

Introduction

- In American Sign Language (ASL) spatial relationships are conveyed by the location of the hands in space.
- To understand perspective-independent relationships, such as “The candle is above the box,” signers map the location of the figure and ground objects to the location of the dominant and non-dominant hands, respectively.
- To understand perspective-dependent expressions (e.g., “The candle is to the right of the ball”), signers must also perform a 180° mental transformation for face-to-face signing.
- In contrast, English expresses spatial relationships with prepositional phrases, and no linguistic spatial transformation or spatial mapping is required.
- Previous research has shown that the production of spatial language differs for ASL and English, with greater involvement of bilateral superior parietal cortex for ASL (Emmorey et al., 2002, 2005, 2013).

Research Questions:

- Do the neural regions engaged during **comprehension** of spatial language differ for ASL signers and English speakers?
- Does comprehension of **perspective-dependent** expressions (e.g., left, right) engage distinct neural regions compared to **perspective-independent** expressions (e.g., above, below) for either ASL or English?

Methods

Participants:

Deaf signers (n = 14, 8 females, mean age: 29.5 ± 4.53)
Hearing speakers (n = 11, 6 females, mean age: 25.2 ± 6.25)

Imaging methods:

Two 6-min scans with 24 trials in each condition were presented in an event-related paradigm. Trials consisted of an ASL 4s video/English 3s video, 2s fixation ISI, and a picture (2s; 20% of trials), followed by variable fixation periods (2–10s).

Acquisition

GE 3T, gradient echo echo-planar imaging
TR = 2s; FOV = 224mm; 34 4.0mm contiguous axial slices, whole brain

Statistical Analysis

AFNI 3dDeconvolve for first level whole-brain analysis and AFNI's 3dttest++ with equitable thresholding and clustering (ETAC) option for whole-brain group comparisons.

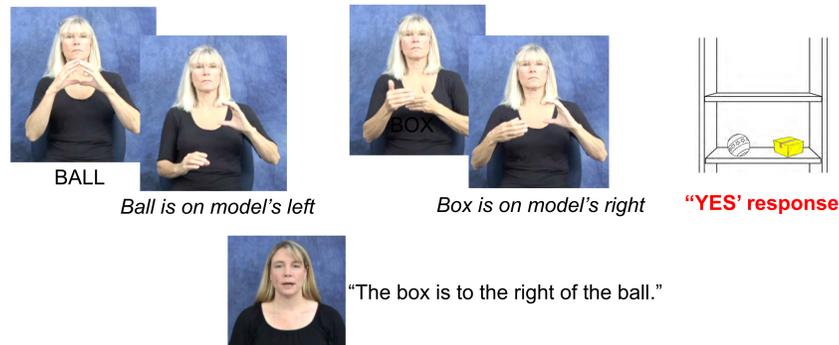
References

- Brozdowski, C., Secora, K., Emmorey, K. (2019). Assessing the comprehension of spatial perspectives in ASL classifier constructions. *Journal of Deaf Studies and Deaf Education*
- Conder, J., Fridriksson, J., Baylis, G. C., Smith, C. M., Boiteau, T. W., & Almor, A. (2017). Bilateral parietal contributions to spatial language. *Brain and language*, 164, 16-24.
- Emmorey, K., McCullough, S., Mehta, S.H., Ponto, L.B., & Grabowski, T.J. (2013). The biology of linguistic expression impacts neural correlates for spatial language. *Journal of Cognitive Neuroscience*, 25(4), 517-533.
- Emmorey, K., Grabowski, T.J., McCullough, S., Ponto, L., Hichwa, R., & Damasio, H. (2005). The neural correlates of spatial language in English and American Sign Language: A PET study with hearing bilinguals. *NeuroImage*, 24, 832-840.
- Emmorey, K., Damasio, H., McCullough, S., Ponto, L., Hichwa, R., & Bellugi, U. (2002). Neural systems underlying spatial language in American Sign Language. *NeuroImage*, 17, 812-824.

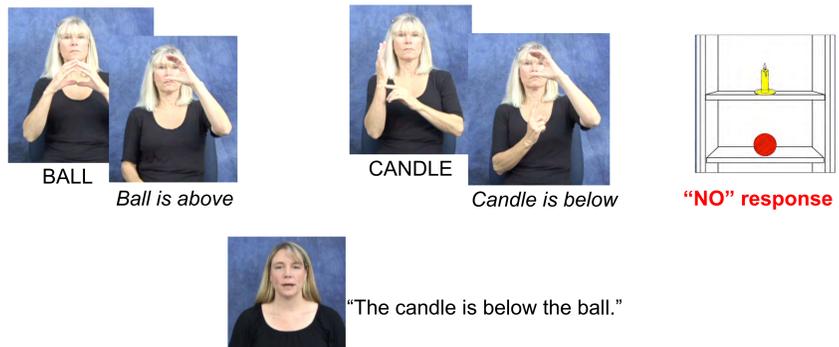
Methods – cont.

Stimuli:

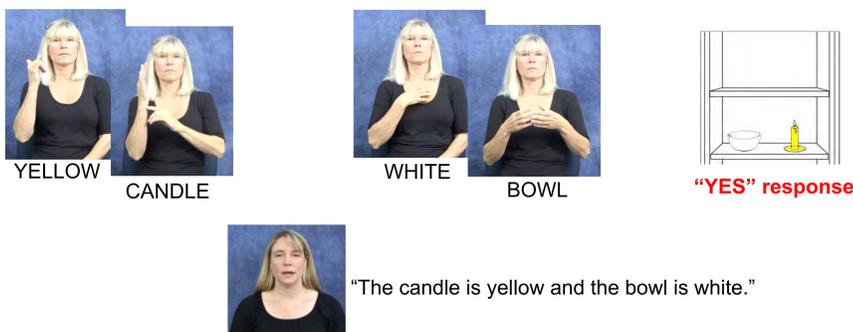
Perspective-dependent (e.g., left, right, front, behind)



Perspective-independent (e.g. in, on, above, below)



Control non-spatial sentences



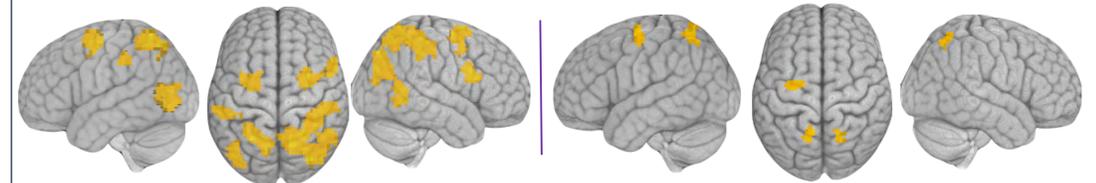
Procedure:

After 20% of trials, participants decided (button press) whether a picture of two colored objects matched the spatial configuration or the colors described in the preceding sentence.

Results – cont.

ASL

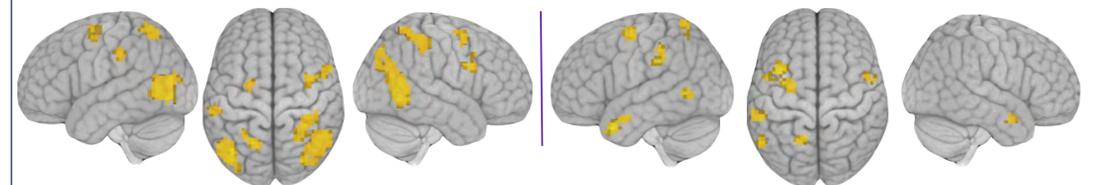
Perspective-dependent (e.g. left, right, front, behind) vs. non-spatial control



- Perspective-dependent expressions engaged the superior parietal lobule (SPL) bilaterally for both ASL and English.

English

Perspective-independent (e.g. in, on, above, below) vs. non-spatial control



- Activation in SPL was more bilateral for ASL and more left-lateralized for English

Perspective-dependent (e.g. left, right) vs. independent (e.g. above, below) spatial expressions



- ASL: Greater bilateral SPL activation for perspective-dependent expressions, but no regions were more active for perspective-independent expressions.
- English: No difference in activation between spatial expression types

Conclusions

- Bilateral superior parietal regions are engaged when both ASL signers and English speakers comprehend perspective-dependent (e.g. left right, in front, behind) spatial expressions, consistent with Condor et al. (2017).
- For perspective-independent spatial expressions (e.g. above, below, in, on), parietal activation was bilateral for ASL and left-lateralized for English. Right parietal regions may support the required visual-spatial mapping between the position of the hands in signing space and a mental representation of the location of referent objects.
- Comprehension of ASL perspective-dependent spatial expressions recruits SPL bilaterally more strongly than for perspective-independent spatial expressions possibly due to the 180° mental transformation required to understand these expressions (e.g., Brozdowski et al., 2019).

Results

	Accuracy (%)		Response Time (ms)		
	ASL (14)	English (9)	ASL (14)	English (9)	
Perspective dependent	82	91	Perspective dependent	1701	1948
Perspective independent	85	93	Perspective independent	1473	2115
Non-spatial control	77	66	Non-spatial control	1704	1832

No significant RT differences for ASL or English. For English speakers, spatial sentences were more accurate than non-spatial sentences; no accuracy differences for ASL signers.

Acknowledgments

This research is supported by NIH Grant HD010997 to San Diego State University and Karen Emmorey. Thank you to all who participated in our research.
Website <https://slhs.sdsu.edu/llcn/> Contact kemmorey@sdsu.edu