

L1 Typology Influences Patterns of Neural Activation for L2 Morphosyntactic Processing: An fNIRS study



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INTRODUCTION

Question: Is L2 learners' processing of L2 (English) subject-verb (SV) number agreement specifically influenced by structural characteristics of their L1s (Spanish, Chinese)?

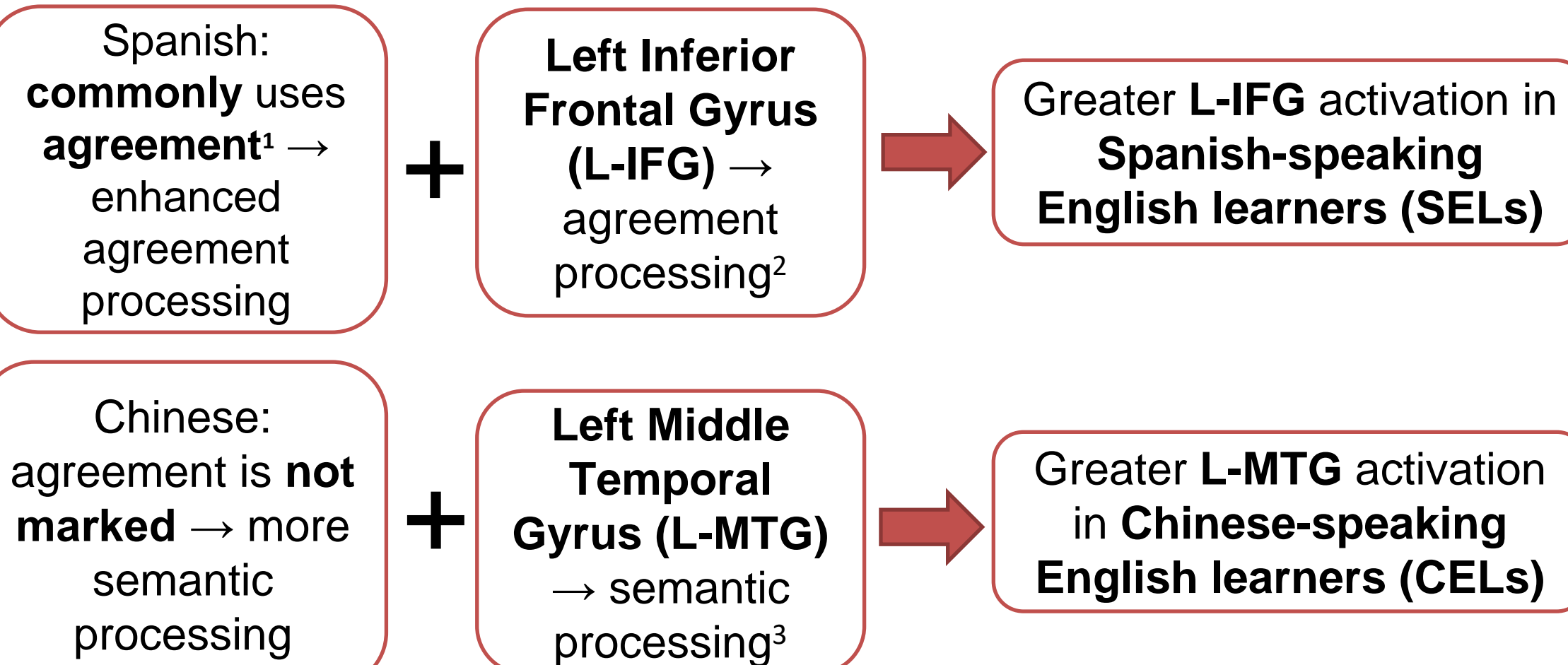
Theoretical relevance: Advance our understanding of the organization and processing of morphosyntactically-distinct languages in the bilingual brain

Novelties: Focus on the understudied morphosyntactic dependency of subject-verb number agreement. Include two groups of L2 learners with contrasting L1s

Hypothesis: Cross-linguistic differences between L2 learners' L1s will impact neural mechanisms supporting L2 morphosyntactic processing.

Predictions:

While processing English SV number agreement:



Additional exploratory question: Are there any differences in the processing of singular vs. plural forms among groups?

METHODS

Participants: 20 Chinese-speaking English learners; 19 Spanish-speaking English learners, 20 English monolinguals

Table 1. Participants' age, English AoA and language proficiency scores / mean (SD)

| | Chinese-speaking English learners | Spanish-speaking English learners | English monolinguals |
|-------------------------------|-----------------------------------|-----------------------------------|----------------------|
| Age (years) | 23.75 (3.64) | 24.74 (4.45) | 21.13 (2.16) |
| English language rating (1-7) | 4.69 (1.08) | 6.33 (0.84) | - |
| English AoA (years) | 9.99 (4.2) | 7.69 (4.79) | - |
| W-J (English raw score) | 22.79 (3.72) | 33.53 (5.59) | 38.25 (2.94) |
| W-J (Spanish raw score) | - | 37.72 (4.30) | - |
| MINT (English % correct) | 0.70 (0.14) | - | - |
| MINT (Mandarin % correct) | 0.88 (0.08) | - | - |

fNIRS Neuroimaging:

Hemodynamic response was measured with Shimadzu LightNIRS Near Infrared Spectroscopy 47-channel system; data acquired at 7.4Hz. Light intensities in the fNIRS signals were analyzed using the NIRS AnalyzIR toolbox⁴.

Task design:

Picture sentence matching task targeting subject-verb agreement –s in English

Procedure:

Hear a sentence and saw a picture. Decide whether the picture matches the sentence.

Figure 1. Experimental Procedure.

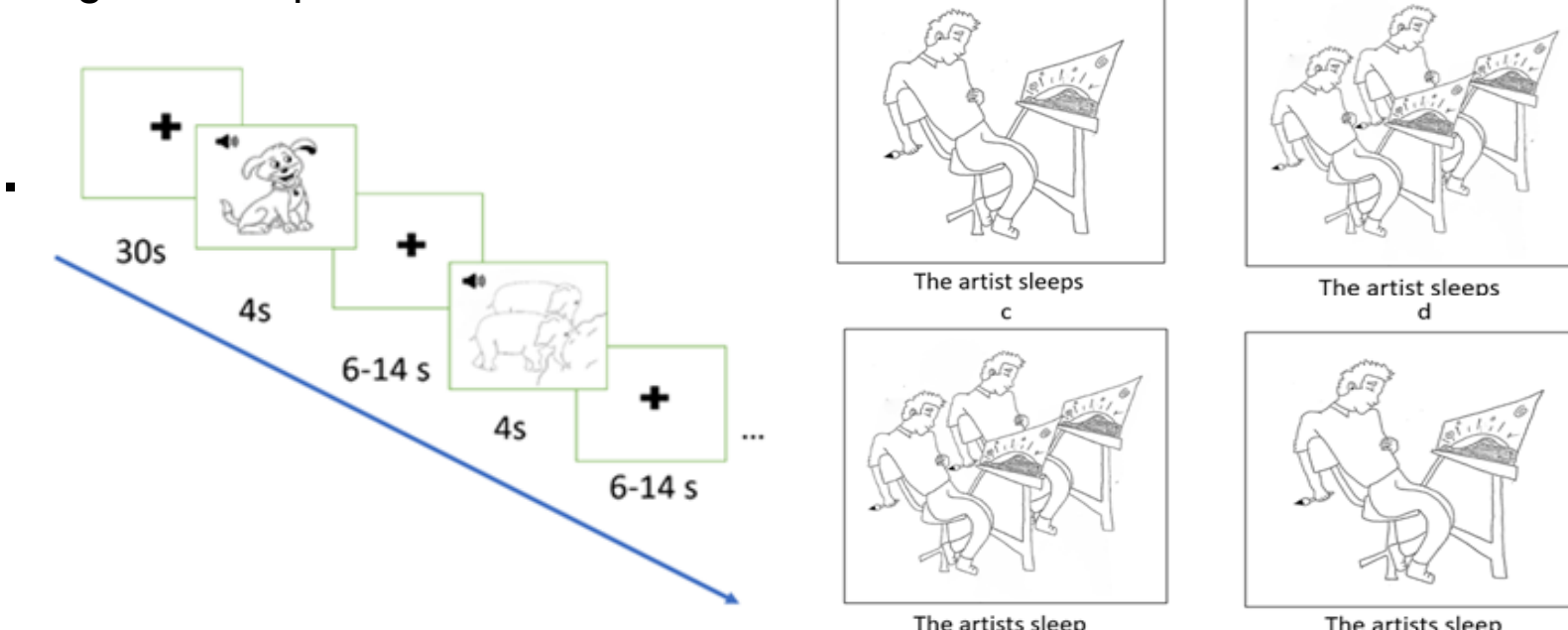


Figure 2. Four conditions in the stimulus design.

NEUROIMAGING RESULTS

L1 typology influences L2 morphosyntactic processing: Spanish-speaking English learners showed greater L-IFG activation and Chinese-speaking English learners showed greater L-MTG activation

1. Group comparison in the plural condition

Compared to monolinguals, Spanish-speaking English learners showed: greater activation in L-IFG, bilateral MTG, bilateral dl-PFC, and bilateral anterior PFC

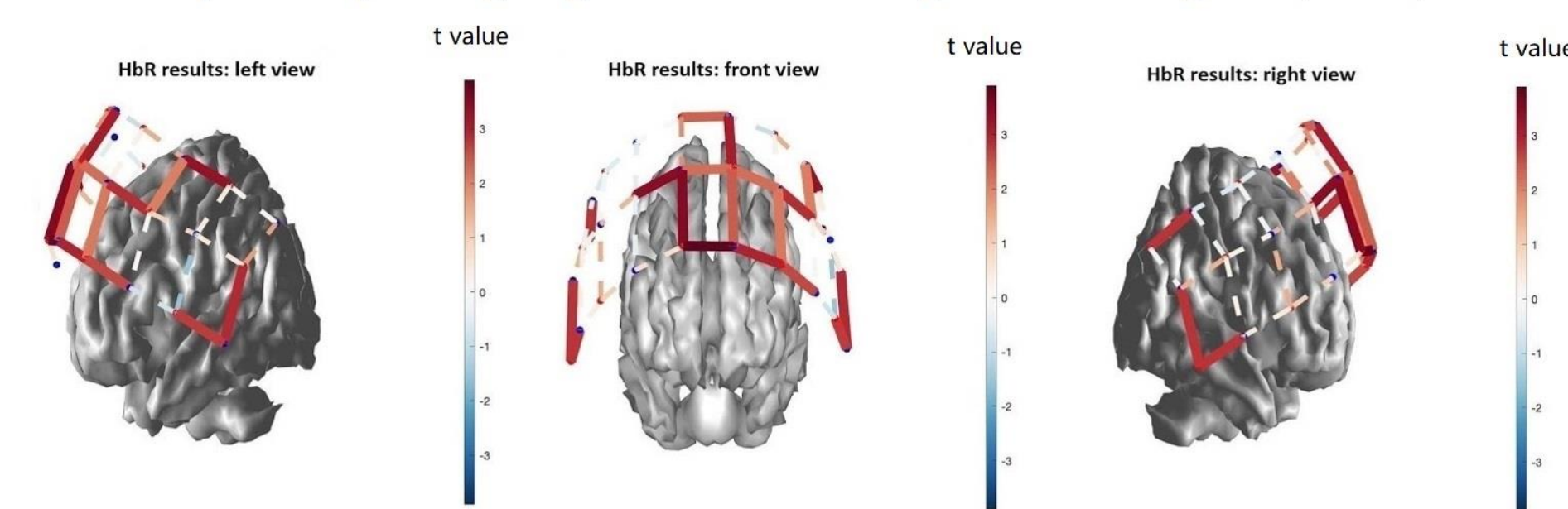
Compared to monolinguals, Chinese-speaking English learners showed: greater activation in L-MTG, bilateral anterior prefrontal cortex, and bilateral dl-PFC

2. Group comparison in the singular condition

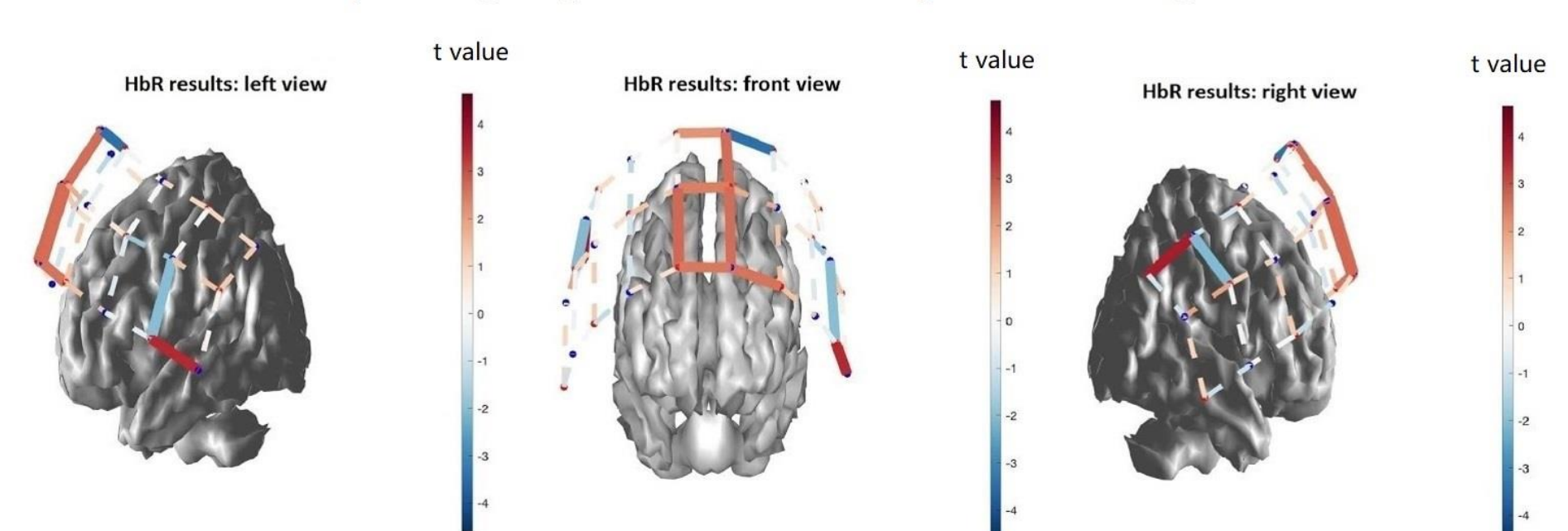
Compared to monolinguals, Spanish-speaking English learners showed: greater activation in L-IFG and left premotor cortex; less activation in L-MTG

Compared to monolinguals, Chinese-speaking English learners showed: greater activation in left premotor cortex; less activation in left STG

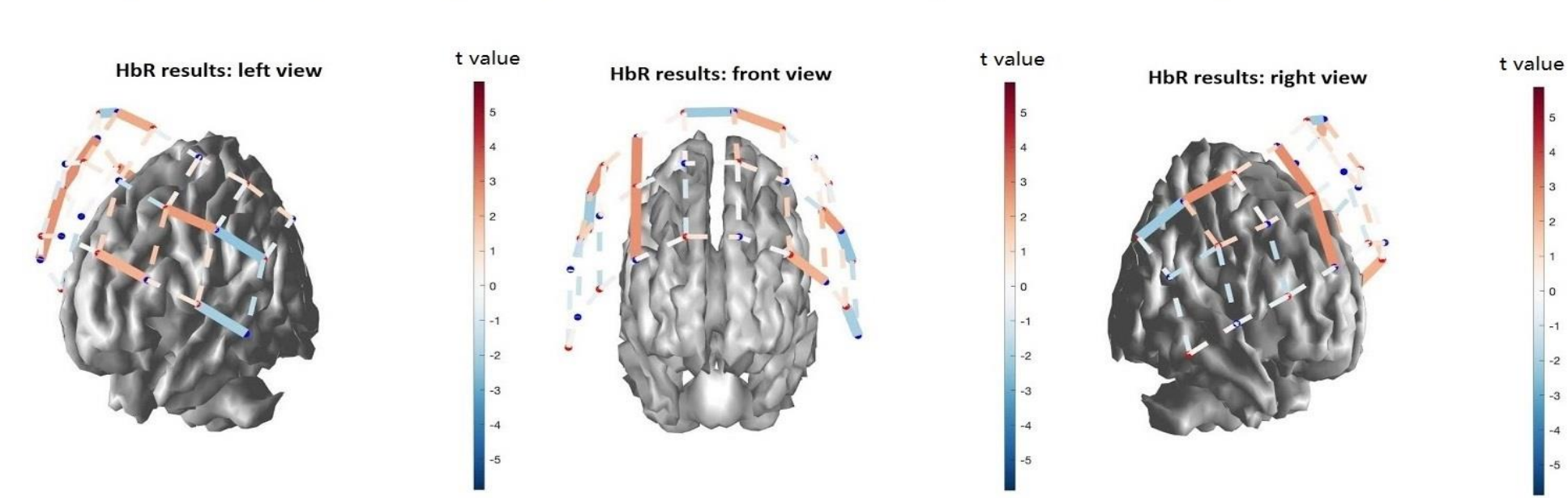
a. Spanish-speaking English learners > English monolinguals (Plural)



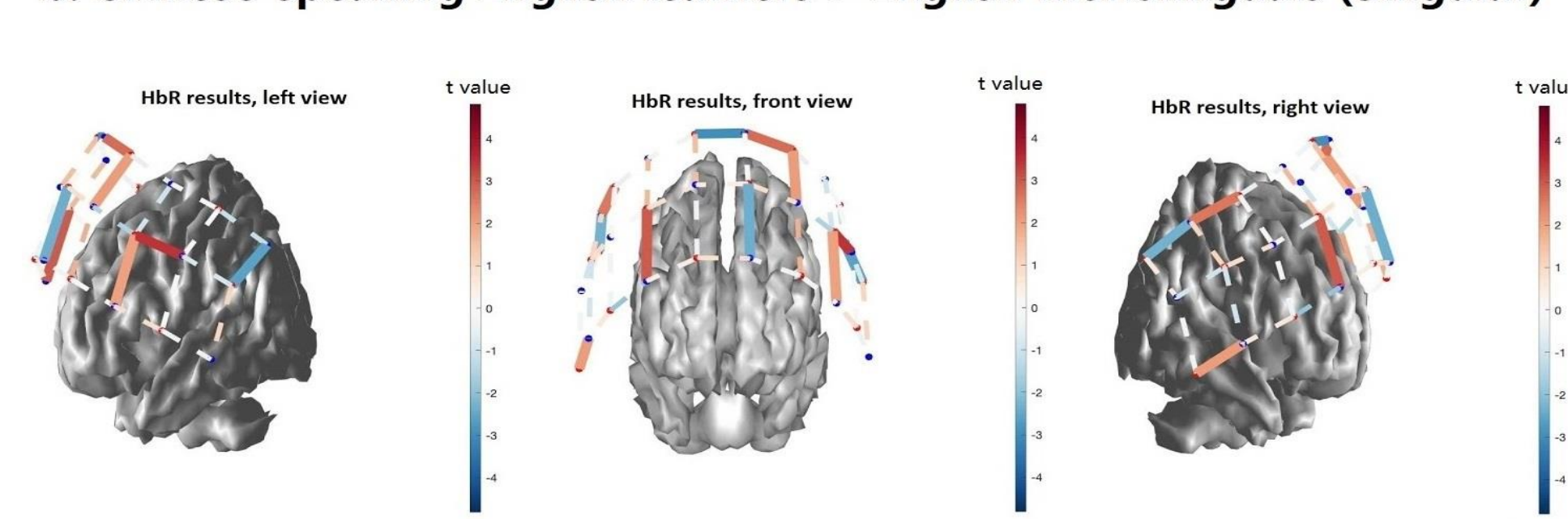
b. Chinese-speaking English learners > English monolinguals (Plural)



a. Spanish-speaking English learners > English monolinguals (Singular)



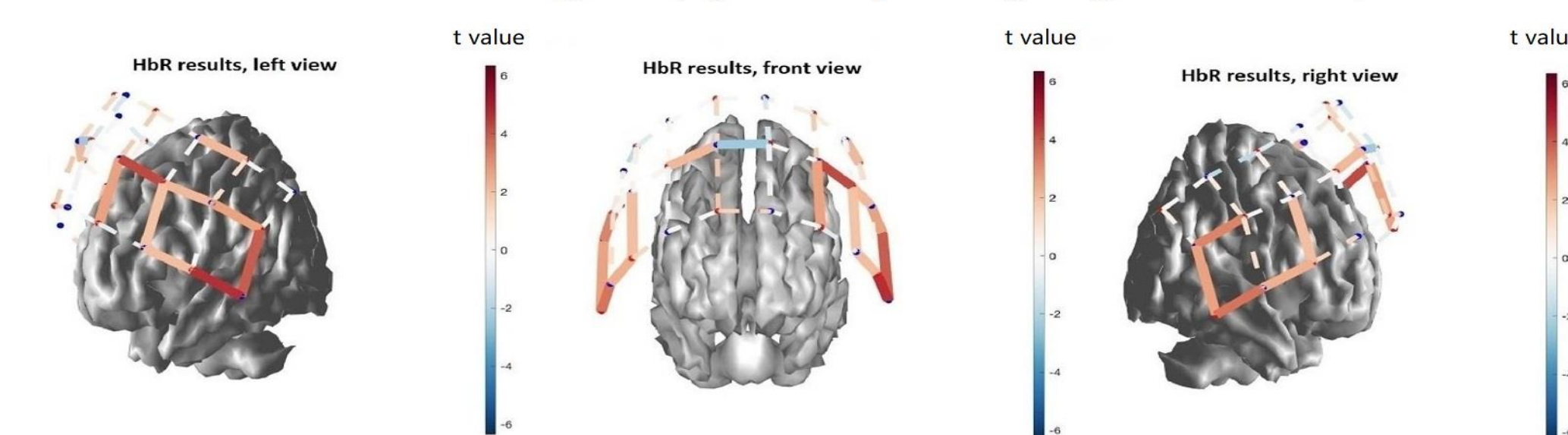
b. Chinese-speaking English learners > English monolinguals (Singular)



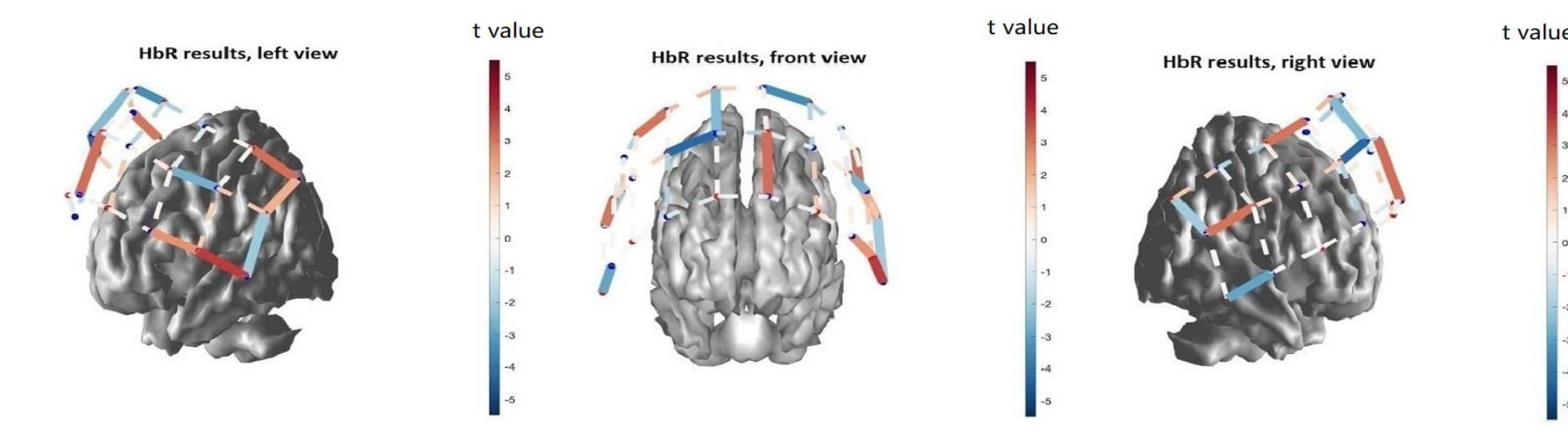
*The ROI stats averaged across all participants was used to obtain the MNI coordinates and anatomical labels. The specific regions are reported in the text. The images show the representation of the channel data using the probe that is averaged across all participants. The solid lines indicate channels where significant differences were found ($q < .05$). Red lines indicate positive t-values (L2 learners > English monolinguals) and blue lines indicate negative t-values (English monolinguals > L2 learners).

3. Number condition comparison in the three groups

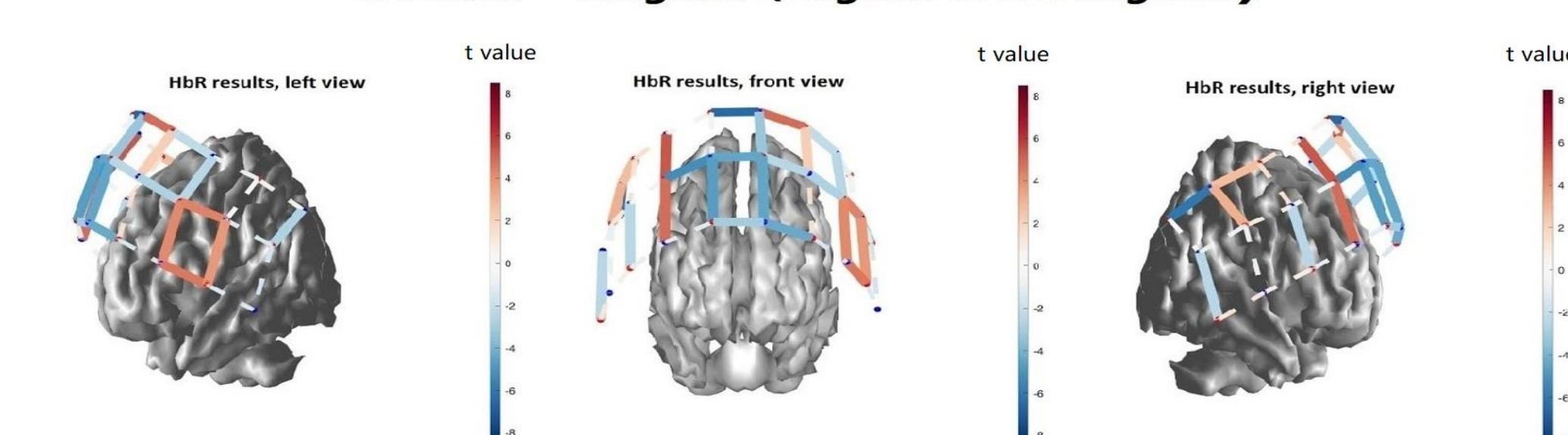
a. Plural > Singular (Spanish-speaking English learners)



b. Plural > Singular (Chinese-speaking English learners)



c. Plural > Singular (English monolinguals)



*Red lines indicate positive t values (plural > singular) and blue lines indicate negative t values (singular > plural).

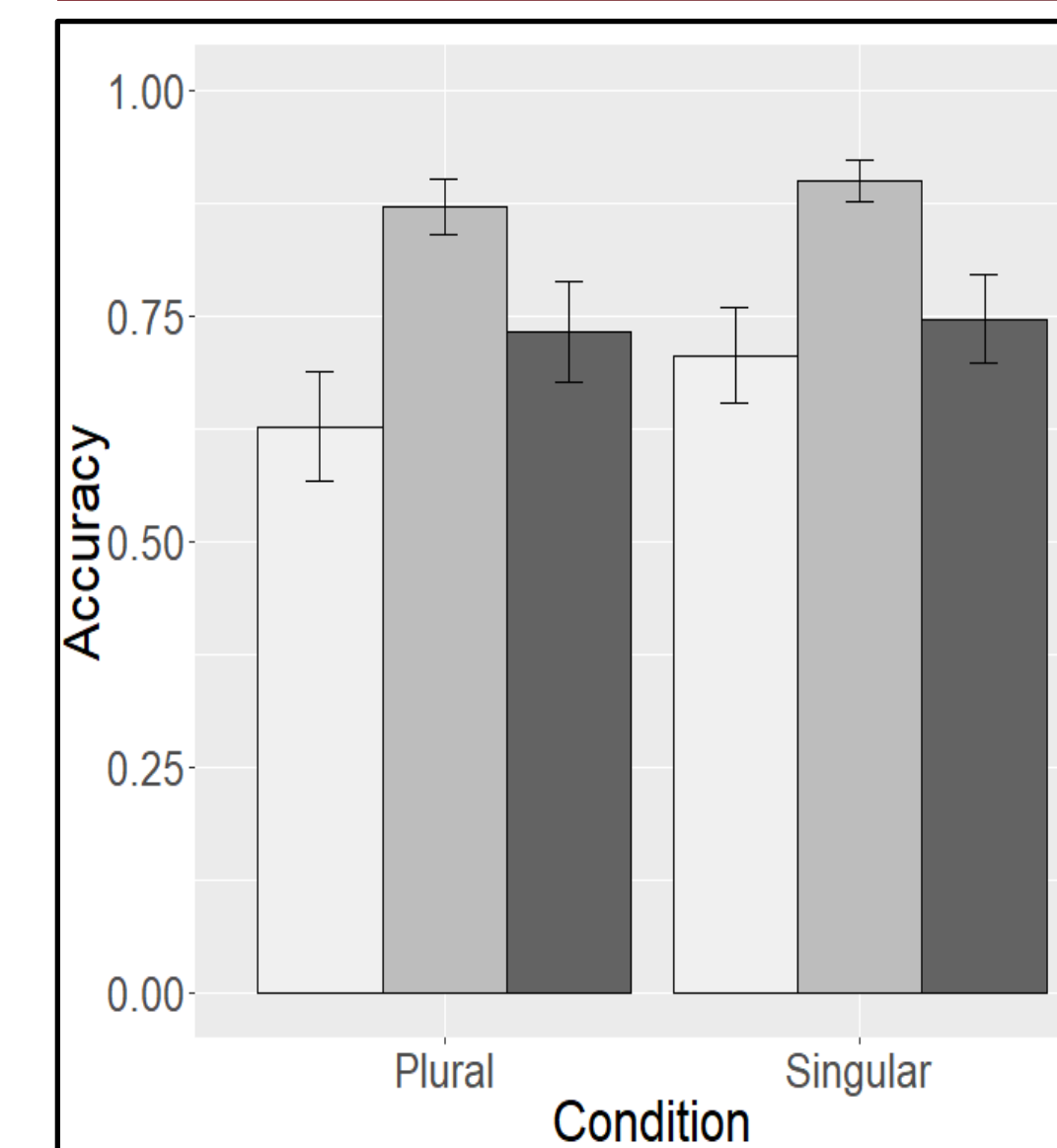
English monolingual group:

Singular vs. Plural: greater activation in singular in prefrontal cortex; less activation in singular in left precentral gyrus

Two L2 learner groups:

Singular vs. Plural: greater activation in plural generally, including L-MTG for both groups

BEHAVIORAL RESULTS



Accuracy:

English monolinguals > SELS
English monolinguals > CELS

Response Time:

No main effect of group, condition, or group by condition interaction

DISCUSSION

Main Question - Group Comparison:

L2 learners' English morphosyntactic processing is affected by L1 characteristics in linguistically principled ways

Greater L-IFG activation in SELs reflected the common use of agreement features in their L1 Spanish

Greater L-MTG activation in CELs reflected the lack of grammatical markings for number agreement in their L1 Chinese

Exploratory - Condition Comparison:

L2 learners' processing of singular vs. plural forms may be impacted by the encoding of the same features in their L1

English monolinguals: singular > plural – singular is marked with suffix –s, thus requiring greater activation⁵.

SELS: plural > singular - may reflected the number agreement feature in Spanish: instead of singular, plural is marked with suffix –n.

CELS: plural > singular – may reflected that both singular and plural are expressed by bare forms in Chinese. Greater activation to reject the bare (plural) forms.

LIMITATION & FUTURE DIRECTION

Limitation:

The L2 learners' poor performance on our task suggested that their subject-verb agreement processing is not native-like.

Future direction:

Include bilingual speakers with higher English proficiency.

Acknowledgements

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