METHODS

Participants. Young adult (18–35 y) native English speakers (n=22; 13f). Young adult (18–35 y) nonnative English speakers (n=28; 18f) were recruited from the Acoustical Society of America. All participants were right-handed, and had normal hearing and no history of neurological or psychiatric disorders. All participants gave written informed consent before the study, which was approved by the institutional review board. The data was analyzed using SPM8 (Wellcome Unit, London, UK).

Stimuli. Meaningful English sentences (n=80). These were presented in meaningful and non-meaningful forms. The non-meaningful forms were created by reversing all consonants and vowels, and were mathematically scrambled to avoid any meaningful patterns. The meaningful forms were created by reversing all consonants and vowels, and were mathematically scrambled to avoid any meaningful patterns. 

Procedures. Participants were seated in a sound-attenuated booth. They were instructed to listen to each sentence, and to indicate whether it was meaningful or not. 

RESULTS

Background. The modality by speaker interaction (AV Nat-Non) was activated in the right middle temporal gyrus, and the right middle frontal gyrus. The Results section contains the details of the analysis. 

Inefficient non-native AV speech processing may be affected by an underlying bias of assuming non-Caucasian speakers to be less intelligible, inefficiently integrating non-native visual cues, and exhibiting greater modality by nativeness interaction in V1 activation. These results suggest that: 

- AV Nat-Non activation in V1, crucial for AV processing, is activated stronger for native AV than non-native AV speech. 
- Greater neural index was associated with: (a) better audiovisual integration in noise in general; (b) but poorer non-native audiovisual integration (p=.0092); (c) increased clarity rating for sentence recognition, regardless of modality (p=.0092). (d) increased implicit bias towards making Caucasian-American and Asian-foreign associations (p=.0092).


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Figure 1 | Implicit bias in non-native speech

- The finding suggests that a non-linguistic bias can affect non-native speech perception.

Figure 2 | Poor integration of non-native visual cues

- Speech is often processed in adverse listening situations. Listeners use visual cues to compensate for degraded speech intelligibility.

Figure 3 | Implicit bias in non-native speech

- In the American English-speaking environment, Asian speakers are assumed to be not native speakers of English. The implicit association test can measure this automatic bias.

Figure 4 | Main effect of nativeness

- Native vs. non-native speech activated the right posterior middle and superior temporal gyrus, and the right anterior middle and superior temporal gyrus.

Figure 5 | Main effect of modality

- AV vs. AO (AOnat+AOnon-AVnat-AVnon) activated the ventral portion of the cortex including the bilateral occipital cortices and anterior portions of the bilateral superior and inferior temporal sulci.

Figure 6 | Modality by nativeness interaction

- The modality by speaker interaction (AV Nat-Non) was observed in V1. This area showed greater activation in the AV than in AO modality, but more so for native than for non-native speech.

Figure 7 | Results of the main effect of nativeness

- Native and non-native speech activated the right posterior middle and superior temporal gyrus, and the right anterior middle and superior temporal gyrus.

Figure 8 | Results of the main effect of modality

- AV vs. AO (AOnat+AOnon-AVnat-AVnon) activated the ventral portion of the cortex including the bilateral occipital cortices and anterior portions of the bilateral superior and inferior temporal sulci.

Figure 9 | Results of the main effect of nativeness

- Native and non-native speech activated the right posterior middle and superior temporal gyrus, and the right anterior middle and superior temporal gyrus.

Figure 10 | Results of the main effect of modality

- AV vs. AO (AOnat+AOnon-AVnat-AVnon) activated the ventral portion of the cortex including the bilateral occipital cortices and anterior portions of the bilateral superior and inferior temporal sulci.

Figure 11 | Results of the main effect of nativeness

- Native and non-native speech activated the right posterior middle and superior temporal gyrus, and the right anterior middle and superior temporal gyrus.

Figure 12 | Results of the main effect of modality

- AV vs. AO (AOnat+AOnon-AVnat-AVnon) activated the ventral portion of the cortex including the bilateral occipital cortices and anterior portions of the bilateral superior and inferior temporal sulci.

Figure 13 | Results of the main effect of nativeness

- Native and non-native speech activated the right posterior middle and superior temporal gyrus, and the right anterior middle and superior temporal gyrus.

Figure 14 | Results of the main effect of modality

- AV vs. AO (AOnat+AOnon-AVnat-AVnon) activated the ventral portion of the cortex including the bilateral occipital cortices and anterior portions of the bilateral superior and inferior temporal sulci.

Figure 15 | Results of the main effect of nativeness

- Native and non-native speech activated the right posterior middle and superior temporal gyrus, and the right anterior middle and superior temporal gyrus.

Figure 16 | Results of the main effect of modality

- AV vs. AO (AOnat+AOnon-AVnat-AVnon) activated the ventral portion of the cortex including the bilateral occipital cortices and anterior portions of the bilateral superior and inferior temporal sulci.

Figure 17 | Results of the main effect of nativeness

- Native and non-native speech activated the right posterior middle and superior temporal gyrus, and the right anterior middle and superior temporal gyrus.

Figure 18 | Results of the main effect of modality

- AV vs. AO (AOnat+AOnon-AVnat-AVnon) activated the ventral portion of the cortex including the bilateral occipital cortices and anterior portions of the bilateral superior and inferior temporal sulci.

Figure 19 | Results of the main effect of nativeness

- Native and non-native speech activated the right posterior middle and superior temporal gyrus, and the right anterior middle and superior temporal gyrus.