Temporal Coupling of the Left and Right M100:
Pure Tone Processing in Children with Autism, Siblings and Typically Developing Children

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Assessing Auditory Temporal Resolution

The temporal resolution of the auditory system is exquisite, with neural networks capable of submillisecond resolution in decoding features in the acoustic signal. The auditory evoked M100 component, detected by magnetoencephalography (MEG), is highly sensitive to fine-grained spectrotemporal features in sounds, and is thought to index an intermediate stage between sensory (acoustic) and perceptual (representational) processing.

In healthy adults, M100 latency is closely coupled in time (<20ms) in left (LH) and right hemispheres (RH), with LH latency typically slightly later than RH. The neural bases of this effect have not been elucidated, however it occurs for both speech and non-speech sounds. Far less is known about the temporal coupling of M100 in LH and RH in typical development and in language disorder, such as autism. We measured hemispheric asymmetries in M100 latency in typically developing children (TD), children with autism disorder (AD), and their siblings (SIB) in response to sinusoidal tones of varying frequency. We compared LH and RH M100 latency offset by calculating a symmetry index (SI) and computing absolute left-right M100 latency differences. To examine within hemisphere timing differences, we calculated a dynamic range across tone frequencies. Additionally for a subset of the AD group in whom neuropsychological data were available, we investigated the relationships between the M100 and cognitive function. Lastly, for a partially overlapping sample, we compare patterns found in the auditory brainstem response (ABR) with those found in MEG.

Methods

Participants: MEG: 11 TD, Mean age=10.1 yrs; 10 SIB, Mean age=10.8 yrs; 18 AD, Mean age=11.2 yrs
ABR: 20 TD, Mean age=10.9 yrs; 20 AD, Mean age=10.7 yrs

Stimuli: MEG: Random interleaved presentation with an ITI jittered around 1 second
Binaural pure tones at 250, 500, 1000, and 2000 Hz, each 250 ms in duration
ABR: Square-wave clicks presented to each ear monaurally at 19 and 61 Hz

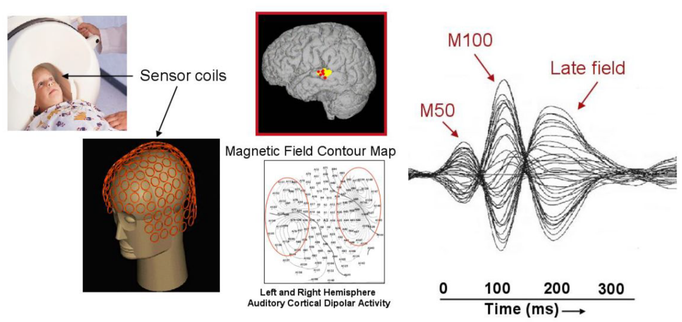
Analyses: MEG: Across hemisphere analyses focused on two factors - magnitude of left/right offset and direction of offset, assessed as below.

Magnitude: Absolute Value of Left - Right M100 Latency Offset
Direction: Symmetry Index = [2(L-R)/(L+R)]
*Positive SI values indicate LH>RH latency, indicative of the typical adult pattern

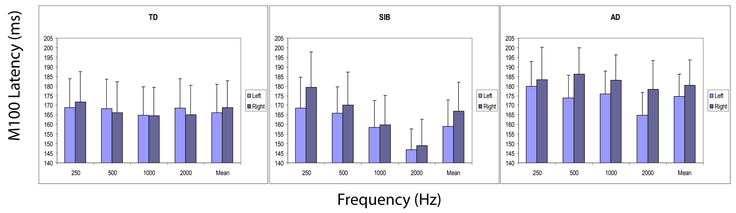
Within hemisphere analyses focused on the dynamic range of latency, as measured by the difference between normalized latencies for 250 Hz and 1000 Hz
ABR: Analyses focused on the difference between fast and slow click rates at each wave.
Neuropsych: Correlational analyses were conducted between MEG measures and standard neuropsychological measures, with focus on those related to language (i.e. PPVT)

Measures of Cortical Sound Processing: Magnetoencephalography (MEG)

The neuromagnetic evoked field detected by MEG reflects the synchronized cortical activity of populations of neurons time locked to stimulus onset.

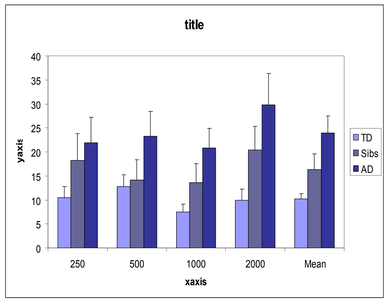


M100 Latencies



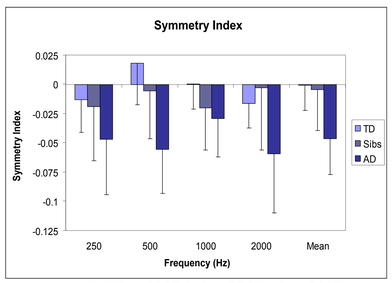
In general, the AD group tended toward increased latencies, but there were no significant group differences in mean latency

M100 Latency Offsets: Magnitude



Magnitude of left-right offset was greatest in the AD group and smallest in the TD group, with the SIB falling in between the two. Group ANOVA was significant, F(2,36)=4.834, p=.014, as was the TD-AD pairwise comparison, t(20.345)=-3.684,p=.001

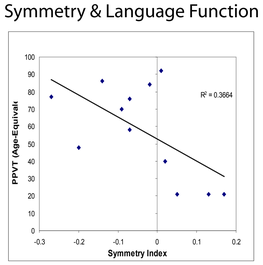
M100 Latency Offsets: Direction



Mean SI: TD = .0007, SIB = .0048 AD = .0467

In all groups, there was a trend toward right latency being longer than left, fairly consistent across stimuli. This trend was strongest in the AD group, weakest in the TD, with the SIB group again representing a midpoint. Due to high individual variability, group ANOVA was non-significant, as were the individual points tested against zero.

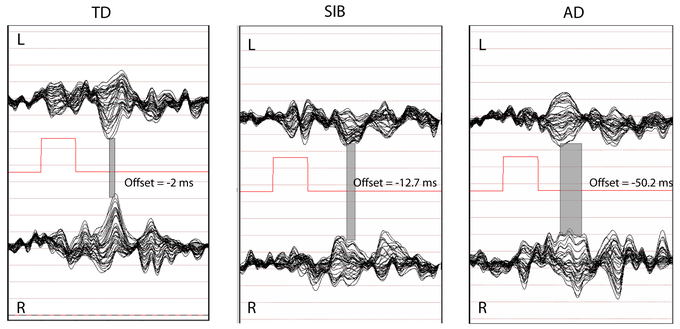
Symmetry & Language Function



AD only
r=-.604,p=.038

The symmetry index was significantly correlated with scores on the PPVT, a measure of word learning, suggesting that rightward latency prolongation has some functional signfiicance in AD for higher-level auditory processing.

Waveforms: Group Comparison

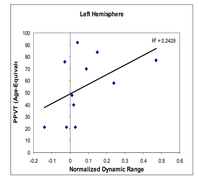


These subjects illustrate the group trend of smallest offset for TD and largest for AD, with SIB's lying between the two.

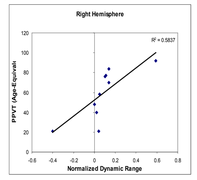
M100 Within-Hemisphere: Dynamic Range

AD Only

r=.497,p=.120



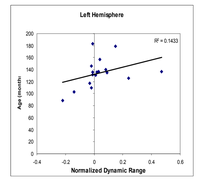
PPVT



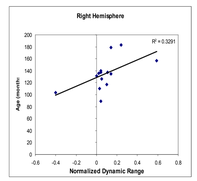
r=.766,p=.010

Greater dynamic range was associated with higher PPVT scores, but the effect was only significant in the right hemisphere.

r=.374,p=.139



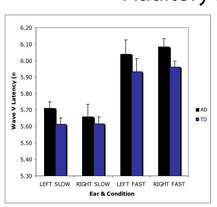
Age



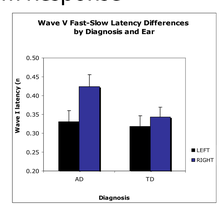
r=.575,p=.031

Greater dynamic range was also associated with an increase in age, but the effect was again only significant in the right hemisphere. Age and PPVT scores were not significantly correlated in this sample, r=.399, p=.199.

Auditory Brainstem Response



Wave V



The AD group generally showed increased latencies across ears and click rates. This difference was particularly marked (and marginally significant at p=.078) in the right ear pathway, which is largely directed to the right hemisphere.

Conclusions

We found that in general, children did not show the relative prolongation of M100 latency in the left hemisphere in response to pure tones that is typically seen in healthy adults, instead tending to show a rightward trend. This effect was most pronounced in children with autism, with their siblings representing a midpoint between AD and typical development, and was seen for both the magnitude and direction of hemispheric offset. Additionally, within the AD group, direction of hemispheric offset was related to language function, as was dynamic range within the right hemisphere. Coupled with the right ear findings in ABR for AD, this suggests the possibility of a role for the right hemisphere in language deficits in autism.

Acknowledgements

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