What Matters in Processing of Scrambling: Cross-Populational Investigation in Russian

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1 1. Scrambling Across Languages and Populations

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Heritage Language Speakers (HSs)

In the present study, our focus is on:

1. The heritage group of bilingual Russian HL-English young adults, compared to monolingual Russian adults and children.

   These are young people who speak more than one language, but who may not speak their HL (i.e., Russian) so well — a special type of bilinguals known as *heritage speakers*. They learned the HL from birth only to later switch to the societal language (i.e., English).

2. *Scrambling*, or word order variation (*filler-gap dependency*):

Canonical SVO:
Корова везёт лошадку.
'Cow$_{\text{NOM}}$ is pulling horse$_{\text{ACC}}$.'

Scrambled OVS:
Корову$_1$ везёт e_1 лошадка.
'Cow$_{\text{ACC}}$ is pulled [by] horse$_{\text{NOM}}$.'

Group Comparisons in Language Processing

Some facts about young L1 children and bilingual HSs in comparison to monolingual adults:

- Children = monolingual adults; HSs ≠ monolingual adults (e.g., *grammatical gender and case*)
- Children ≠ monolingual adults; HSs = monolingual adults (this study)
- Children and HSs ≠ monolingual adults (e.g., *quantifier-spreading)*

Polinsky, 2018; Polinsky & Scontras (2020); Sekerina & Sauermann (2015); Sekerina & Trueswell (2013)

Scrambling Across Languages and Populations

What we know...

Filler-gap dependencies are computationally costly to process. If Scrambling creates a filler-gap dependency ⇒ it can lead to processing difficulties.

- **Monolingual adults:** canonical = scrambled equally easy, but mixed results for ditransitive sentences (self-paced reading, eye movements, neuroimaging).

  Felser (2012); Friederici et al. (2006); Iwabuchi et al., 2019; Makuuchi et al., 2013; Miyamoto & Takahashi, 2004; Tamaoko et al., 2014; Titov, 2017

- **Monolingual children:** Early production (between 2 and 4 years), but errors in comprehension of scrambled sentences into elementary school years.

  Huang et al., 2013; Mirasugi & Kawamura, 2004; Minai et al., 2015; Mykhaylyk, 2012; Otsu, 1992; Schaeffer, 2017; Smolek, 2015

- **Bilingual L2 adults**: Difficulty in processing of noncanonical word orders under cognitive load (e.g., long-distance Scrambling, passives)

  Hara, 2011; Lee & Doherty, 2019

Processing of Scrambling and Case Across Languages

- **Case as a cue:**

  The scrambled DO is marked with the ACC case. Does unambiguous case marking facilitate processing of Scrambling? ⇒ **No**

  One of the explanations: Conflict between word order and processing bias in thematic role assignment: S is expected before O.

- **The German debate for monolingual children:**

  Difficulty with using the case as a cue to Scrambling until the age of 7

  Sauermann & Höhle, 2016; Schipke et al., 2012

  4-to-5-year-old German (and Turkish) children can predict the S in OVS *before* they hear it, as reflected in their eye movements.

  Özge et al., 2016; Özge et al., 2019

Russian

Case system: Elaborate and obligatory, with 6 cases marked on the head nouns and their modifiers. Direct Object (DO) is marked with ACC: *большую корову* 'big$_{ACC}$ cow$_{ACC}$'

Word order possibilities: All 6, but regulated by information structure/genre*

Frequency	News	Social Media
1	SVO 82.9%	SVO 65.5%
2	**OVS 7.1%**	SOV 14.4%
3	OSV 3.6%	OSV 9.2%
4	SOV 2.7%	**OVS 6.3%**
5	V-initial 3.7%	V-initial 4.6%

Baylin, 2015; Ionin & Luchkina, 2017; Titov, 2017

*Makarchuk & Slioussar' (2019): The *Taiga* Corpus: 92 mln tokens (news), 82 mln tokens (social media). Percentages are based on 875,000 transitive sentences

Scrambling and Case Across Populations in Russian

- **Adults:** When the appropriate context is provided,

  Longer RTs in the scrambled ditranstivie DO S V IO sentences.

  Sekerina, 2003

  No difference in RTs between canonical and scrambled sentences.

  Slioussar', 2011

- **Children:**

  Production of the ACC case at ceiling already between 2 and 3 years.
  Comprehension, picture-selection task: SVO 74%-100%, 64-85% OVS

  Ladinskaya et al., 2019
  Janssen & Meir, 2019; Sekerina & Mitrofanova, 2017; Volkova et al., 2020

- **Bilingual HSs**:

  Comprehension of OVS measured by MCQ: 86% + correct choice of OVS vs. SVO based on knowledge of information structure

  Ionin et al., 2020

The Goals

In the Visual World study, we investigate whether children and HSs differ in:

1. comprehension of scrambled OVS vs. canonical SVO sentences,
2. sensitivity to case and word order cues, and
3. how they use case to predict the syntactic structure of the scrambled sentences online.

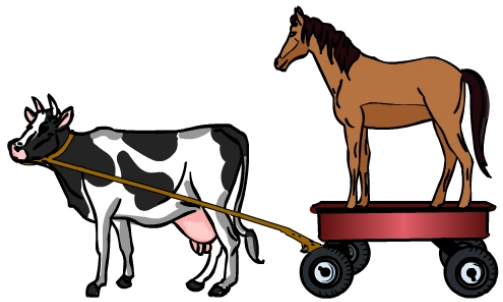
Participants and Materials (1): SVO Condition

- Adults: 16 (M_{age} = 21.5)
- Children: 28 (Range = 5;01-6;10)
- HSs: 21 (M_{age} = 19.5)

16 items interspersed with 24 fillers

Sentence-picture matching: Single picture presentation

The answer was always 'YES'



(1) Canonical SVO:
Корова везёт лошадку.
'Cow_{NOM} is pulling $\text{horse}_{\text{ACC}}$.'
Correct answer: 'YES'

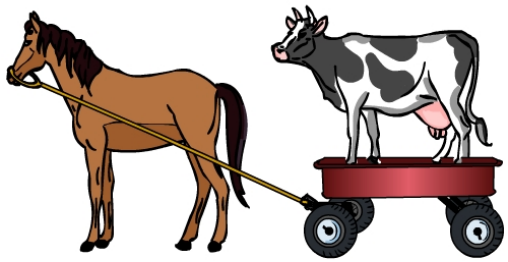
Participants and Materials (2): OVS Condition

- Adults: 16 (M_{age} = 21.5)
- Children: 28 (Range = 5;01-6;10)
- HSs: 21 (M_{age} = 19.5)

16 items interspersed with 24 fillers

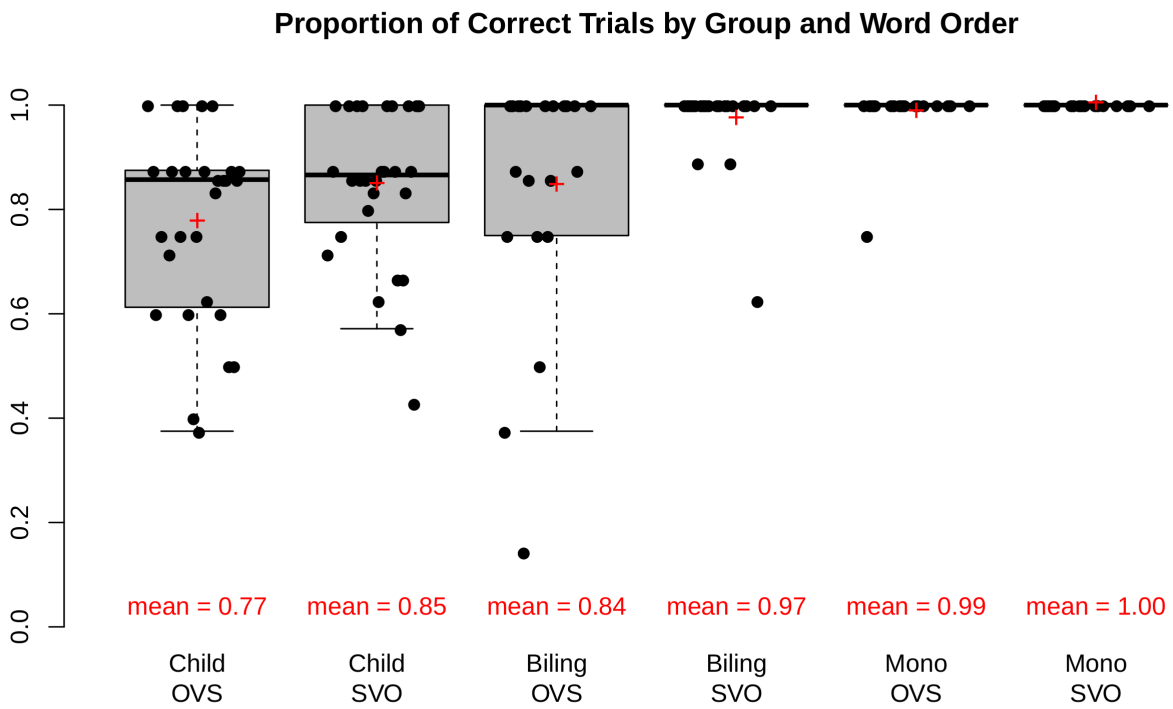
Sentence-picture matching: Single picture presentation

The answer was always 'YES'



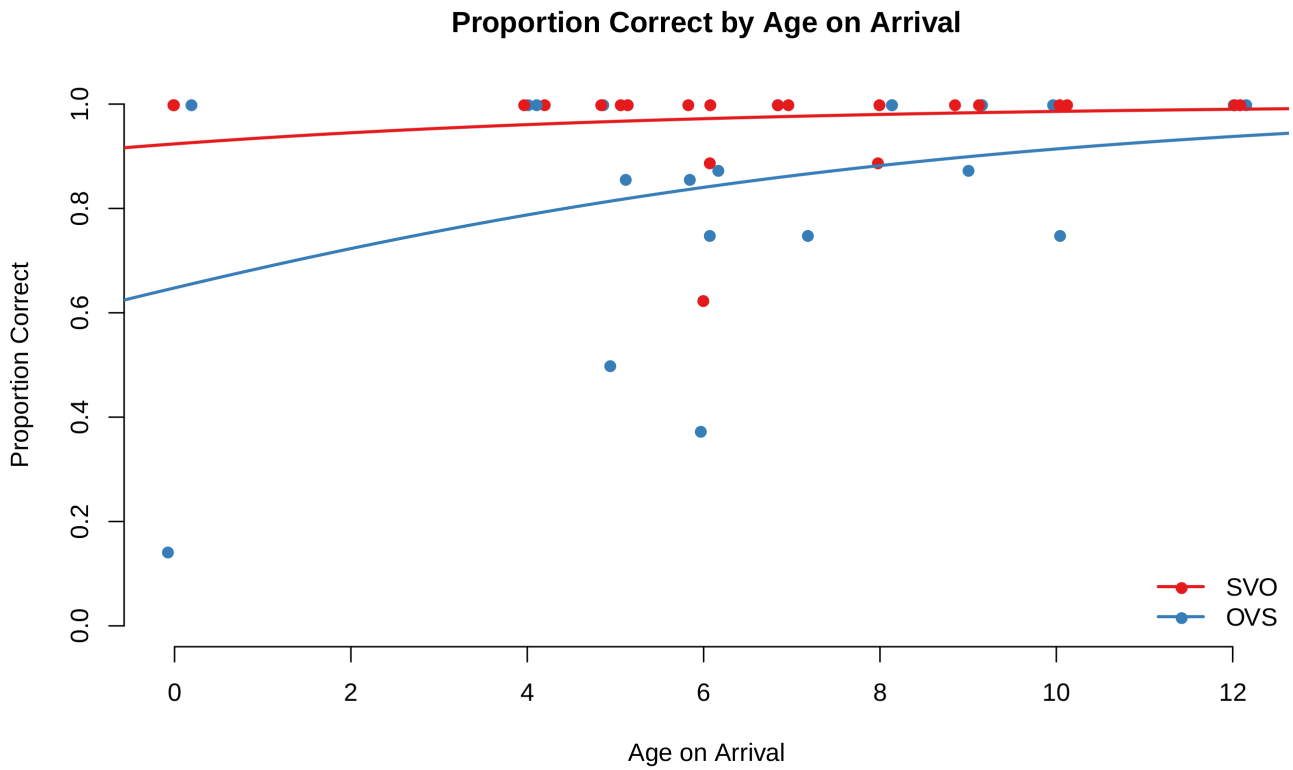
(2) Scrambled OVS:
Корову$_1$ везёт e$_1$ лошадка.
'Cow$_{ACC}$, is pulling horse$_{NOM}$.'
Correct answer: 'YES'

Results: Group Differences in Accuracy



Effect of Group: Adults (M=99.4%) >HSs (M=93%) >Children (M=83%)
HSs: effect of Word Order: SVO (M=97%) > OVS (M=84%) [$p < .001$]
Children: No effect of Word Order: SVO (M=85%) = OVS (M=77%) [$p = .08$]

HSs: Correlation between Accuracy and Age of Arrival



HSs: There was a correlation between Accuracy and Age of Arrival [$p = .006$]
Children: No correlation between Accuracy and Age

Results: Eye Movements – Adults vs. HSs

Bootstrapping analysis: Stone, Lago, & Schad (2021)

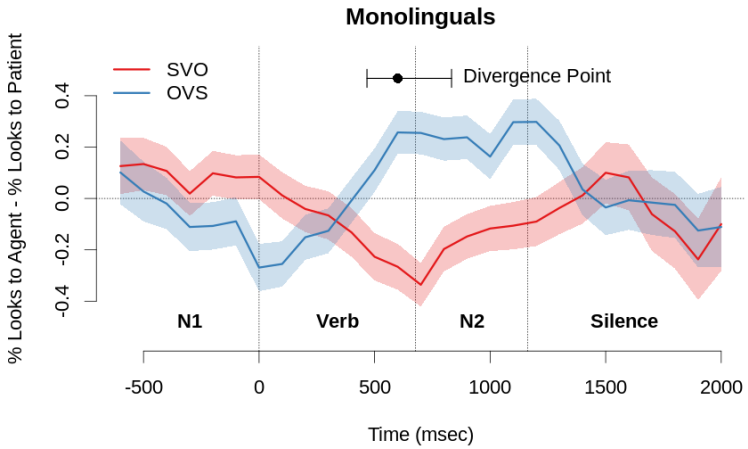
Pairwise comparisons among groups between the Word Order conditions

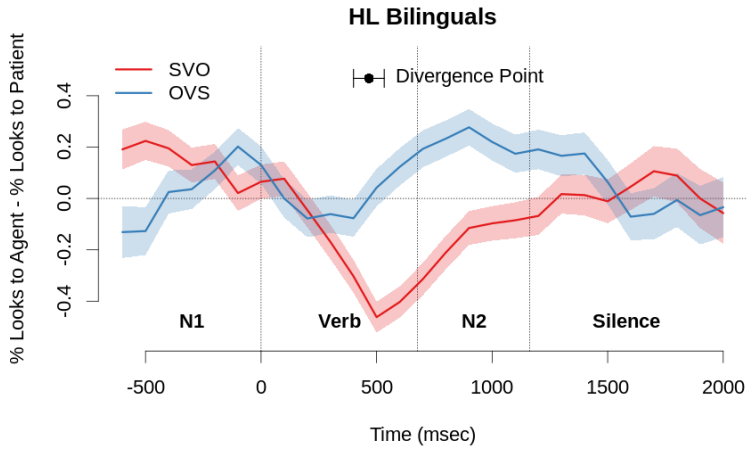
1,000 replicates: # of replicates with 5 significant findings in a row

CIs for divergence point in anticipatory looks to the Agent in SVO vs. OVS:

Adults: Divergence point:
567 ms ⇒ after the V, but before Agent

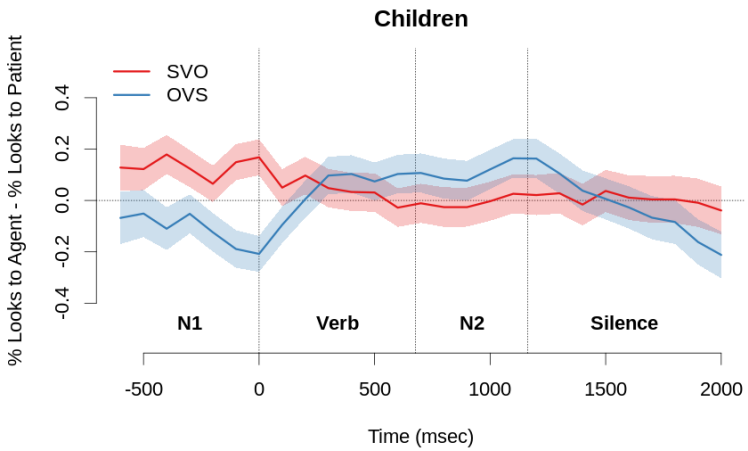
HSs: Divergence point:
467 ms ⇒ after the V, but before Agent



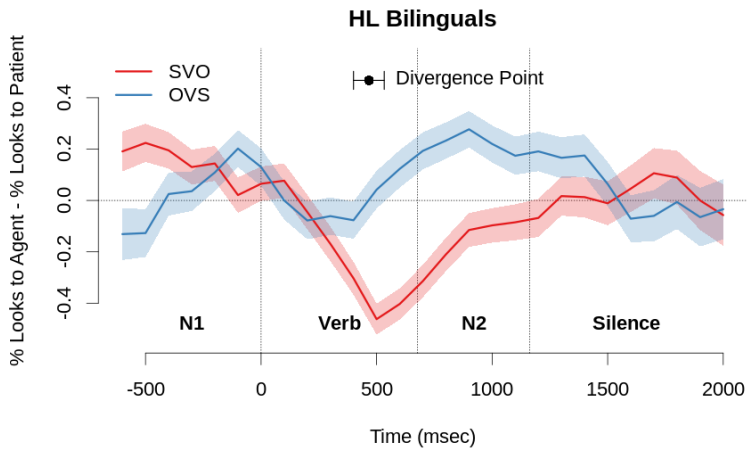


Results: Eye Movements – Children vs. HSs

Children:
No divergence point



HSs: Divergence point:
467 ms $\Rightarrow$ after the V, but before Agent



Results: Summary

Word Order	HSs
Accuracy:	
SVO:	$=$ Adults
	$>$ Children
OVS:	$<$ Adults
	$=$ Children
Eye Movements:	
SVO:	$=$ Adults
	$\neq$ Children
OVS:	$=$ Adults
	$\neq$ Children

Accuracy	Subset	Comparison	Bootstraps	Valid	Mean	SD	LB	Median	UB
1	Biling	SVO vs. OVS	1000	1000	464.8	37.4	400	467	533
1	Child	SVO vs. OVS	1000	72	1,411.6	1,506.8	0	1,900	4,007
1	Mono	SVO vs. OVS	1000	977	551.6	188.0	0	567	753
1	OVS	Child vs. Mono	1000	32	2,017.8	1,124.3	193	2,550	3,280
1	OVS	Biling vs. Mono	1000	579	2,026.1	867.3	0	2,367	2,767
1	OVS	Biling vs. Child	1000	74	2,127.5	1,092.4	0	2,367	3,833
1	SVO	Child vs. Mono	1000	100	628.3	114.7	433	633	937
1	SVO	Biling vs. Mono	1000	34	819.6	1,006.2	400	467	3,461
1	SVO	Biling vs. Child	1000	972	421.6	54.4	300	433	533

Back to the Goals: 1. Comprehension

Authors	#	Age	SVO	OVS	Method
Janssen & Meir (2019)	36	4;02-5;03	82%	85%	2-pic. sentence-pict. matching
Volkova et al. (2020)	37	3;10-5;10	74%	64%	2-pic. sentence-pict. matching
Sekerina & Mitrofanova (2017)	37	3;02-4;0	85%	88%	2-pic. sentence-pict. matching
This study	28	5;01-6;10	85%	77%	single picture verification

Children: Our results confirm previous research on accuracy of comprehension: Both above chance, worse than adults, but no difference between SVO and OVS

HSs: SVO at ceiling (=adults), OVS significantly worse than SVO (=children)

Back to the Goals: 2. Sensitivity to Case and Word Order

Children and HSs are sensitive to Case as demonstrated by their (averaged) above-chance comprehension of SVO and OVS.

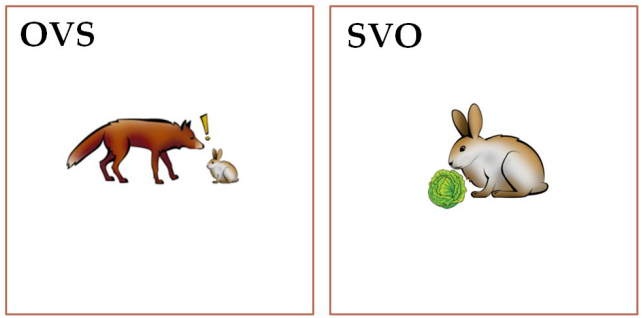
Individual variation in both groups.

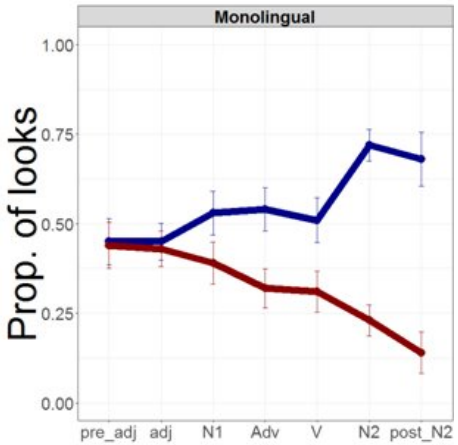
Children: SVO 100% (n=7), OVS 100% (n=4); a trend (p=.08) for improvement with Age. As children get older, their accuracy increases.

HSs: Both SVO and OVS 100% (n=9); significant correlation with the Age of Arrival (a proxi for proficiency)

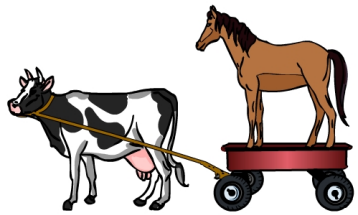
Back to the Goals: 3. Predictive Use of Case

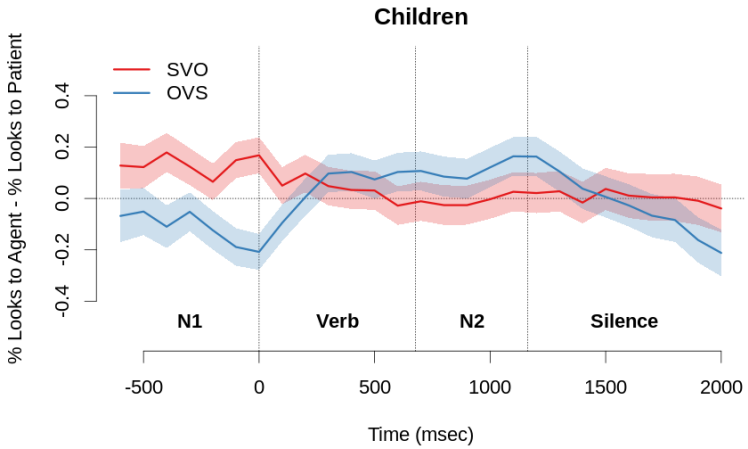
Sekerina & Mitrofanova (2017)





This study





Methodological approach matters for children: 3-Referent (Özge et al., 2019) ⇒ Single picture matching ⇒ 2-Picture selection (Sekerina & Mitrofanova, 2017; Volkova et al., 2020)

Conclusion

A complete theory of processing of Scrambling across different populations must include extra-linguistic and developmental factors:

Age (children)

Methodology (children)

Proficiency (heritage language speakers).

THANK YOU!

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