Effect of sensory impairment on language processing

"The influence of language deprivation in early childhood on L2 processing: An ERP comparison of deaf native signers and deaf signers with a delayed language acquisition"

Skotara, Salden, Kügow, Hänel-Faulhaber & Röder, 2012

Outline

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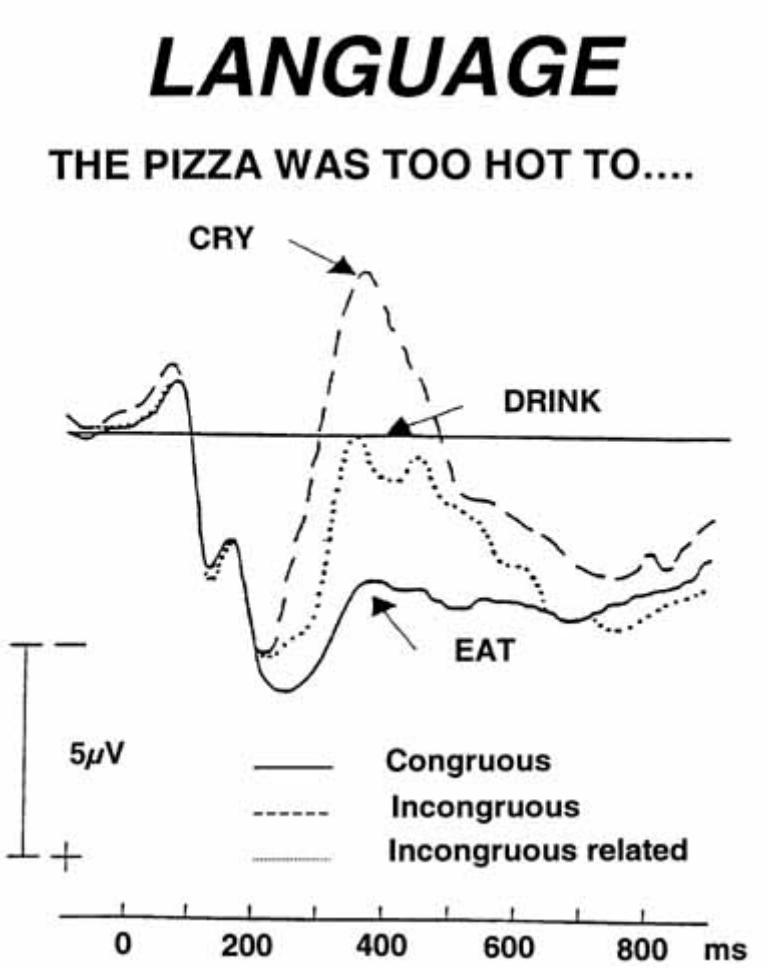
Do you remember?



Background

Deaf children with hearing parents	Deaf children with deaf parents
No access to spoken language of parents	Sign language from parents
→ no language acquisition from birth	→ from birth
Germany: DGS in primary school (or later)	
“homesign” (no real natural language)	Complete, natural, fully realised language (phonology, syntax...)
→ no language development support	Language development similar to hearing children of hearing parents

Background

- Effects of a delayed L1 acquisition in a violation paradigm
- Semantic violations: N400 + positive ERP
- Syntactic violations: LAN + P600
- L2 learners: negative correlation between age of onset of acquisition of L2 and achieved grammatical competence
- Lexical-semantic < syntactical & phonological

Background

- N400: robust to effects of AoA
- LAN: more effected
- Compare L2 processing of ESL and LSL

  → effects of delayed L1 acquisition compared to a timely one in signers tested in their L2 German

Hypotheses

- Performance: LSL < ESL
- EEG:

	EGL	ESL	LSL
Semantic condition	N400 (centro-parietal)	N400 (centro-parietal)	N400
Syntactic condition	LAN (Cluster L1/+L2) → P600 (posterior)	LAN (Cluster L1/+L2) → P600 (posterior)	No LAN

Methods

- Participants: 3 groups (1.) ESL, (2.) LSL & (3.) EGL
- Excluded: with < 60% correct responses in all three conditions

  → 8 ESL & 8 LSL & 12 EGL

Methods: Material

- (1.) Language tests (ATBG) to access language abilities in German and DGS
- (2.) EEG: written German sentences

(1.) subject	(2.) predicate	(3.) direct object	(4.) prepositional phrase

- Each sentence: 3 different conditions

Table 10 Sentence examples for each experimental condition

Condition	Example sentence
Correct	Der Mann *kocht* das Essen in der Küche.Engl.: The man *cooks* the meal in the kitchen.
Syntactic verb-agreement violation	*Der Mann *kochen* das Essen in der Küche.Engl.: *The man *cook* the meal in the kitchen.
Semantic violation	*Der Mann kocht das in der Küche.Engl.: *The man cooks the picture in the kitchen.

Methods: Procedure

- Decision: Correct or incorrect
- 5 blocks with 80 sentences
- Sentences shown for 600ms in random order

Methods: EEG recording

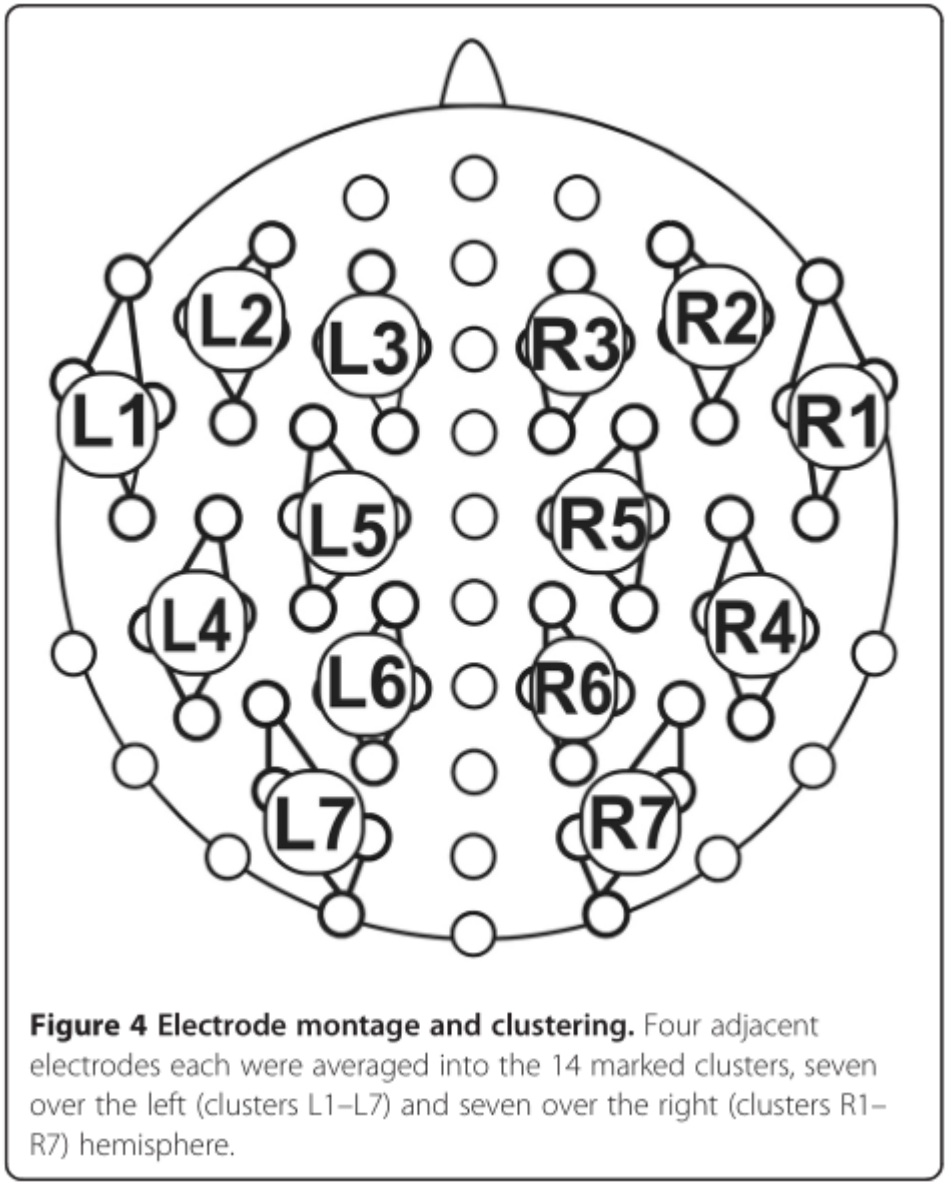


Figure 4 Electrode montage and clustering. Four adjacent electrodes each were averaged into the 14 marked clusters, seven over the left (clusters L1–L7) and seven over the right (clusters R1–R7) hemisphere.

Methods: Data analysis

- Mean amplitudes for **300-500ms** and **600-800ms** (semantics and syntax separately) were analysed
- Syntax: first interval divided into 3 segments each 66ms

Results: ATBG

- ESL > LSL in
  - grammatical competence in written German,
  - Comprehension of written German vocabulary,
  - Comprehension of DGS

Results: Behavioural data

- Main effect: Group; Condition
- Interaction between Group and Condition

Correct condition	Semantic condition	Syntactic condition
LSL < EGL LSL < ESL	No group differences	EGL > LSL EGL > ESL

Results: EEG data

- With-in factors: Condition (CO), Hemisphere (HE), Cluster (CL)

Table 3 ANOVAs for the semantic condition

Semantics groups	effects	Time epoch 300–500 ms		600–800 ms	
		F	p	F	p
EGL	CO	**46.717**	**≤ 0.001**	**22.307**	**≤ 0.001**
	CO,HE	2.183	0.168	0.096	0.763
	CO,CL	**17.399**	**≤ 0.001**	**16.294**	**≤ 0.001**
	CO,HE,CL	0.545	0.612	0.373	0.660
		F	p	F	p
LSL	CO	**32.549**	**≤ 0.001**	**28.762**	**0.001**
	CO,HE	5.572	0.050	0.395	0.549
	CO,CL	**11.111**	**0.004**	**12.062**	**0.002**
	CO,HE,CL	5.239	0.020	2.257	0.166
		F	p	F	p
ESL	CO	4.943	0.062	11.999	0.010
	CO,HE	9.011	0.020	0.033	0.862
	CO,CL	**6.883**	**0.007**	5.918	0.016
	CO,HE,CL	5.416	0.026	0.296	0.741

CO: Condition, HE: Hemisphere, CL: Cluster; p ≤ 0.05; p ≤ **0.01**; p ≤ **0.001**; EGL: hearing early German language learners, ESL: deaf early sign language learners, LSL: deaf late sign language learners.

Results: EEG data

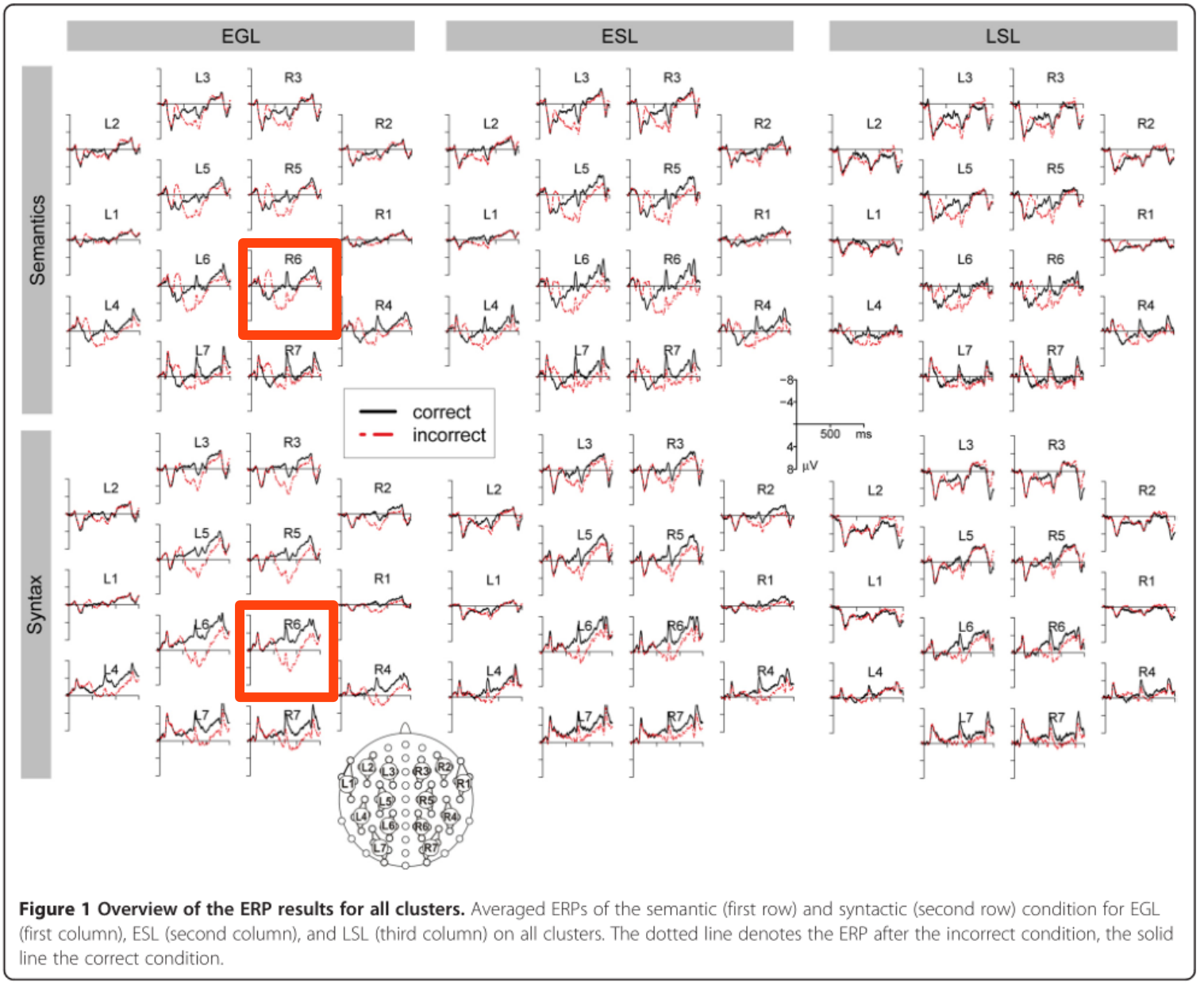


Figure 1 Overview of the ERP results for all clusters. Averaged ERPs of the semantic (first row) and syntactic (second row) condition for EGL (first column), ESL (second column), and LSL (third column) on all clusters. The dotted line denotes the ERP after the incorrect condition, the solid line the correct condition.

Results: EEG data

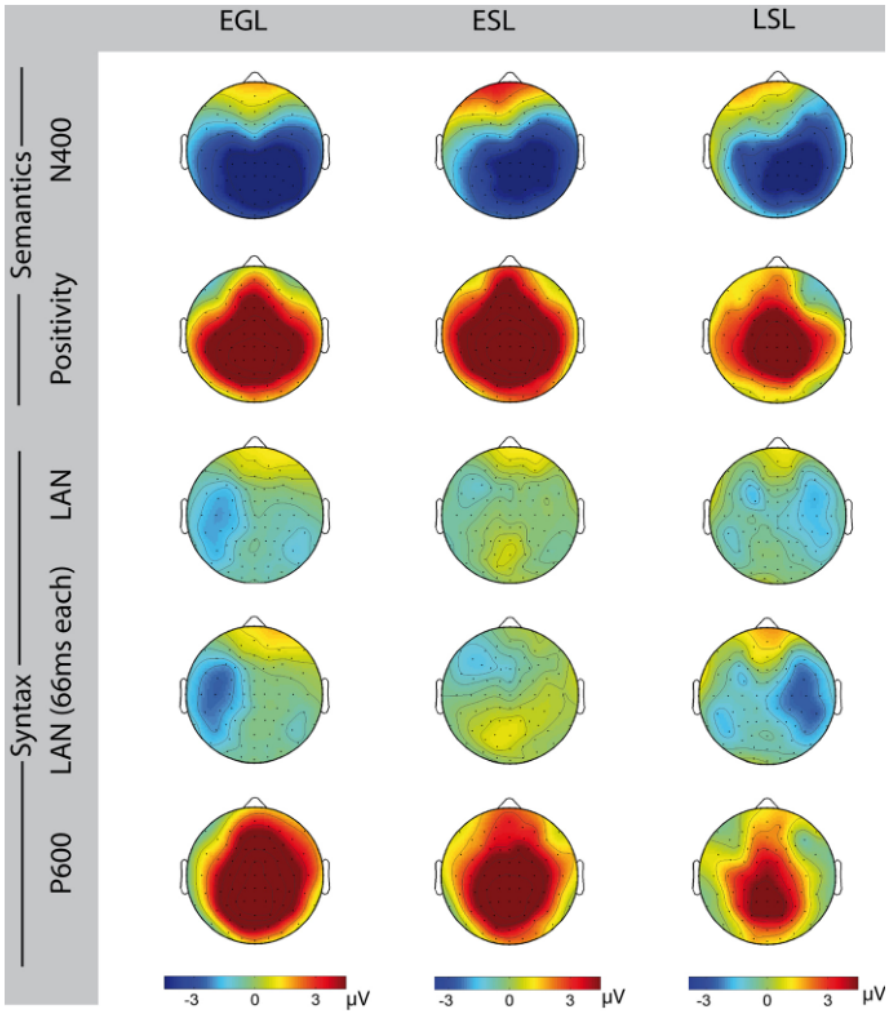


Figure 2 Overview of the topographic distributions of the ERPs. Topographies of the N400 (first row), semantic positivity (second row), LAN for 300–500 ms (third row), LAN for 66 ms each (fourth row), and P600 (fifth row) for EGL (first column), ESL (second column), and LSL (third column). Blue denotes negative differences of incorrect minus correct words and red denotes positive differences in μV. The annotation '66 ms each' denotes 366-433 ms for EGL, 433–500 ms for LSL, and 300–366 ms for ESL.

Discussion

- Acquisition of semantic aspects of a language (L2) not linked to a sensitive period within the first years of life
- Acquisition of a sign language results in the establishment of brain systems important to process the syntax of a human language (sensitive developmental periods)?
- LSL: no sign of cerebral organisation of syntactic language aspects comparable to people who grew up with a natural language

Discussion

- Higher L2 competence in deaf native signers compared to LSL

  → access to a natural language = requirement for the syntactic aspects of a written L2

- General **disadvantage** of deaf people in Germany:
  - overall effects of late acquisition
  - available impoverished German language input
  - educational situation of deaf people in Germany

Conclusion

- Semantic aspects of an L2 = attainable
- Syntactic: cerebral organisation highly vulnerable to a delayed L1 acquisition

  → **learning a natural language (incl. syntactic complexity) seems crucial for acquisition of further languages in later life**

Thank you for your attention!
Questions?

How can we enhance the situation of deaf born children with hearing parents, so that they learn a natural and fully realised language from birth?

References

http://e-book.lib.sjtu.edu.cn/iupsys/Proc/stock1/images/st2000v1c05g001.jpg

Skotara, N., Salden, U., Kügow, M, Hänel-Faulhaber, B. & Röder, B. (2012). The influence of language deprivation in early childhood on L2 processing: An ERP comparison of deaf native signers and deaf signers with a delayed language acquisition. *BMC Neuroscience*