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Supplemental Information

A Visual Cortical Network for Deriving Phonological Information from Intelligible Lip Movements

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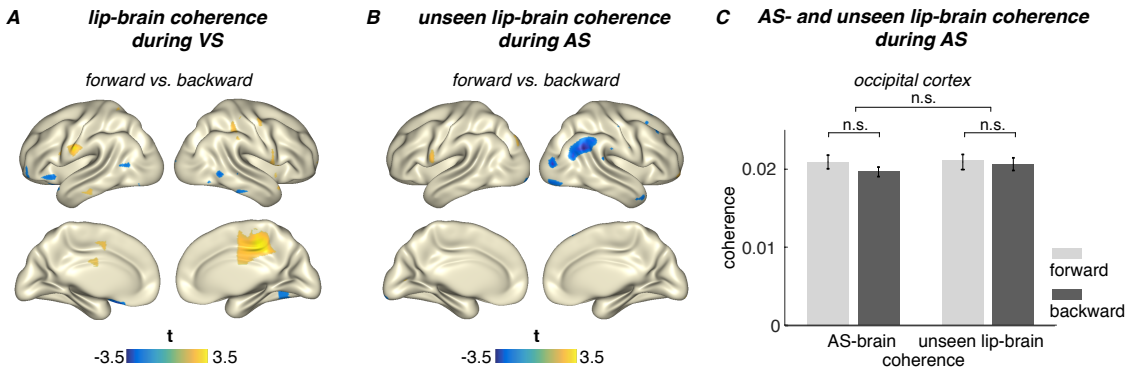

Figure S1: **Lip-brain coherence during VS and AS. Related to Figure 2B and C.** A) Coherences of theta band brain sources (4-7 Hz) with the lip contour of speech while watching visual speech (VS, contrasted between forward and backward conditions, $p < .05$, not corrected for multiple comparisons) is increased at paracentral regions, face regions of primary motor cortex, left inferior temporal regions, and decreased at bilateral inferior temporal regions and left frontal superior lobe. Importantly, no visual cortex effect between forward and backward lip-brain coherence during VS was identified, even at liberal statistical threshold. This underlines the uniqueness of our finding of increased coherence between unheard AS and activity in visual cortex. B) Coherences of theta band brain sources (4-7 Hz) with the not-seen lip contour while listening to acoustic speech (AS, contrasted between forward and backward conditions, $p < .05$, not corrected for multiple comparisons) is decreased during forward presentation mainly at right angular cortex. These findings support the uniqueness of our finding of visual regions showing increased coherence with unheard AS. C) Mean of the individual acoustic speech (AS)-brain and unseen lip-brain coherence values (extracted at the occipital voxels of the statistical effect found for forward versus backward unheard acoustic speech-coherence) during acoustic speech. Contrast of forward-backward acoustic speech-brain coherence ($t(23)=1.29$, $p=0.21$) and unseen lip-brain coherence ($t(23)=-0.43$, $p=0.67$) did not show differences. Also, the contrast between forward-backward difference for acoustic speech-brain and unseen lip-brain was not significant ($t(23)=0.76$, $p=0.43$). Error bars indicate standard error.

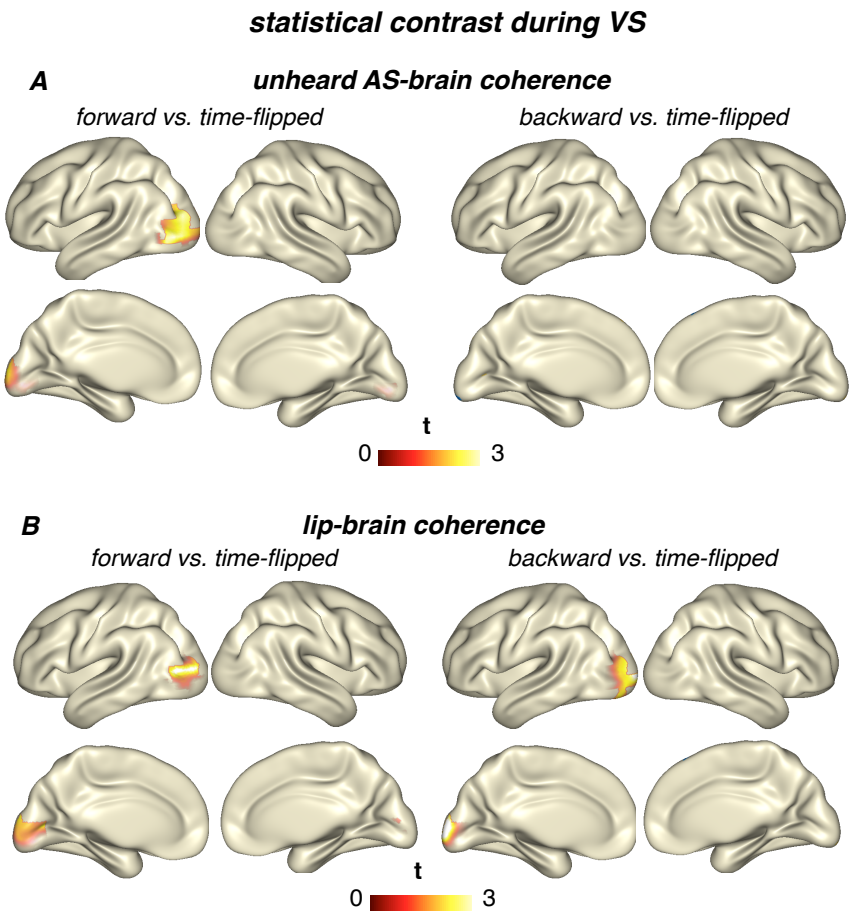

Figure S2: Unheard AS-brain and lip-brain coherence during VS contrasted with time-flipped data. Related to Figure 2B. Coherence between brain activity at 4-7 Hz and unheard acoustic speech envelope (AS, A) as well as lip contour (B) while watching visual speech contrasted with the respective time-flipped surrogate data. We tested if forward and backward coherences tracked the corresponding signal (lip for lip-brain coherence, acoustic speech envelope for unheard AS-brain coherence) compared to their surrogate data of time-flipped lip contour or unheard AS. Effects are calculated for the visual voxels showing the difference between forward and backward unheard AS-brain coherence (see. Figure 2B). As expected and correcting for multiple comparison (p<0.05, 1000 randomization) we found increased coherence compared to time-flipped surrogate data for forward lip-brain coherence (p=0.006), backward lip-brain coherence (p=0.01) and forward unheard AS-brain coherence (p=0.003) while no effect occurred for backward unheard AS-brain coherence compared to time-flipped surrogate data. This analysis supports our conclusion that visual cortex faithfully tracks both forward and backward lip movements during visual speech but additionally only tracks the unheard forward acoustic speech envelope.

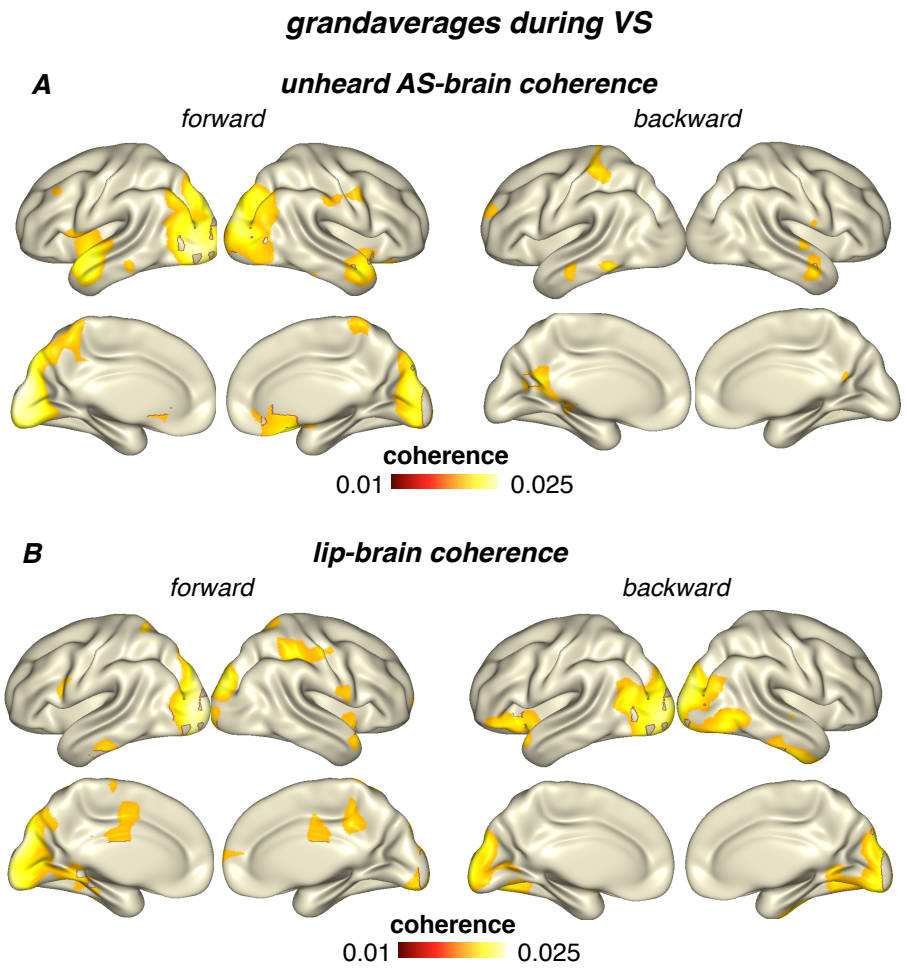

Figure S3: Grand averages of unheard As-brain and lip-brain coherence during VS. Related to Figure 2B and C. Grand averages of coherence between brain activity at 4-7 Hz and unheard acoustic speech envelope (AS, A) as well as lip contour (B) separately for forward and backward conditions while watching visual speech. Grand averages are masked by 75% of the maximum value of unheard AS-brain coherence (0.0198). Maximal coherence is consistently seen in occipital regions with the exception of unheard backward AS-brain coherence during VS. Furthermore, auditory regions also showed increased values during the forward unheard AS-brain coherence also regions, particularly, the superior temporal lobes showed increased coherence, including parts of the auditory cortex (Brodmann area 22) and Brodmann area 21. These results support our conclusion that the visual cortex tracks forward and backward lip movements as well as additionally the unheard AS during VS. Further, the grand averages show some involvement of auditory-related regions during the putative visuo-phonological transformation during the forward unheard AS condition.