therapist reads them, reading along with the therapist, and reading words independently as they are highlighted. The second program, Aphasia Scripts, trains individuals with aphasia to have conversations that are designed by the patient in collaboration with the therapist. The ORLA and Aphasia Scripts program were both demonstrated by Dr. Cherney. Initial results of the virtual therapy programs were presented, along with videos and recordings of individuals before and after receiving the treatments.

Dr. C. Thompson and Ms. J Chou of Northwestern University presented Sentactics, a linguistically based program that trains individuals with aphasia to understand and produce linguistically complex sentences, which are shown to generalize to simpler constructions. The virtual therapy program was demonstrated by Ms. Chou.

In the area of Parkinson's disease, Ms. A. Halpern of the National Center for Voice and Speech in Denver Colorado described LSVT, a voice treatment that trains individuals with Parkinson disease to think and speak loudly. This treatment, used by over 3000 certified LSVT clinicians worldwide, has been shown to produce long term benefits to individuals with Parkinson disease. After Ms. Halpern described the treatment and demonstrated the LSVT Virtual Therapy program in English, Pr K Dziubalska-Kolaczyk, and Ms. Polszynska-Fischer of

University Adam Mickiewicz in Poznan Poland presented a Polish version of the program which has been used successfully by Polish LSVT clinicians.

At the end of the afternoon, Pr P Dominey, of the CNRS of Lyon-Bron, presented impressive work in which a robot was able to carry out instructions in response to spoken commands.

Then the researchers of the Institut Fédératif of Research : Handicap Network IFR 25, were invited to visit two research sites and to meet research students at the University Victor Segalen Bordeaux 2: the platform of analysis of the movement of UMR CNRS 4553, affiliated with the IFR of the Neurosciences of Bordeaux, directed by Pr JR Cazalets, and the Virtual Reality laboratory of Institute of Cognitique, directed by Pr B Claverie.

The second day of the workshop, coordinated by Pr PA Joseph, Pr P Giraux and Pr T Pozzo, was devoted to the applications of Virtual Reality in the fields of motor movement, navigation and cognition. It was chaired by Pr JF Ravaud, Director of the Federative Institute of Research Handicap Network IFR 25, who made an introductory address. Ms E Klinger, of laboratory ELHIT of Laval, presented the general history and the current state of development of the techniques of evaluation and rehabilitation of cognitive functions using Virtual Reality as well as prospects for future development. Mr. A Saimpont, representing Pr Pozzo of Dijon, presented research of their laboratory on the coupling of action and perception and the prospects for rehabilitation of this coupling using Virtual Reality. The following talks presented examples of Virtual Reality research so that workshop participants could understand the extent of the field of research offered and the diversity of the possible applications in this field. These included: space perception impairment and disorders of memory, approached by the talks of E Sorita and H Sauzéron (University Victor Segalen Bordeaux 2), motor and postural disorders of individuals with Parkinson disease (talk of JC Ceccato, CNRS UMR 4553), a research directed at understanding and alleviating the pain associated with phantom limbs (Pr P Giraux, University Jean Monnet, St-Etienne) and another analyzing cerebral function via imagery of the social behavior of children with autism (L Centelles, CNRS Marseille and CHS CH Perrens). Questions by participants in the audience related to technical details specific to the covered subjects, but also illustrated the common points and the technological projection represented by Virtual Reality. One of the principal characteristics of Virtual Reality to emerge from the

discussions was the critical role of interactivity when the patient is immersed in the virtual world. So Pr P Guitton, of the University Bordeaux 1, discussed the difficulties and the limitations of the interfaces that are now available. A general discussion concluded this session.

During the afternoon, the researchers of Institut Fédératif of Research Handicap Network IFR 25 held their annual general meeting. At the same time, the American and Polish researchers met with the speech therapists members of the UNADREO, their president T Rousseau, Dr. Pradat-Diehl, Pr JM Mazaux and Pr B Nkaoua, to consider the prospects and specific projects for future collaboration. This session revealed a strong commitment among the American, Polish and French researchers to collaborate on future projects. Pr Cole, Dr. Cherney, Dr. Thompson and Ms. Halpern each agreed to collaborate with specific French researchers to extend current English versions of the Virtual Therapy programs to French applications. The French researchers, on their side, proposed to think of new possible applications, for example in the field of the disorders of the memory and space orientation. It was decided that following additional discussions between U.S, and French researchers, a scientific contract of partnership would be drawn up to specify the practical methods of collaboration. The first stage would be the French adaptation of the software of scripts in the aphasia program designed by Dr. L Cherney. Other prospects for scientific collaborations also took shape: first, in the field of the virtual therapy, the assessment of the value added by Virtual Reality compared to the current French therapies, then in other fields, for example studies of functional imagery of the language and recovery of aphasia. Thus, the meeting produced great potential for future collaboration.

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