Phonologically related EEG as a more reliable diagnostic tool in the recovery of aphasia in the different stages after stroke

Background

Stroke-related aphasia recovery follows different stages, evolving from the acute and subacute phase (< 6 months post stroke) into the chronic phase (> 6 months post stroke). In general, phonology remains tenaciously disturbed, making it a reliable language marker to investigate in every stage of recovery. Phonological abilities can be examined both on a behavioral and on an electrophysiological level (by means of phonological event-related potentials/ERP's).

In Aerts et al. (2015), phonological ERP's were suggested to be 1) a reliable tool for the follow-up of aphasia recovery and 2) more sensitive than the behavioral data. The current study was performed in order to sustain these preliminary findings.

Method

Patients (6♂ and 2♀):
- Mean age T1: 59.0 years (+/- 9.4); mean age T2: 59.4 years (+/- 9.5)
- Hemorrhagic stroke (n=4) or ischemic stroke (n=4) in the left hemisphere
- Right-handed (n=7)

Table 1: Demographic information of the 8 patients with aphasia

<table>
<thead>
<tr>
<th>Patient</th>
<th>Lesion localization</th>
<th>Weeks post stroke (T1)</th>
<th>Recovery stage (T1)</th>
<th>Aphasia type (T1)</th>
<th>Weeks post stroke (T2)</th>
<th>Recovery stage (T2)</th>
<th>Aphasia type (T2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Parietal temporal</td>
<td>5.7</td>
<td>(sub)acute</td>
<td>Remitted</td>
<td>26.1</td>
<td>chronic</td>
<td>Amnestic</td>
</tr>
<tr>
<td>2</td>
<td>Putamen, caudatum</td>
<td>1.0</td>
<td>(sub)acute</td>
<td>Remitted</td>
<td>4.9</td>
<td>chronic</td>
<td>Amnestic</td>
</tr>
<tr>
<td></td>
<td>putamen, globus pallidus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Parietal temporal</td>
<td>1.0</td>
<td>(sub)acute</td>
<td>Remitted</td>
<td>24.0</td>
<td>chronic</td>
<td>LC</td>
</tr>
<tr>
<td>4</td>
<td>Putamen temporal</td>
<td>1.4</td>
<td>(sub)acute</td>
<td>Remitted</td>
<td>20.1</td>
<td>chronic</td>
<td>Amnestic</td>
</tr>
<tr>
<td>5</td>
<td>Temporal</td>
<td>40.0</td>
<td>chronic</td>
<td>Remitted</td>
<td>88.8</td>
<td>chronic</td>
<td>Remitted</td>
</tr>
<tr>
<td>6</td>
<td>Parietotemporal, putamen, globus pallidus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Caudatum, putamen, globus pallidus</td>
<td>26.6</td>
<td></td>
<td></td>
<td>48.6</td>
<td>chronic</td>
<td>Remitted</td>
</tr>
<tr>
<td>8</td>
<td>Basal ganglia, internal capsule</td>
<td>76.9</td>
<td></td>
<td></td>
<td>119.1</td>
<td>chronic</td>
<td>Global</td>
</tr>
</tbody>
</table>

T1 = first evaluation moment; T2 = second evaluation moment; LC = unclassified

Behavioral evaluation: Aachen Aphasia Test (AAT)

Electrophysiological evaluation:
- Pre-attentive phonological discrimination - Mismatch Negativity/MMN
- Attentive phonological discrimination - P300

Results

1. The predictive value of the phonological MMN and P300 in aphasia recovery

Fig. 1 Grand average of the MMN of the 4 patients in the (sub)acute stage (T1) – electrode position Cz

Fig. 2 Grand average of the P300 of the 4 patients in the (sub)acute stage (T1) – electrode position Pz: red = standard stimulus, black = deviant stimulus

The presence of a phonological MMN or P300 in the (sub)acute stage is predictive of ceiling effects on several AAT-subtests in the chronic phase:
- Language comprehension (4/4 patients)
- Naming (3/4 patients)
- Written language (3/4 patients)

2. The sensitivity of the phonological MMN and P300 in aphasia recovery

In both the (sub)acute and chronic stage, behavioral deficits (AAT) are confirmed by deviant amplitude and/or latency values of the MMN and P300 as compared to the normative data (Aerts et al., 2013).
- The MMN and P300 are highly sensitive for subtle language deficits since amplitude or latency deviations are detected even when behavioral ceiling effects have been reached.

Conclusion

The predictive value and high sensitivity of the MMN and P300 advocate a definite implementation of linguistic ERP’s in aphasia examination. In this context, the development of a user friendly and financially acceptable EEG device is necessary.

References
