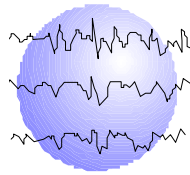# THE RELATIONSHIP BETWEEN AUDITORY NAMING AND FUNCTIONAL NEUROIMAGING OF THE LATERAL TEMPORAL LOBE

Robert C. Doss, PsyD
Gail L. Risse, PhD
Wenbo Zhang, MD, PhD

This paper has been prepared specifically for:

American Epilepsy Society Annual Meeting
Philadelphia, PA
November 30 - December 4, 2007

Please consider this information to be preliminary findings.

Abstract available electronically at: www.aesnet.org [2.259]

REVISED ABSTRACT

RATIONALE: Auditory naming (AN) is an ecologically valid method for assessing word-finding deficits and has been reliably interrupted by electrocortical stimulation (ECS) of the temporal lobe. Moreover, AN has been found to be impaired in left vs. right temporal lobe (TL) epilepsy patients and appears to best discriminate these two groups among a number of common neuropsychological (NP) measures. Magnetic Source Imaging (MSI) is a functional neuroimaging procedure, which is being used to localize language specific regions in the brain. This study investigated the relationship between MSI TL language activations and performance on language measures by patients undergoing pre-surgical NP evaluation. The hypothesis is that AN will demonstrate the strongest relationship with left hemisphere MSI TL activations.

METHODS: The sample consisted of 27 subjects (age 18-65 years) with epilepsy and/or brain tumor who had undergone presurgical evaluation at the Minnesota Epilepsy Group. The sample was 56% male and 85% right handed. Left hemisphere pathology was seen in 78%. For MSI language mapping, an auditory word recognition task was used to activate TL language-specific cortex. The MEG unit consisted of a 148-channel Magnes 2500 WH system housed in a magnetically shielded room. Single equivalent current dipole (ECD) model across each whole hemisphere was used in the analysis of language data. However, only activations in the lateral right and left TL were retained for further analysis. A language asymmetry index (AI) was calculated using the formula R-L/R+L. NP test results were obtained as part of a standard pre-surgical evaluation. The following tests were correlated with both the MSI total TL language activations and MSI AI using a bivariate SPSS procedure: WAIS-III Vocabulary (VOC), Information (INF), and Similarities (SIM), AN, Boston Naming Test (BNT), and D-KEFS Animals fluency (AF). Total correct raw scores were used for each test.

RESULTS: In this sample, 82% showed relative left hemisphere dominance with respect to MSI TL language activations. There were no significant correlations between any test and total TL language activations. The following 1-tailed Pearson correlation coefficients (r) between the AI and NP test results were obtained: VOC = -.13(ns), INF = -.21(ns), SIM = .09(ns), BNT = -.35(p = .035), AF = .06(ns), and AN = -.41 (p = .017).

CONCLUSIONS: As predicted, AN demonstrates the strongest relationship to MSI TL language activations among commonly administered language measures. The observed relationship reveals that higher AN scores are associated with a greater preponderance of language activity sources in the left TL. These data indicate the superiority of the left hemisphere to support language regardless of handedness or lesion location. These preliminary results further support the finding that AN is a valid measure of left TL function and the inclusion of this test in presurgical evaluations.

Introduction:

Auditory naming (AN) may be a more ecologically valid method of assessing word-finding deficits than confrontational visual naming (VN) procedures. Focal left (L) temporal lobe epilepsy (TLE) patients have consistently shown reduced visual naming as compared to right (R) TLE patients in both pre-surgical1 and post-surgical evaluations.[2]

Several authors have reported on AN performance in TLE[3-4] with L TLE patients performing significantly worse than R TLE patients on all aspects of the test. Moreover, AN appears to best discriminate L and R TLE patients among a number of common neuropsychological (NP) measures including VN.[5] Auditory naming has been reliably interrupted by electrocortical stimulation (ECS) of the temporal lobe (TL).[6] Finally, resection of auditory naming sites identified by ECS mapping is associated with naming decline postoperatively.[7]

Magnetic Source Imaging (MSI) is a functional neuroimaging procedure, which is being used to reliably localize language specific regions in the TL of the brain.[8]

This study investigated the relationship between MSI TL language activations and performance on language measures by patients undergoing pre-surgical NP evaluation. The hypothesis is that AN will demonstrate the strongest relationship with left hemisphere MSI TL activations.

Methods:

The sample consisted of 27 subjects (age 18-65 years) with epilepsy and/or brain tumor who had undergone presurgical evaluation at the Minnesota Epilepsy Group. Please see Table 1 for group characteristics. The sample was 56% male and 85% right handed. Left hemisphere pathology was seen in 78%.

For MSI language mapping, an auditory word recognition task was used to activate TL language-specific cortex. An auditory stimuli system (Apple Macintosh, SuperLab software, and sound amplification) was used to deliver a pre-designed task (word recognition) that has been developed and reported previously.[8]

The MEG unit consisted of a 148-channel Magnes 2500 WH system (4-D Neuroimaging, San Diego, CA). The authors who completed the MSI language analysis were blinded to the patients' neuropsychological test results. Single equivalent current dipole (ECD) model was used in the analysis of language data and has been validated by other investigators. Selection of dipoles was restricted to the lateral temporal lobe including the perisylvian region of both cerebral hemispheres.[8] Moreover, mesial temporal activations were not included in these analyses. A language asymmetry index (AI) was calculated using the formula R-L/R+L. Index values between -0.1 and 0.1 were considered to denote bilateral language activation. Values greater than 0.1 or less than -0.1 were indicative of relative right or left hemisphere dominance, respectively. Please see Figure 1 for typical MSI TL activation profiles.

NP test results were obtained as part of a standard pre-surgical evaluation. The following tests were correlated with both the MSI total TL language activations and MSI AI using a bivariate SPSS procedure: WAIS-III Vocabulary (VOC), Information (INF), and Similarities (SIM), AN, Boston Naming Test (BNT), and D-KEFS Animal fluency (AF). Total correct raw scores were used for each test.

Results
In this sample, 82% showed relative left hemisphere dominance with respect to MSI TL language activations.

There were no significant correlations between any test and whole brain TL language activations: AN = -.02, BNT = .06, INF = -.05, VOC = -.02, SIM = -.04, and AF = .08.

Significant 1-tailed Pearson correlation coefficients (r) between the AI and NP test results were obtained for AN = -.41(p = .017) and BNT = -.35(p = .035).

All other correlations were not significant: INF = -.21, VOC = -.13, SIM = .09, and AF = .06. Please see Figure 2 for an array of scatter plots of these data.

The direction of the two significant relationships (AN & BNT) shows that higher naming scores are associated with a greater number of language activity sources in the left TL.

Conclusions:
◆ 82% of the sample showed relative left hemisphere dominance with respect to MSI TL language activations.
◆ As predicted, AN demonstrates the strongest relationship to MSI TL language activations among commonly administered language measures.
◆ The observed relationship reveals that higher AN scores are associated with a greater preponderance of language activity sources in the left TL.
◆ These data indicate the superiority of the left hemisphere to support language regardless of handedness or lesion location.
◆ These preliminary results further support the finding that AN is a valid measure of left TL function and the inclusion of this test in presurgical evaluations.

References:

1. Schefft, B.K., Testa, S.M., Dulay, M.F., Privitera, M.D., & Yeh, H. (2003). Preoperative assessment of confrontational naming ability and interictal paraphasia production in unilateral temporal lobe epilepsy. Epilepsy & Behavior, 4, 161-168.
2. Hermann, B.P., Perrine, K., Chelune, G.J., Barr, W., Loring, D.W., Strauss, E., Trenerry, M.R., & Westerveld, M. (1999). Visual confrontational naming following left anterior temporal lobectomy: A comparison of surgical approaches. Neuropsychology, 13, 3-9.
3. Hamberger, M.J., & Tamney, T.R. (1999). Auditory naming and temporal lobe epilepsy. Epilepsy Research, 35, 229-243.
4. Hamberger, M.J., & Seidel, W.T. (2003). Auditory and visual naming tests: Normative and patient data for accuracy, response time, and tip-of-the-tongue. Journal of the International Neuropsychological Society, 9, 479-489.
5. Doss, R.C. & Risse, G.L. (2006). Auditory naming performance in temporal lobe epilepsy. Poster presented at the International Neuropsychological Society Annual Meeting, Boston, MA, USA.
6. Hamberger, M.J., Goodman, R.R., Perrine, K., & Tamney, T.R. (2001). Anatomic dissociation of the auditory and visual naming in the lateral temporal cortex. Neurology, 56, 56-61.
7. Hamberger, M.J. Seidel, W.T., McKhann, G.M., Perrine, K., & Goodman, R.R. (2005). Brain stimulation reveals critical auditory naming cortex. Brain, 128, 2742-2749.
8. Papinicolaou, A.C., et al (2004). Magnetoencephalography: a noninvasive alternative to the Wada Procedure. Journal of Neurosurgery, 100, 867-876.

Table 1

Patient Characteristics & Test Descriptives

N	27
Age at MSI[1]	42.0 (15.3)
Gender (% Male)	56%
Handedness (% Right)	85%
Education[1]	13.3 (2.3)
Full Scale IQ[1]	100.0 (14.1)
Laterality of Pathology	
Left	21
Right	6
Etiology	
Seizure	9
Brain Tumor	9
Brain Tumor/Seizure	9
VOC[1]	41.5 (12.7)
INF[1]	16.0 (6.7)
SIM[1]	21.2 (5.3)
AF[1]	17.5 (5.7)
BNT[1]	51.0 (6.6)
AN[1]	46.7 (5.8)

[1] = M(SD)
VOC = WAIS-III Vocabulary
INF = WAIS-III Information
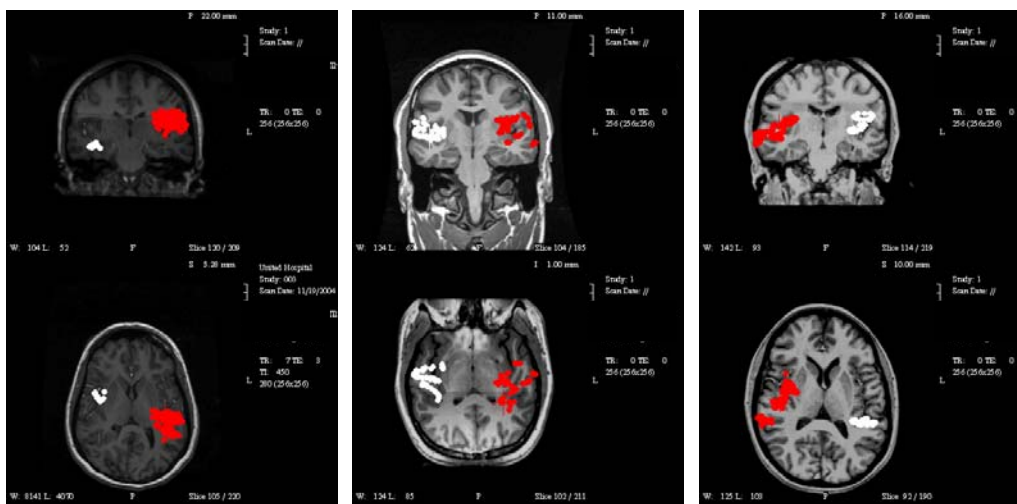SIM = WAIS-III Similarities

AF = D-KEFS Animal Fluency
BNT = Boston Naming Test
AN = Auditory Naming
Note: All scores are Total Correct raw scores

Figure 1

Typical MSI TL Activation Profiles

AI = -.83; Left Dominant   AI = -.05; Bilateral   AI = .59; Right Dominant

Note: These figures represent composite MEG receptive language activation sites merged onto a central slice from 3T MRI

Figure 2

MSI x NP Scatter Plots