Does reading words associated with body parts somatotopically activate the motor cortex?

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BACKGROUND
- There is considerable transcranial magnetic stimulation (TMS) and neuroimaging evidence of general action word processing activating areas in the vicinity of the left precentral gyrus.
- Only a handful of neuroimaging studies have examined whether a somatotopic activation of primary motor (BA4) and premotor (BA6) cortices occurs for verbs associated with specific body parts 1,2,3

ISSUES WITH EXISTING EVIDENCE
- No previous studies used cytoarchitectonically defined probabilistic maps, instead relying on functional and/or macrostructural information to define BA4 and BA6. As such their peak maxima for overlapping action meaning representations did not accord well with the cytoarchitectonic boundaries of BA4 and BA6 (see Fig.1).
- What other levels of lexical processing activate the motor cortices?

THIS STUDY
- We combined functional MRI with cytoarchitectonically defined probabilistic maps plus used control stimuli with different levels of lexical information to examine the somatotopic involvement of BA4 and BA6 in processing words with specific motor valence.
- We defined ROIs according to action observation and execution.

METHOD
- 17 healthy right handed, native English speakers (13 female; mean age 28.72 years, SD = 7.21) participated.
- Lexical Stimuli: 75 effector related verbs with 25 each specific to the hand, foot and mouth, 25 concrete words unrelated to body parts, 25 non-words and a series of six hashes (control for generic meaning, phonological and visual character processing).
- Video Stimuli: 40 silent video clips with ten each involving the hand, foot or mouth performing simple actions repeatedly and 10 of frequently encountered stimuli moving as they would in their natural environments.
- Lexical task: Block design (five items per block, presentation time 3 sec per item) for silent reading task. After six blocks (one for each category), a fixation cross was presented for 15 seconds.
- Video task: Event design (presentation time 10 sec per item). Video’s were followed by a green dot (replicate the movement just viewed; always followed action video) or red dot (remain still; always followed control video) for 10 seconds and a blank screen for 5 seconds.

RESULTS
- Specific body part actions
- We identified action execution and observation ROIs within BA4 and BA6 that were common to hand, foot and mouth (height threshold p < .001, cluster threshold > 25 contiguous voxels). Next, we combined action words.
- There was no effect of lexical category in BA4 (red: p > .05). Generic action execution and observation ROIs located in the rostral medial portion of BA6 (blue): the pre-SMA; showed an effect of lexical category (peak x, y, z: -4, 0, 60; Z = 4.78, peak x, y, z: -6, 3, 54; Z = 4.97, respectively). Paired t-tests showed general action words had significantly increased BOLD responses compared to other stimuli in the observation ROI (see Fig. 2).