SpeechEasy International

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Newsletter: SpeechEasy International, LLC

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Distributor Conference

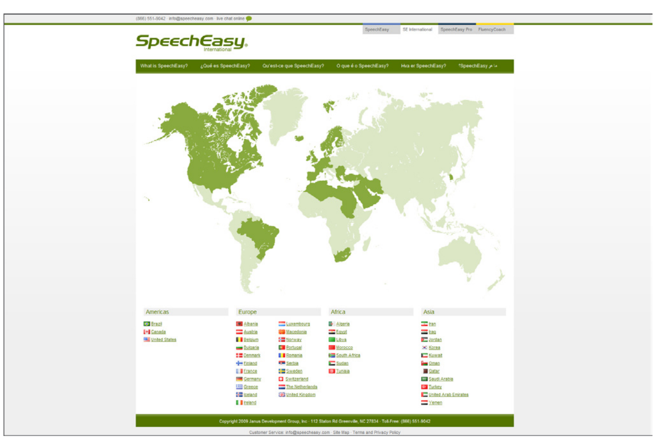
SEI's first Distributor Conference was held in San Diego on April 13, 2010. It was a full day of information, exchange of ideas, and fellowship. Feedback from participants was that it was definitely worthwhile, and that a forum for communicating amongst Distributors needs to be continued, possibly expanded. Copies of the PowerPoint presentation and a summary of the discussion that took place will be sent to you in the next week to 10 days.

In attendance representing SEI were Alan Newton and Dr. Tao Jiang, Managers, and Amber Snyder, Clinical Services Manager. Representing Distributors were Robin Matari, Arabian Millennium Trading; Janet Gibson, True Fluency Canada; Maria do Carmo Branco, Microsom; and Maria Hargrove and Vivian Topp, Ambilingual Latin America.

Janet Gibson (left) exhibiting SpeechEasy at a Canadian Stuttering Association conference, along with John Paskevitch (middle), producer of "Unspeakable", a film about stuttering, and Carla DiDomenicantonio (right), SpeechEasy Provider from Toronto.

Website Improvements

Please visit our site at **speecheasyinternational.com**. It is no longer necessary to access it through the Janus Development site, although that approach is still available. You'll notice that the list of countries is now grouped alphabetically by continent. Most importantly, information about SpeechEasy is now available in six languages, not English only. Your feedback and ideas for further improvement will continue to be appreciated.



Screenshot of the new SpeechEasy International website.

In The Spotlight!

SEI wants to use the next few issues of this newsletter to recognize the contributions of our International Distributors. Congratulations to Janet Gibson, President of True Fluency Canada. Janet began her association with SpeechEasy over six years ago, managing the SpeechEasy Department for Island Hearing Services based in Vancouver, Canada. When IHS elected to concentrate on their core business (hearing aids), they offered Janet the opportunity to acquire the distribution rights for SpeechEasy in Canada. We're glad!

Janet is dual-certified as a Speech Pathologist and Audiologist, and her company serves a population of about 34 million people through seven Speech Pathology clinics spread across Canada. TFC's vision is to "help People Who Stutter increase their fluency by providing quality fluency devices that are known, accepted and accessible throughout Canada." See the TFC website, **www.speecheasy.ca**, for more information. Janet's sales are impressive, especially when compared to other territories of similar size.

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(continued from "In The Spotlight!" on page 1)

To quote Janet, "It has been a great pleasure working with SEI over all these years and it is remarkable how many of the same people have remained involved. I feel that TFC is part of a big family that shares the values of integrity, client care and a passion for ensuring that SpeechEasy is accessible to People Who Stutter all over the world."

Thank you Janet for your pursuit of excellence! SEI is proud to be associated with you and True Fluency Canada.

Consumer Feedback

It's always nice to hear from satisfied customers, especially when the feedback is unsolicited. Please see the following letter from a consumer in Norway, whose evaluation and device were supplied by Aurismed, our Scandinavian Distributor:

Hello,

I'm a 28 year old nurse from Norway. I have been a stutterer all my life, and I only recently heard about the chances of getting a SpeechEasy. I got mine on January 5th this year, and it has completely changed my life around. My job has been much easier, and everybody around me has noticed the major difference and commented on it. Phone calls are a breeze, meetings with people and I no longer experience the same tiredness I used to due to all the repetitions I had during a busy day at work. It worked from day one, and I haven't stuttered since I got my SpeechEasy.

Thank you for creating such a wonderful device, I do hope that it will become less expensive and more available for the younger generations so that they might grow up without the social stigma that the rest of us have had to endure.

Sincerely,
Mette Krangnes, RN, BSN

Research

Attached is the latest known SpeechEasy research completed… "Neuronal Effects of the SpeechEasy Treatment for Stuttering." The study was conducted at three USA locations: Henry Ford Hospital, Oakland, University Rochester, and Wayne State University. The main conclusion was it shows there are neural processes that are altered with the SpeechEasy, and these alterations correlate with stuttering inhibition and functional areas of the brain that are implicated in stuttering.

Within the next week to 10 days, you will receive summary notes and PowerPoint presentations from the international conference. Please see the PowerPoint section on "Research Update" for the latest information on the Logan study at University of Florida, the Foundas study at Louisiana State University, and the Wang study with Parkinson's Disease at Rush University.

Distributor List

As a matter of practice, this publication will always include an updated listing of Distributors with contact information. It can be found on the following page.

Please Let Us Hear From You…

We hope you'll find this information interesting and useful. Once again, your thoughts, opinions, and suggestions are always appreciated. Best Wishes and good luck from the staff and management of SpeechEasy International!

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Neuronal effects of the SpeechEasy treatment for stuttering

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Abstract— **MEG imaging was used to localize brain regions activated during language processing in subjects who stutter with and without the use of the SpeechEasy device (compared to non-stuttering control subjects). This study was done to determine if the SpeechEasy device actually alters cortical processing when it helps relieve the symptoms of stuttering. Stuttering is a disruption in speech production, characterized by repetition, blocks or prolongation. The SpeechEasy is an in-the-ear auditory feedback device demonstrated to enhance fluency in people who stutter. It combines delayed auditory feedback with frequency altered feedback to create a choral effect, which occurs when people who stutter speak or sing in unison with others and the stutter is dramatically reduced or even eliminated. Eight stuttering subjects and five control subjects underwent MEG imaging to detect cortical activity during verb generation (VG) and single word speaking aloud (SA) tasks. MEG data analyses were performed utilizing a distributed source model (MR-FOCUSS) and displayed on a standard MRI brain image. These results indicated that VG task activates Wernicke's similarly regardless of the SpeechEasy device in the supramarginal gyrus (SMG). The SA tasks activated Broca's areas with a longer delay with the SpeechEasy device in place than without the use of the device (487 vs. 479ms). Greater activation in Broca's area was seen with the use of the SpeechEasy device. The main aim of this study is to establish the efficacy of specific MEG imaging techniques in determining the structure, activation sequence, and strength of neuronal interaction modulations during language processing with and without the SpeechEasy device. This study of MEG neuroimaging has increased our understanding of how choral effects, from the SpeechEasy device, impact the process of stuttering.**

Keywords— **Stuttering, MEG, MR-FOCUSS, SpeechEasy, Treatment.**

I. Introduction

Stuttering is a disruption in speech production that is primarily characterized by repetitions (sounds, syllables, words or phrases) or prolongations (audible or inaudible). There are many different theories about the anatomic basis for persistent stuttering, including those involving auditory perceptual deficits, hemispheral asymmetry, and deficits in motor planning or sequencing (Sommer, 2002; Foundas 2001 and 2004; Braun 1997; Salmelin 2000). To-date the underlying mechanism of stuttering has not been discovered and there is no cure for stuttering. One method for reducing the frequency of overt stuttering involves the presentation of auditory feedback. One type of treatment uses a device called the SpeechEasy. The SpeechEasy is an in-the-ear auditory feedback device that is reported to enhance fluency in people who stutter. It combines delayed auditory feedback (DAF) with frequency altered feedback (FAF) to create a choral effect. The choral effect occurs when people who stutter speak or sing in unison with others and the stutter is dramatically reduced or even eliminated.

Magnetoencephalography (MEG) imaging has been used to localize brain regions activated during language processing in normal subjects (Salmalin 2007, Bowyer 2004, Simos 1998). Since MEG can detect the activation of brain regions during langauge processing, it has been used in studies to explore cortical activation in people who stutter (PWS) and fluent speakers (Salmelin 2000, Salmelin 1998). These studies indicate differences in cortical organization between PWS and fluent speakers, but acknowledge that more detailed studies are required to determine the functional roles of the areas affected.

fMRI research has looked at the results of DAF on cortical functioning. Results suggest that there may be two biological subgroups of PWS, 1) those with anomalous anatomy of the auditory cortex, who improved more when using DAF than 2) those considered to have typical anatomy of the auditory cortex (Foundas 2004)

MEG was used in the present study to image the location of cortical processes of stuttering with and without the SpeechEasy device and to determine the latency and sequence of activation of the cognitive neural pathways involved in stuttering. These results will be of clinical use in determining if the SpeechEasy device actually alters cortical processing when it helps relieve stuttering.

II. Methods

A. Subjects

Nine patients who stutter and 5 non-stuttering control subjects were studied with 148 channel MEG (Magnes WH2500, 4D-Neuroimaging). Seven of the patients who stutter had never used the SpeechEasy device. The other two has used the SpeechEasy for over 1 year.

The stuttering population was referred by the Henry Ford Hospital Division of Speech-Language Sciences and Disorders. The control subject population had no history of stuttering, drug use, psychiatric or neurological (including head injury leading to loss of consciousness) and was not on any active CNS medications. All subjects gave written informed consent prior to MEG study. The Institutional Review Board of Henry Ford Hospital approved the protocol.

B. MEG Data collection procedures

Neuromagnetic recordings were carried out to measure spontaneous and language evoked brain activity. Each subject was prepared for the MEG study in our standard way (Bowyer 2003). The subject then lay comfortably on the bed, inside the magnetically shielded room. The neuromagnetometer helmet containing the detector array was placed around the subject's head in close proximity to most of the cortical surface. The subject was asked to avoid excessive eye blinks and body movements during data collection. Each data collection run lasted 5-10 minutes. From start to finish, the MEG procedure lasted ~1.5 hours.

MEG data were sampled at a rate of 508.63 Hz with a low pass filter set to 0.1 Hz and the high pass filter set to 100 Hz. Changes in the subject position between the beginning and end of a study were detected by changes in magnetic fields from the coils on the forehead and ears. Runs during which the subject's head shifted position more than 0.5 cm were repeated. Epochs that contain large artifacts were eliminated. Each subject was monitored by video camera and two-way audio speaker system during the time he/she is in the shielded room.

Spontaneous (resting state) brain activity was recorded by MEG for 10 minutes, while the subject was lying quietly on his/her back, with eyes open. Keeping eyes open eliminated coherent activity in the occipital cortex corresponding to alpha activity (7-12 Hz range).

Language evoked brain activity was measured during two separate tasks:

1) A semantic language task involved Verb generation (VG) which depicted everyday objects as visually printed nouns. During each presentation the subject was asked to generate a verb that is linked to each noun (e.g. airplane-fly). A set of 60 nouns were randomly shown for 2 seconds each with a new word generated every 3 seconds.

2) The second task was a Speaking aloud (SA) task where the subjects read the word visually presented. Approximately 60 concrete nouns [every day objects, selected for concreteness, and high frequency] were randomly shown for 1-second. After a blank interval of 1 second, a question mark appeared for 2 seconds, prompting the subject to read the word aloud.

These language tasks were run first with out the SpeechEasy device (stuttering treatment device). Then they were repeated with the SpeechEasy device in place. The SpeechEasy device was taped the patient's shoulder and an 8 inch tube was used to connect it to a sponge ear insert in the right or left ear. The analyses was performed on the latency, location and amplitude of functional brain activity utilizing a standard MRI scan rescaled to their digitized head shape, collected during the MEG study.

C. MEG Data Analysis

All data processing was performed with MEG-Tools (Moran 2004) using MATLAB. Data were then forward and backward filtered 1-50Hz. Independent Component analysis (ICA) was used to remove heart artifact from the raw MEG data. Then singular valued decomposition (SVD) of MEG data was used if needed to eliminate and other noise components, such as dental artifact, not removed by the ICA and frequency filtering.

<u>Analysis of language evoked data:</u> Language tasks were recorded as continuous data. The timing of stimuli presentations were recorded as pulse codes on a trigger channel. These trigger events were used to segment the data in to epochs of 2 seconds. These activation epochs (N=60) were averaged with a 500 ms pre-stimulus baseline and 1500 ms post-stimulus time. Data analysis was performed utilizing MR-FOCUSS (Moran 2005). MR-FOCUSS is a whole brain current density imaging technique designed to image focal concentrations of cortical activity. The MR-FOCUSS technique employs a discrete model of approximately 4000 source locations matched to the distribution of cortical gray matter derived from the volumetric MRI. Wernick's area activations were studied using the verb generation task. Evoked responses in the time interval 200-270 ms after word onset were located and used as the time mark for determination of the amplitude and latency of this response. Broca's area was studied using the Speaking aloud task. Evoked responses in the time interval 390-480 ms after word onset were used to located the latency and amplitude of this response.

<u>Analysis of the Spontaneous resting state MEG data:</u> Coherence imaging analysis was performed on the 10 minutes of resting state MEG data to identify cortical sources that interacted strongly within each frequency. MEG data were analyzed using MR-FOCUSS-ICA. First the ICA signal separation was applied to the filtered data to obtain signals from distinct cortical sources and then Secondly MR-FOCUSS-ICA (Moran 2005) was used to image cortical activation corresponding to these ICA signals. Then for

each frequency of the FFT spectra, the cross-spectral matrix of active brain sources was calculated then normalized and the absolute magnitude of each off-diagonal element was the coherence between 2 source locations. Finally, for each active cortical site, the average coherence with all other sources was calculated for each frequency. In addition, for each cortical site the connectivity was also calculated. The connectivity spectrum of an active site with other active sites was calculated by creating a histogram of the number of sources that are coherent with the target site for each of 20 levels of coherence between 0.05 and 1 for each FFT frequency component. Coherence images were generated for each consecutive 7.5 seconds of the 10 minutes of MEG data using MR-FOCUSS. These were averaged to obtain coherence magnitude and location of strongly interacting cortical sources. The variance across this set of images is a measure of the stability of the cortical network activity and allows changes in coherence across time to be assessed for statistical significance.

III. RESULTS

All patients who stutter (PWS) completed the language tasks with and without the Speech Easy device and underwent a 10-minute continuous resting state MEG scan without the SpeechEasy device. One subject's data (#9) was contaminated with noise artifact. Control subjects completed the language tasks and had a resting state scan.

Visual activation was detected in all subjects at ~100ms after stimulus onset during the language task runs.

Results from the verb generation (VG) task indicated activation in Wernicke's area was similar in controls and patients who stutter regardless of the SpeechEasy device. Activation was located in the supramarginal gyrus (SMG) in the latency interval 230$\pm$ 20 ms across all subjects. These latencies are consistent with those found in our previous study using a Picture naming task in Epilepsy patients and control subjects (Bowyer 2003) where latency of activation in Wernicke's area was 239$\pm$31 ms for all subjects.

The speaking aloud (SA) task was divided into two epochs the reading of the word and the speaking out loud of the word. The reading of the word detected activation in Wernicke's area similar to the VG task. In the speaking out loud trials activation of Broca's areas (Brodmann's area 45) was detected with a longer delay in patients who stutter with the SpeechEasy device in place than without the use of the device (438ms vs. 403ms). Figure 1 displays the MEG traces from a subject who stutters. The top trace is the evoked response to reading the word out loud without the speech easy device in place. In the bottom trace the same subject is using the SpeechEasy device and a larger amplitude wave is seen under the third arrow.

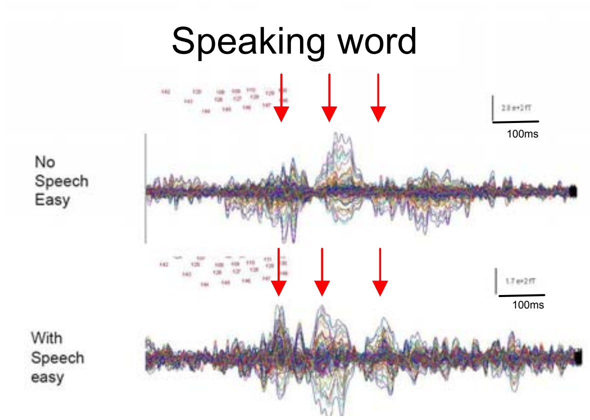

Figure 1: 148 MEG channel butterfly plots. MEG averaged evoked responses during speaking words aloud. Initial peak is visual processing, second peak is Wernicke's activation, and third peak is Broca's activation. Note in bottom trace Broca's activation is clearly seen with the use of the SpeechEasy device.

Figures 2 displays brain activation during Broca's area activation without the use of the SpeechEasy device in one left handed subject who stutters. Figure 3 is the same subject with using the speech easy device during the same speaking aloud trial of the SA task. Note greater activation in the Right Inferior Frontal Gyrus (IFG) Brodmann's area (BA) 45 also known as Broca's area was detected with the SpeechEasy device in place (Fig 3 ~0.17 nAm) than without (Fig 2 ~ 0.08). The Talairach XYZ center for this subject was located at: 42.5 40.6 8.1 in mm and the MNI XYZ center was located at: 47.6 45.4 6.5 also in mm. Activation was detected in the Left IFG in right-handed subjects. Our previous study of picture naming to determine Broca's activation detected activation latencies of 436$\pm$40 ms across Epilepsy patients and control subjects. This study found similar latencies for Broca's activation.

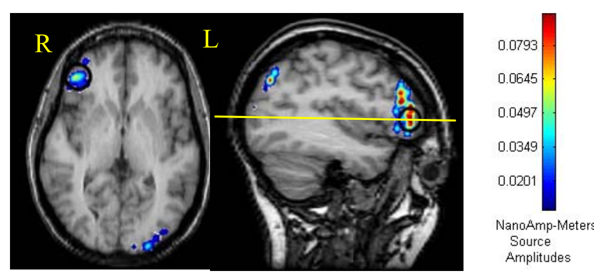

Figure 2 MRI scan with cortical activation located in Broca's area (BA 45) seen at 403ms after onset of visual stimuli (question mark). This is a Left handed subject who stutters, but does not have the SpeechEasy device in his ear. Yellow line indicates axial slice.

Coherence imaging detected high activation in the inferior frontal cortex (Broca's area) compared to controls dur-

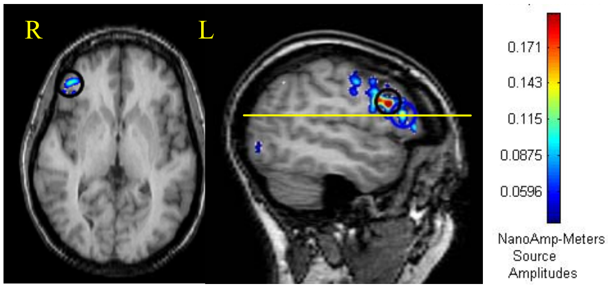

Figure 3 MRI scan with cortical activation located in Broca's area (BA 45 and 46) seen at 438ms after onset of visual stimuli. This is the same subject in fig 2 while using the SpeechEasy device. Note higher source amplitudes and larger areas of activation in the IFG compared to figure 2. Yellow line indicates axial slice.

ing the resting state (no speech). Figure 4 displays the IFG area of a patient who stutters while at rest. Activation in the right or left IFG and STG did not correlate with handedness. All PWS had high coherence in the IFG. Coherent levels were ~0.33 for the PWS group. The Control subjects had very low levels of coherent activity detected during the rest state MEG scan, all coherence levels were below 0.2.

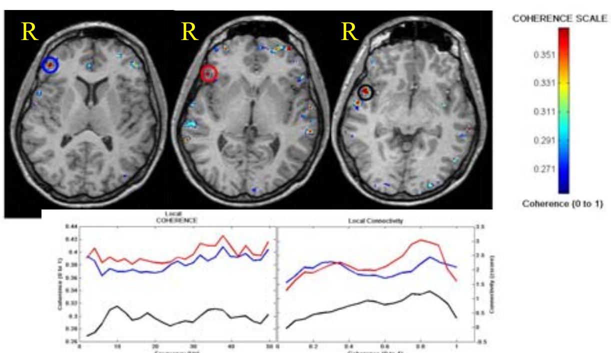

Figure 4: Resting state data shows high levels of coherence in the inferior frontal gyrus (IFG) (Circles: blue BA 45, red BA 47) as well as auditory cortex (Circle: black BA 22), same subject as Fig 2 and 3.

IV. DISCUSSION

The main aim of this study was to determine the location, latency and and strength of neuronal interaction differences during language processing with and without the SpeechEasy device. We found increased cortical activity in each subject IFG (Broca's area) during the use of the Speech Easy Device compared to the MEG measurement without the SpeechEasy in place. The increased cortical activation with the SpeechEasy device in place (~0.200nAm) was still lower compared to control subjects (~0.380nAm).

Our findings are similar to other studies that noted activation differences in Broca's area between subjects who sutter and contol subjects. We also found high areas of coherent activity in the inferior frontal gyrus and auditory cortex during the resting state while the subject was not speaking. Further investigation is indicated as a result of the resting state finds.

V. CONCLUSIONS

This study of MEG neuroimaging has increased our understanding of how choral effects, from the SpeechEasy device, impact the process of stuttering.

ACKNOWLEDGMENT

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