

## Supplemental Material S1. fMRI task design.

Functional scans were collected during the same session as the structural scans using the following parameters: TR = 2s, TE = 25 ms, FOV=240 mm, matrix=96×96 pixels, number of slices = 32, voxel size 2.5×2.5×2.5 mm, and flip angle = 90°, number of slices per volume = 32. For each participant, the structural integrity of stimulated regions was confirmed by examining the grey matter atrophy patterns determined using VBM and functional responsiveness was confirmed by examination of results from task related fMRI.

The individual pre-treatment language responses were examined with event-related fMRI using primarily phonological task. In the phonological task (*homophone judgement*), participants decided whether two written words were pronounced the same (e.g., *homophones: VAIN (arrogant person) vs. VEIN (blood vessel)*) or different (*orthographic controls: VAIN-VAN*). Brain regions related to phonological processing were identified by contrasting activation for homophone judgment with its relevant orthographic controls. In the same session but in different counterbalanced blocks participants also completed semantic, and letter strings judgement tasks. In the semantic task (*synonym judgment*), participants decided whether two words meant similar things (e.g., *synonyms: COUCH and SOFA*) or different (*unrelated controls: SOFA and SPUN*). In the orthographic task (*letter strings*), participants decided whether two consonant letter strings were identical (e.g., *MTSK-MTSK*) or different (e.g., *MTRK-MTSK*). This control task shared visual, decision, and response features with the lexical tasks but no linguistic components. For all tasks, the responses were collected via button press in the scanner using Eprime 3.0 (Psychology Software Tools, Pittsburgh, PA).

For each task, items were divided into four lists of 40 items (160 items). The number of “yes” and “no” choices were matched in each list, and participants never saw the same pair twice. Word stimuli were matched across homophone and synonym tasks for frequency (CELEX), length, imageability (MRC), number of syllables, lexical factors ( $p > 0.244$ ), and neighborhood size from N-watch (Davis, 2005). All comparisons,  $F_s < 1$ ,  $p > 0.24$ . The consonant strings were matched in length and orthographic similarity to the lexical stimuli ( $F < 1$ ,  $p = .823$ ). Although words in the homophone task had different spelling in 45% of cases (e.g., *jeans-genes vs. altar-alter*), homophone pairs and their orthographic controls were matched for spelling similarity (from 0 = no match to 1 = complete match;  $F < 1$ ,  $p > .001$ ) to prevent participants from performing similarity judgments based solely on spelling. Words were also controlled for pronunciation.

In a separate study, we normed pronunciation ratings for the homophone task and semantic similarity for the synonym task using online Qualtrics surveys (<https://it.arizona.edu/service/qualtrics-surveys>) in native US English speakers who did not participate in the tDCS or fMRI study ( $n = 25$  for each survey). For homophones and their orthographic controls: from 1 = pronounced in a different way to 6 = pronounced the same way, the mean ratings were 5.86 for homophone pairs vs. 2.14 for orthographic controls,  $F(1,157) = 2112$ ,  $p < 0.001$ . For semantic similarity rating scale ranged from 1 = mean different things to 6 = mean almost the same thing. The semantic similarity for each word pair was evaluated by averaging responses for each item across raters. The mean ratings were 5.3 for synonyms vs. 1.5 for unrelated controls,  $F(1,157) = 4124$ ,  $p < 0.001$ . These ratings were used to select final items

for the fMRI-localizer task and the main fMRI-rTMS experiment.

Visual stimuli were presented on an fMRI compatible screen behind the scanner, which projected to a mirror fitted to the head coil. Padding minimized head motion and corrective lenses were available to correct visual acuity. The total duration of the fMRI experiment was about 45 min with tasks presented in blocks of 2 runs (6 min each) to minimize task-switching costs and ensure a constant cognitive set. Within each run, items were randomized and the order of runs and tasks were counterbalanced across participants and sessions.

Between runs, subjects were able to take a self-paced break. Before fMRI acquisition, the magnet was shimmed to achieve maximum homogeneity. To ensure that participants understand the task and to familiarize to the button press, they practiced each type of judgement using 10 novel items. Visual stimuli were presented in a white font on a black background using Eprime 3 (Zuccolotto et al., 2016) which was also used to record accuracy and reaction times from button presses. Following the instruction screen, each trial began with a fixation cross followed by a pair of stimuli in capital letters presented above and below the fixation cross for 4000 ms. After a 1000 ms blank screen, a response prompt "?" appeared for 4000 ms. Participants indicated their responses with a button press. For each task, an event-related design was implemented with pseudorandom interstimulus intervals (ISI "jittered" 1000, 2000 or 3000 ms) to allow for a fine-grained comparison between conditions (i.e., homophones vs. orthographic controls; synonyms vs. unrelated) by fitting the hemodynamic response for each stimulus. fMRI activity related to phonological processing were quantified by contrasting the homophone condition with the orthographic control condition.