Exploratory Study of the Central Nervous System Response in Facial Synkinesis after Bell’s palsy

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Introduction

- Facial synkinesis is the coupling of unintentional facial movements with those that are intentional, generally involving the periocular, midface, perioral, chin and neck muscles [Figure 1].[1]
- Commonly, patients with synkinesis attempt to close their eyes and experience unintentional lip movement or attempt to smile and experience unintentional eye closure.
- Facial synkinesis develops weeks or months after facial nerve injury, and is most commonly seen after idiopathic facial nerve injury, e.g. Bell’s palsy (BP).
- Synkinesis is thought to occur secondary to both aberrant peripheral nerve regeneration and neuronal reorganization in the facial nucleus.[2,3]
- Although there are data to support cortical reorganization in patients with BP, there are no such data in synkinesis.[4-7]

Figure 1. Subject with right-sided synkinesis with inadvertent eye closure and decreased excursion of the oral commisure during smile.

Methods

- Functional magnetic resonance imaging (fMRI) was used to characterize changes in the central nervous system (CNS) by studying changes in the motor cortex and sensorimotor integration regions during motor tasks that elicit facial synkinesis.
- 14 subjects with a history of BP (7 fully recovered (FR), 7 with synkinesis) completed the validated Synkinesis Assessment Questionnaire (SAQ) and Edinburgh Inventory forms.
- Subjects performed a series of facial motor tasks, alternating between blinking, smiling and a baseline rest condition, while undergoing fMRI scans in a 3 Tesla Siemens Prisma scanner.

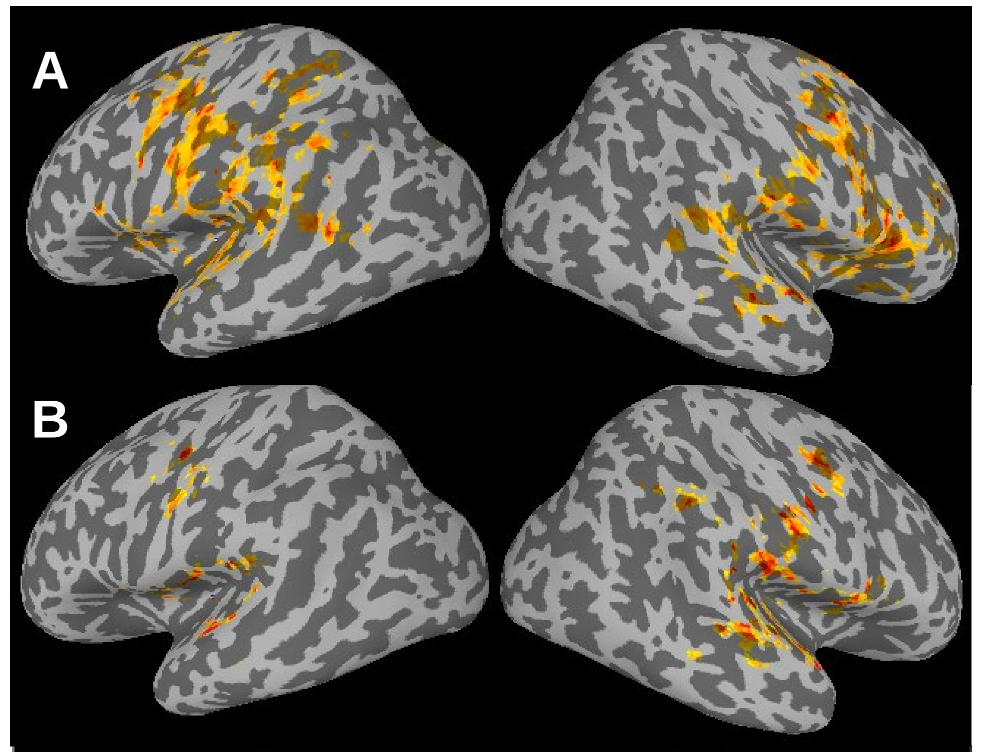

Figure 2. Cortical activation associated with both Smile and Blink conditions, overlaid on an inflated cortical surface (left is on left) and mapped in the MNI coordinate atlas. Activation maps reflect random effects analysis thresholded at P < 0.01, minimum cluster filter = 50 voxels). Activation in the (A) FR group (N=7) was stronger than in (B) Synkinesis group (N=7). Activation was present bilaterally in anterior supplementary motor cortex along midline, preCentral gyrus, Central Sulcus and postCentral gyrus in FR group. Refer to Fig. 4 for ROI mapping.

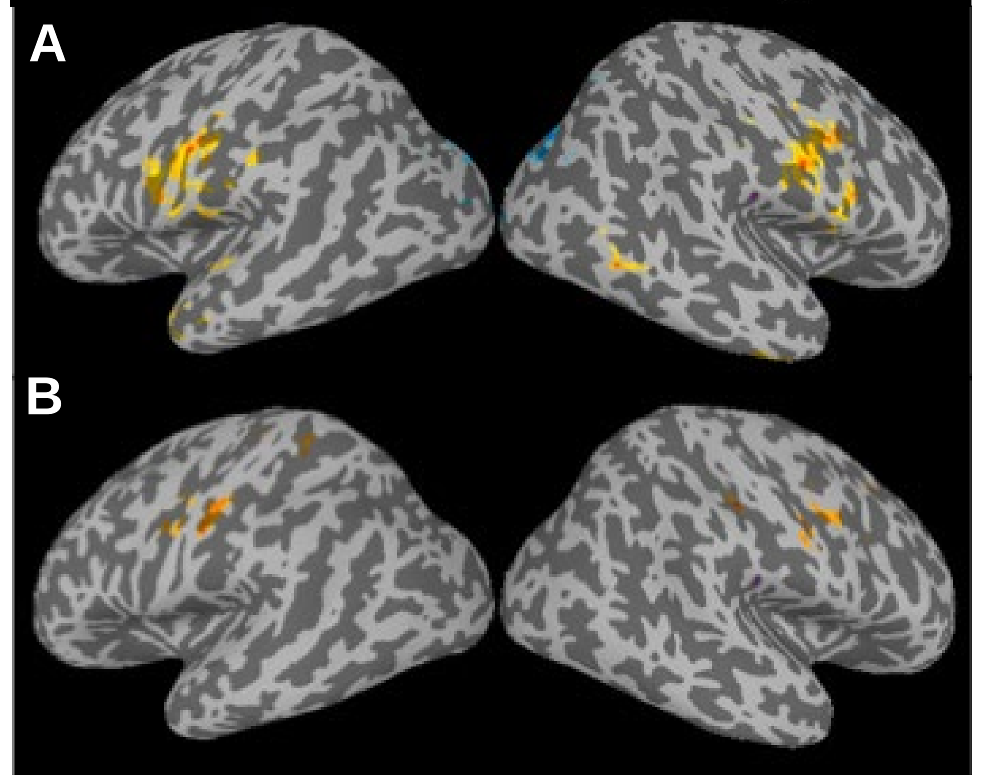

Figure 3. The contest of the the Smile and Blink conditions (Smile-Blink) revealed those brain areas were relatively more responsive during Smile than Blink tasks for both groups. FR group had activation in preCentral gyrus and Central sulcus related to the Smile condition, while Synkinesis again showed less response in the preCentral and Central sulcus bilaterally.

ROI Comparison between Fully Recovered and Synkinesis Subjects

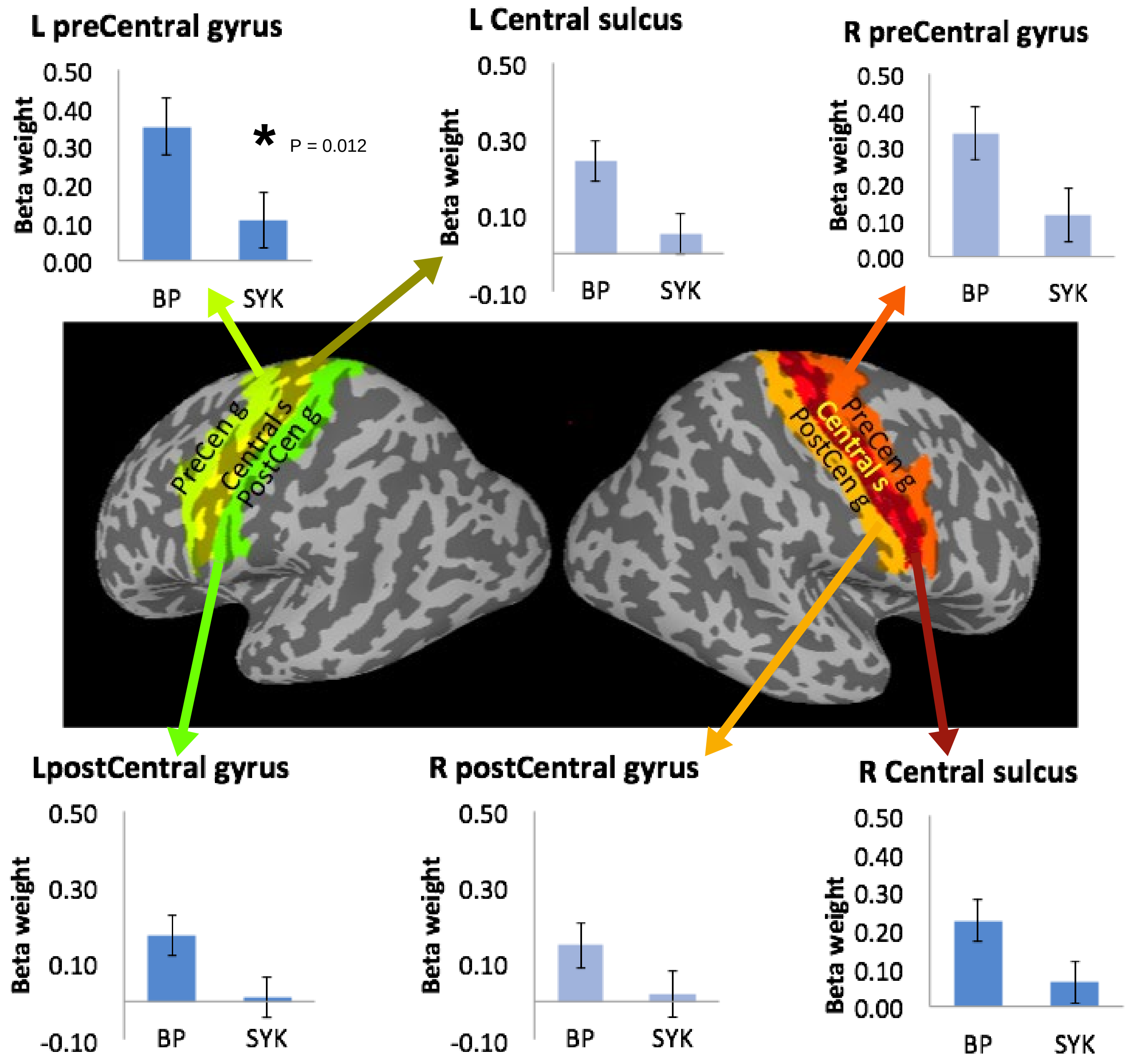

Figure 4. We compared ROI within the motor planning (preCentral gyrus), motor execution (Central sulcus), and somato-motor feedback (postCentral gyrus) areas. Synkinesis group has less signal during smile and blink conditions than FR group. Across all regions bilaterally, Synkinesis showed less activation during tasks than FR, although the effect only reached significance in the left preCentral gyrus. BP = fully recovered from BP; SYK = synkinesis after BP. Beta weight = signal change from baseline, “signal strength”.

ROI Comparison Between Affected and Unaffected Hemispheres

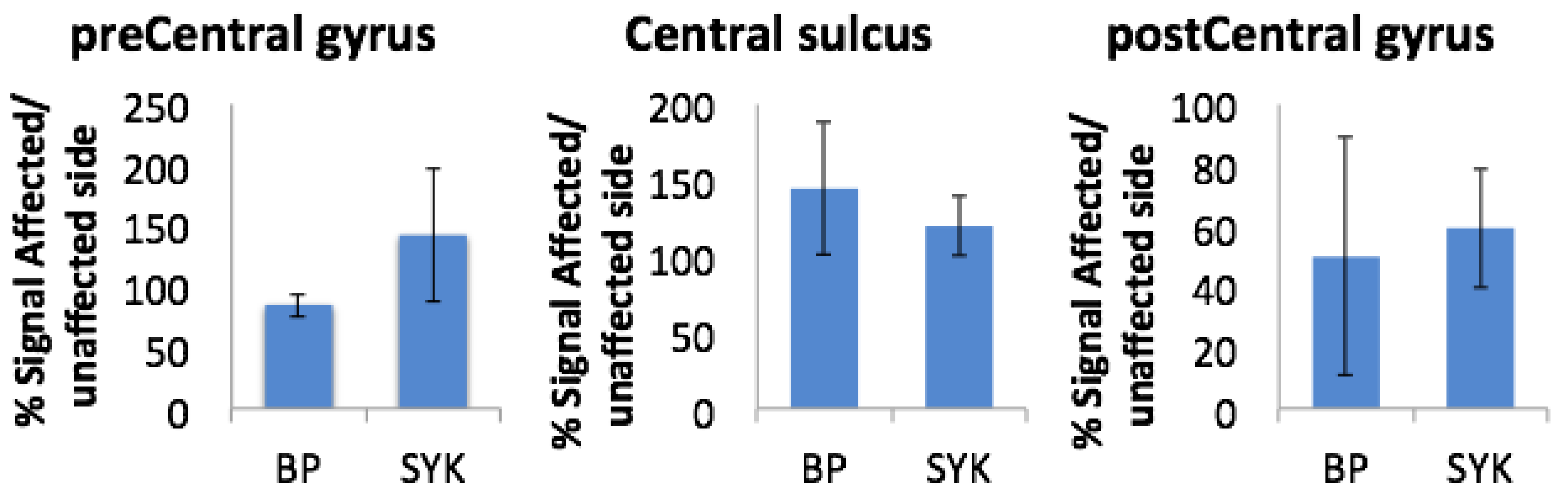

Figure 5. One possible explanation for the weak signal in Synkinesis group is the affected side of the face differed among these individuals. Therefore, normally responsive cortex from the unaffected side was averaged with affected cortex from other subjects. To test whether the affected side differed from the unaffected side, we compared the relative signal between the affected and unaffected hemispheres as follows: (Affected/Unaffected)*100 gives the % signal change in the affected side (100% equates to the affected side having signal equal to the unaffected side).
BP = fully recovered from BP; SYK = synkinesis after BP.

Results

- 14 subjects with a history of BP were enrolled. 7 subjects with synkinesis (avg SAQ 73, SD 20; avg age 60, SD 15) and 7 FR subjects (avg SAQ 23, SD 5; avg age 61, SD 12) underwent fMRI scanning. All participants were right-handed.
- Regions of interest (ROI) were determined for smile and blink conditions [Figure 2]
- Question 1: Is there a difference in central activation between the FR and synkinesis subjects?
  - Signal during smile and blink conditions is reduced in synkinesis compared to FR subjects [Figure 3]
  - Greater signal strength during smile condition along bilateral central sulci and premotor regions seen in FR subjects [Figure 4]
  - Reduced signal in central sulcus and premotor cortical regions in synkinesis subjects was seen [Figure 4]
    - Region activated in the left precentral gyrus corresponds to the area in Figure 3A , where there is substantial activation in FR subjects
    - This area has been identified as responsive when healthy subjects perform "lip corner pulling".[8]
- Question 2: Is there a difference in central activation between unaffected and affected sides?
  - Synkinesis subjects show greater activation in pre-central gyrus on the affected side relative to the unaffected side (not statistically significant) [Figure 5]

Conclusion

- Facial synkinesis is associated with alteration in cortical areas involved in motor preparation and execution
- fMRI can provide substantial insight into CNS changes as a consequence of synkinesis
- fMRI may be a useful to further understand the therapeutic utility associated with therapies that enhance motor control and sensorimotor integration, such as proprioceptive-based training and mirror facial exercises

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