The relation between linguistic and spatial working memory capacity and sign language processing

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Introduction

- Linguistic working memory (WM), but not spatial WM, is strongly predictive of spoken language comprehension (e.g., Caplan & Waters, 1999; King & Just, 1991)
- Sign languages utilize visual-spatial contrasts at all linguistic levels, but it is unknown whether either linguistic or spatial WM correlates with language comprehension

Research questions

- Do linguistic and spatial spans rely on common resources?
- Do linguistic and/or spatial WM span predict language comprehension for deaf signers?

Participants

	Deaf ASL signers (n=33, 28 for narrative task)	Hearing English speakers (n=43, 27 for narrative task)
Age	33.7 (11.1)	23.2 (6.2)
Age of exposure	28 native or early (< 7 yrs), 5 late	n.a.
Gender	18 female, 15 male	35 female, 8 male
Years of education	16.5 (2.9)	15.1 (1.4)

Tasks

Spans

- **Corsi block span**
  Recalling sequences of spatially distributed blocks in forwards or backwards order

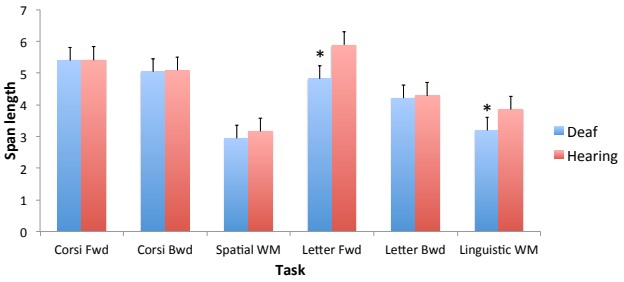
- **Spatial WM span** (based on Shah & Miyake, 1996)
  Deciding whether rotated letters on the screen are mirrored or not while remembering the direction in which the top of the letters are pointing

- **Letter span**
  Recalling sequences of spoken/signed letters in forwards or backward order

- **Linguistic WM span** (based on Daneman & Carpenter, 1980)
  Making plausibility judgments on signed/spoken sentences while remembering the last sign/word of each of each sentence

Language comprehension

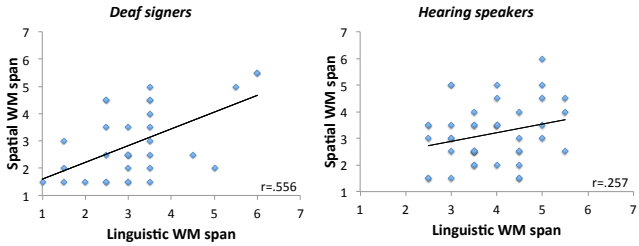
- **Narrative comprehension**
  (data available from 28 signers and 27 speakers)
  Answering fact and location questions after viewing signed/spoken topographic narratives (e.g. the layout of an apartment)



- Hearing speakers scored significantly higher than deaf signers ***only*** on forward letter span and linguistic WM span
  - Advantage for hearing speakers on WM tasks that require serial recall (cf. Bavelier et al., 2008; Hall & Bavelier, 2011; Rudner & Rönnberg, 2008)

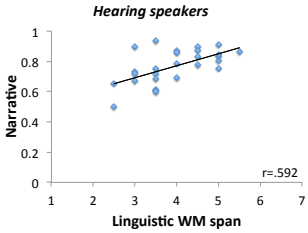
Do linguistic and spatial spans rely on common resources?

- Linguistic WM span correlated with both spatial WM span (r=.556, p=.001) and the Corsi block span (forward: r=.504, p=.003; backward: r=.487, p=.004) for deaf signers, ***but not for hearing speakers***

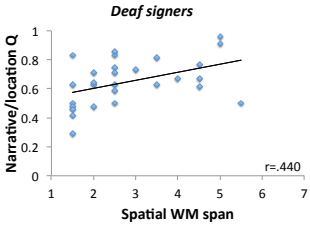


Do linguistic and/or spatial WM span predict language comprehension for deaf signers?

- Linguistic WM span correlated strongly with narrative comprehension for hearing speakers (r=.592, p=.001), ***but only weakly for deaf signers*** (r=.332, p=.08)



- Spatial WM span correlated with comprehension of location questions for deaf signers (r=.440, p=.019), ***but not for hearing speakers*** (r=.274, p=.167)



Discussion

- *Linguistic WM may draw on non-linguistic spatial resources for signers, but not for speakers*
  - Linguistic WM correlated with spatial WM and with Corsi spans only for deaf signers
- *Signers may rely less on serial order information during language comprehension*
  - Linguistic WM weakly predicted language comprehension, in contrast to hearing speakers
- *Signers, but not speakers, draw on non-linguistic visuospatial WM processes when comprehending spatial narratives*
  - Spatial WM predicted memory for location information only for deaf signers

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References

Caplan, D., & Waters, G. S. (1999). Verbal working memory and sentence comprehension. *Behavioral and Brain Sciences*, *22*(1), 77-94

Bavelier, D., Newport, E. L., Hall, M., Supalla, T., & Boutla, M. (2008). Ordered short-term memory differs in signers and speakers: Implications for models of short-term memory. *Cognition*, *107*(2), 433-459

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of verbal learning and verbal behavior*, *19*(4), 450-466.

Hall, M. L., & Bavelier, D. (2011). Short-term memory stages in sign vs. speech: The source of the serial span discrepancy. *Cognition*, *120*(1), 54-66

King, J., & Just, M. A. (1991). Individual differences in syntactic processing: The role of working memory. *Journal of memory and language*, *30*(5), 580-602

Rudner, M., & Rönnberg, J. (2008). Explicit processing demands reveal language modality-specific organization of working memory. *Journal of deaf studies and deaf education*, *13*(4), 466-484

Shah, P., & Miyake, A. (1996). The separability of working memory resources for spatial thinking and language processing: an individual differences approach. *Journal of Experimental Psychology: General*, *125*(1), 4-27