Advance movement preparation in hemiparetic patients: Electrophysiological indices

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**Background**

- Stroke frequently causes hemiparesis, a unilateral loss of motor function. A better understanding of the processes associated with this motor deficit is important for treatment development.
- Motor control is heavily dependent on movement planning and motor cognition mediated by areas such as SMA and pre-motor cortex. How hemiparesis affects these processes is presently unclear.
- In this event-related potential (ERP) study, advance movement preparation, a key principle of motor cognition, was investigated in stroke patients with hemiparesis using the response-priming paradigm.
- The late Contingent Negative Variation (CNV) was recorded as a electrophysiological marker to evaluate movement preparation deficits in this patient group.

**Methods**

**Participants**

* Stroke Patients
  - 30 stroke patients with lower-functioning chronic hemiparesis of the left arm
  - Right hemispheric lesions
  - 15 Male, 15 Female
  - Mean age: 53.3 ± 2.3 [25-76] yrs
  - Premorbid hand dominance: 26 right/4 left

* Controls
  - 30 age-matched controls
  - 14 Male, 16 Female
  - Mean age: 53.5 ± 2.2

**Response Priming Paradigm**

- prime (S1) 
- response cue (S2)
- RT 1300 ± 150ms
- no response

**EEG recording and analysis**

- 64 electrode array placed according to the International 10-10 system
- Sampling rate: 500Hz, low-pass filter: 25Hz
- Statistical analysis of CNV and scalp-topography maps in time window from -100 to 0 ms relative to the response cue onset (S2)
- Electrode clusters comprised: LH, RH, and midline electrodes
- Data analysis comprised within-group comparisons for patients (affected vs. unaffected hand) and between-group comparison for all conditions.

**Behavioural Results**

- Stroke patients were significantly slower than controls (difference: 270ms), both for the affected (414ms, p<0.001) and the unaffected arm (125ms, p<0.005).
- Responses with the affected arm were slower than responses with the unaffected arm (302ms, p<0.001).
- Response priming effects (neutral minus valid cue) were larger in stroke patients (181ms) than controls (51ms, p<0.001).
- Priming effects were enhanced for the affected (243ms) compared to the unaffected arm (119ms, p<0.001).

**CNV Results**

- EEG activity differed between the four motor preparation conditions for both stroke patients (p<0.001) and controls (p<0.001).

- Stroke (Blue Border):
  - The CNV amplitude for the validly cued affected hand was significantly enhanced compared to all other cueing conditions over the right (lesioned, contralateral) hemisphere, midline, and central left (intact, ipsilateral) hemisphere.
  - The CNV amplitude of the validly cued unaffected hand was significantly larger compared to the CNV of the no response cue and the neutral cue condition for the left hemisphere (intact, contralateral) but not for the midline and not the right (lesioned, ipsilateral) hemisphere.

- Control (Green Border):
  - CNV amplitudes measured over the hemispheres contralateral to the validly cued hand were enhanced relative to CNV amplitudes in the neutral and no response cue conditions.

**Conclusion**

- Slower reaction times, but larger validity effects, in hemiparetic patients compared to controls indicate that advance movement preparation is present in patients but might not be as efficient.
- Movement preparation for the affected hand utilises areas in the midline and intact, ipsilateral hemisphere to a greater degree. The CNV activity over the lesioned, contralateral hemisphere might be caused by volume conduction.
- Movement preparation of the unaffected hand is normal over the contralateral, intact hemisphere but reduced for the lesioned hemisphere.
- These data, in combination with the data showing a significant reduction in activity for the neural and no priming condition, imply that the lesioned hemisphere has little if any motor preparatory role.
- Competition for resources in unaffected motor areas could explain the generalised reaction time slowing of the patients.