Expression of information structure in West Slavic: Modeling the impact of prosodic and word order factors

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How is information structure expressed in West Slavic languages?

Common view: In Slavic languages information structure gets primarily expressed by word order. (In English, it is primarily expressed by prosody.)

Our view: The expression of information structure is primarily prosodic in Slavic languages (and only secondarily word-order-based).

Further issues

Optionality

- Syntax generates more outputs for a single meaning (example: focus in situ vs. focus fronting, scrambling to various positions).
- Free (non-feature-driven) external and internal merge (Chomsky's recent work).

Gradience

- Some outputs might be preferred over others (without those being unacceptable).
- We capture this by a post-syntactic Linear OT model.
- This model also allows for a precise evaluation of (competing) hypotheses.

Givenness

Givenness (after Schwarzschild 1999)

An expression α is given if and only if it is in the common ground that there is an expression β in the preceding discourse such that

  a. if $[\![\alpha]\!] \in D_e$, then $[\![\alpha]\!] = [\![\beta]\!]$

  b. if $[\![\alpha]\!] \in D_{\langle\sigma,t\rangle}$ (for any type σ), then the existential closure of $[\![\beta]\!]$ entails the existential closure of $[\![\alpha]\!]$

Examples

A: Did you speak to [$_\beta$ Eddy]?
B: Sorry, I don't <u>know</u> [$_\alpha$ Eddy].

A: Look, Jane is eating a [$_\beta$ carrot].
B: Yeah, she <u>loves</u> [$_\alpha$ vegetables].

See also Ladd 1980, Rochemont 1986, Schwarzschild 1999, Wagner 2012.

"Free word order" in Slavic languages

In Slavic, information structure is expressed by word order.

Example: given-left, new-right

A: Kdo nakrmil psa? (Cz)

   'Who fed the dog?'

B: Psa nakrmil Milan.

   dog.acc fed Milan.nom

cf. Milan fed the dog. (En)

Notation: given, stressed

Two hypotheses of how this comes about

The word order approach

information structure ↔ word order

Word order is changed in order to satisfy constraints that relate information structure with word order directly.

E.g., Prague School linguists, Choi (1999), Kučerová (2012)

The prosodic approach

information structure ↔ prosody ↔ word order

Word order is changed in order to satisfy prosodic constraints and constraints that relate information structure with prosody.

E.g., Zubizarreta (1998), Neeleman and Reinhart (1998)

Common ground

Constraints that are, in one form or another, assumed by everybody.

NSR (Nuclear Stress Rule)

Sentence stress falls on the rightmost constituent.

CWO (Canonical Word Order)

The linear order of S, V, and O is SVO.

NSR: Chomsky & Halle (1968) for English, Daneš (1957) for Czech, Szwedek (1976) for Polish

CWO: Grimshaw's (1997) and Müller's (1999) OT constraint Stay; otherwise Sgall et al. (1980) for Czech

Prosodic hypothesis

In addition to CWO and NSR, a special constraint relating IS (givenness) and prosody is postulated.

*SG (*STRESS GIVEN)

A given expression does not realize sentence stress.

NSR (NUCLEAR STRESS RULE)

Sentence stress falls on the rightmost constituent.

CWO (CANONICAL WORD ORDER)

The linear order of S, V, and O is SVO.

*SG: Féry and Samek-Lodovici's (2006) OT constraint DESTRESS GIVEN; otherwise Petřík (1938); Daneš (1957); Szwedek (1976, 2011); Schmerling (1976); Ladd (1980); Reinhart (1997)

Prosodic hypothesis

Example

A: Kdo nakrmil psa? (Cz)
'Who fed the dog?'

B_1: Psa nakrmil <u>Milan</u>.
dog.acc fed Milan.nom CWO

B_2: Milan nakrmil <u>psa</u>. *SG

B_3: <u>Milan</u> nakrmil psa. NSR

Notation: violated constraint, given, <u>stressed</u>

Word order hypothesis

In addition to CWO and NSR, a special constraint relating IS (givenness) and word order is postulated.

G>N (Given before New)

Within a clause/proposition, given expressions precede new ones.

NSR (Nuclear Stress Rule)

Sentence stress falls on the rightmost constituent.

CWO (Canonical Word Order)

The linear order of S, V, and O is SVO.

G>N: Choi's (1999) OT constraint New; otherwise Mathesius; Firbas; Clark and Haviland (1977); Siewierska (1993); Kučerová (2007, 2012); Skopeteas and Fanselow (2009)

Word order hypothesis

Example

A: Kdo nakrmil psa? (Cz)

'Who fed the dog?'

B_1: Psa nakrmil Milan.

dog.acc fed Milan.nom CWO

B_2: Milan nakrmil psa. G>N

B_3: Milan nakrmil psa. NSR, G>N

Notation: violated constraint, given, stressed

Combined hypothesis

According to the combined hypothesis, G>N and *SG jointly determine the expression of IS.

*SG (*STRESS GIVEN)

A given expression does not realize sentence stress.

G>N (GIVEN BEFORE NEW)

Within a clause/proposition, given expressions precede new ones.

NSR (NUCLEAR STRESS RULE)

Sentence stress falls on the rightmost constituent.

CWO (CANONICAL WORD ORDER)

The linear order of S, V, and O is SVO.

Combined hypothesis

Example

A: Kdo nakrmil psa? (Cz)

'Who fed the dog?'

B_1: Psa nakrmil Milan.

dog.acc fed Milan.nom CWO

B_2: Milan nakrmil psa. *SG, G>N

B_3: Milan nakrmil psa. NSR, G>N

Notation: violated constraint, given, stressed

We conducted a modeling study to test which of the hypotheses provides the **best fit** to a data set of acceptability ratings.

Core assumption: if a constraint like *SG or G>N is really active, its violation will lead to a decrease in acceptability that is **consistent across the whole data set**.

Background assumptions: architecture of grammar

We assume a structure-building component that generates syntactic structures S_n, which, together with prosodic and information-structural information, P_n and I_n, serve as the input to an evaluating component, which assigns acceptability values a_n to each of the structures.

syntax, prosody, information structure
$\downarrow$
$\{\langle S_1, P_1, I_1 \rangle, \langle S_2, P_2, I_2 \rangle, \langle S_3, P_3, I_3 \rangle, \dots\}$
$\downarrow$
evaluation
$\downarrow$
$\{\langle\langle S_1, P_1, I_1 \rangle, a_1 \rangle, \langle\langle S_2, P_2, I_2 \rangle, a_2 \rangle, \langle\langle S_3, P_3, I_3 \rangle, a_3 \rangle \dots\}$

Background assumptions: evaluative component

As for the evaluative component, we adopt the following assumptions from Keller's (2000) **Linear Optimality Theory**:

- Each structure is evaluated with respect to a set of constraints.
- Each constraint is associated with a certain weight.
- The weights of the constraints that a structure violates add up in a cumulative weight and lead to a decrease in "harmony" (which we assume to correspond to acceptability).
- The weights are language-specific.

Experiments: general information

- **Participants**: 40 students in Prague (native speakers of Czech), 40 students in Poznań (native speakers of Polish); 40 students in Bratislava (native speakers of Slovak)
- **Materials**: Auditory stimuli consisting of a context utterance and a target sentence.
- **Task/procedure**: Participants were instructed to rate the target sentence in the given context on a 1–9 scale via computer keyboard. We report normalized z-score values.

Note: For reasons of space, we will only present the results for Czech and Polish here; the results for Slovak are very similar to Czech.

We manipulated three factors that are relevant for evaluating the predictions of the prosodic/word order/combined hypotheses:

- Word order
- Position of <u>stress</u>
- IS-status (focused, given, new/broad focus)

Experiment 1: all new

Question: What structures are acceptable when everything is new?

We manipulated word order. Sentence stress was always on the rightmost element. All elements were discourse-new (= not mentioned in the preceding context).

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all new experiment (32 items)

(C) Píšou něco zajímavého v novinách? (Cz)
'Is there anything interesting in the newspaper?'

(a) Dnes prý své zastupitele Němci volí do parlamentu. OSV<u>PP</u>
'Today the Germans allegedly vote their representatives to the parliament.'

(b) Dnes prý Němci své zastupitele volí do parlamentu. SOV<u>PP</u>

(c) Dnes prý Němci volí své zastupitele do parlamentu. SVO<u>PP</u>

(d) Dnes prý Němci volí do parlamentu své zastupitele. SVPP<u>O</u>

Experiment 2: given object

Question: What structures are acceptable when the object is given?

We manipulated word order and whether the subject was new or given. Sentence stress was always on the rightmost element. The object was always given (= mentioned in the preceding context).

(C) Zjistil jsi, proč dnes sekretářka tak nadávala? (Cz)
'Did you find out why our secretary was so angry today?'

(a) Protože prý sekretářku Karel poslal do obchodu.
'Because Karel allegedly sent the secretary to the store.' OSVPP

(b) Protože prý Karel sekretářku poslal do obchodu. SOVPP

(c) Protože prý Karel poslal sekretářku do obchodu. SVOPP

(d) Protože prý Karel poslal do obchodu sekretářku. SVPPO

Experiment 2: given object

Question: What structures are acceptable when the object is given?

We manipulated word order and whether the subject was new or given. Sentence stress was always on the rightmost element. The object was always given (= mentioned in the preceding context).

given object experiment with a given subject (32 items)

(C) Zjistil jsi, proč dnes sekretářka nadávala na Karla? (Cz)
'Did you find out why our secretary was so angry with Karel today?'

(a) Protože prý sekretářku Karel poslal <u>do obchodu</u>. OSVPP
'Because Karel allegedly sent the secretary to the store.'

(b) Protože prý Karel sekretářku poslal <u>do obchodu</u>. SOVPP

(c) Protože prý Karel poslal sekretářku <u>do obchodu</u>. SVOPP

(d) Protože prý Karel poslal do obchodu <u>sekretářku</u>. SVPPO

Question: How do stress shift and scrambling interact when the object is given?

We manipulated word order (only OV/VO), whether the subject was new or given, and the position of sentence stress (on O/on V). The object was always given.

stress shift (given O) experiment (48 items)

(C) Doufám, že ta bouřka nerozbije to okno. (Cz)
'I hope that the storm will not break this window.'

(a) Myslím, že učitelka to okno zavřela.
'I think that the teacher closed this window.' S<u>OV</u>

(b) Myslím, že učitelka zavřela to okno. S<u>V</u>O

(c) Myslím, že učitelka zavřela to okno. SV<u>O</u>

(d) Myslím, že učitelka to okno zavřela. S<u>O</u>V

Question: How do stress shift and scrambling interact when the object is focused?

We manipulated word order (only OV/VO) and the position of sentence stress (on O/on V). The object was always focused.

Stress shift and scrambling (focused object) (48 items)

(C)	Nevíš, co učitelka zavřela?	(Cz)
	'Do you know what the teacher closed?'	
(a)	Myslím, že učitelka to okno zavřela.	
	'I think that the teacher closed this window.'	SOV
(b)	Myslím, že učitelka zavřela to okno.	SVO
(c)	Myslím, že učitelka zavřela to okno.	SVO
(d)	Myslím, že učitelka to okno zavřela.	SOV

Modeling: procedure

We use **Multiple Regression** modeling to evaluate the hypotheses:

- Each hypothesis is formulated as a set of constraints.

- The Multiple Regression model determines **optimal estimates** for the **constraint weights**, i.e. those that result in the best fit for all data points.

- $\rightarrow$ Model comparison statistics allow to assess which set of constraints gives rise to the most successful model.

- $\rightarrow$ Plots help to see where particular inconsistencies arise.

Prosodic model: exp 1 (all new)

Experiment 'all new', Czech
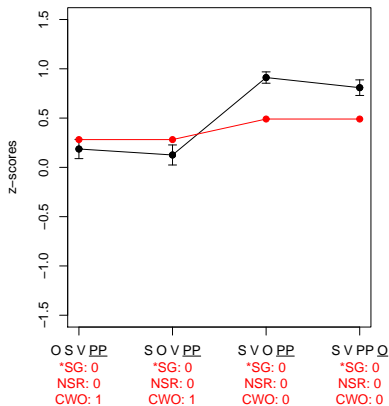
Experiment 'all new', Polish
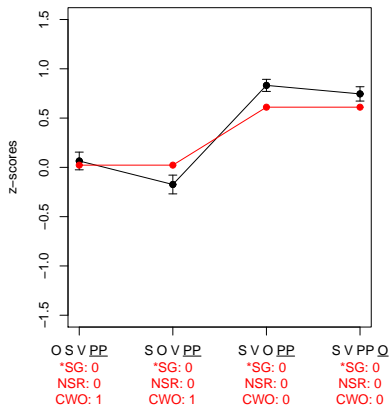
Prosodic model: exp 2 (given object)

Experiment 'given object', Czech
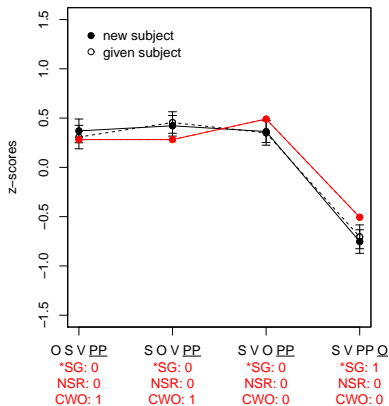
Experiment 'given object', Polish
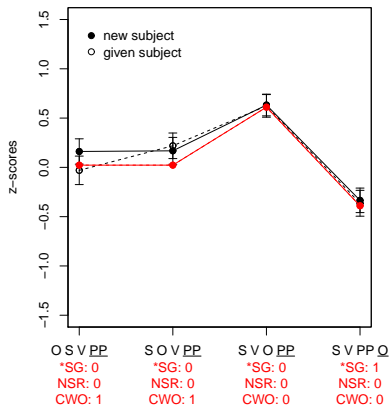
Prosodic model: exp 3a (stress shift, given O)

Experiment 'stress shift' (given O), Czech
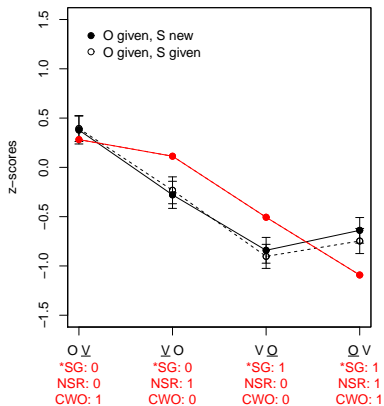
Experiment 'stress shift' (given O), Polish
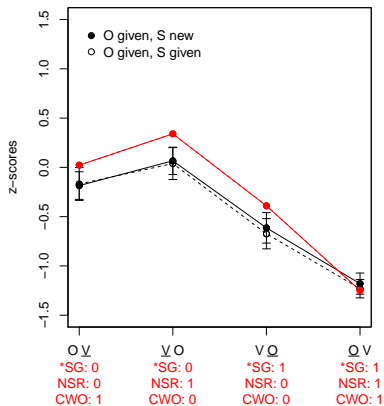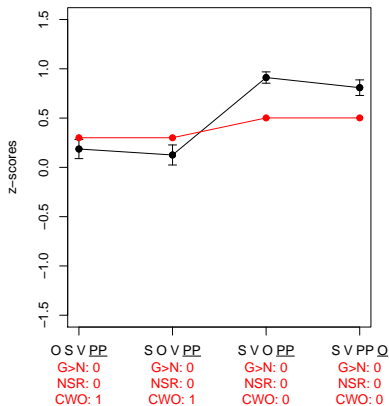
Prosodic model: exp 3b (stress shift, focused O)

Experiment 'stress shift' (focused O), Czech
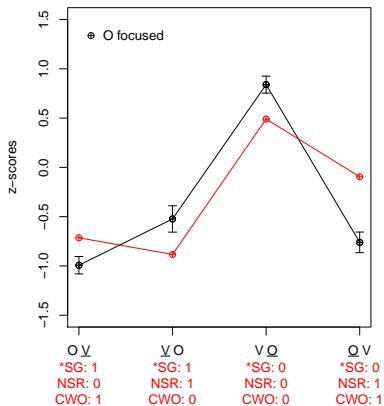
Experiment 'stress shift' (focused O), Polish
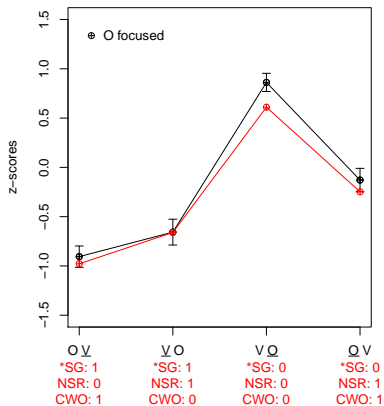
Prosodic model: discussion

- No fully consistent estimate can be found for CWO: experiments 2 and 3a, where a given element scrambles, suggest a small/zero weight, whereas experiment 1 and 3b, where new elements scramble, suggest a larger weight.
- The results of the given object experiment are captured successfully by the *SG constraint: only the condition with sentence stress on the given object deviates.
- The observation that Czech and Slovak prefer scrambling, whereas Polish prefers stress shift, can be modeled by language-specific weights for NSR and CWO.
- The observation that focused objects are best in situ is captured, but the full pattern is not modeled perfectly in Czech due to the inconsistent requirements on CWO.

Word order model: exp 1 (all new)
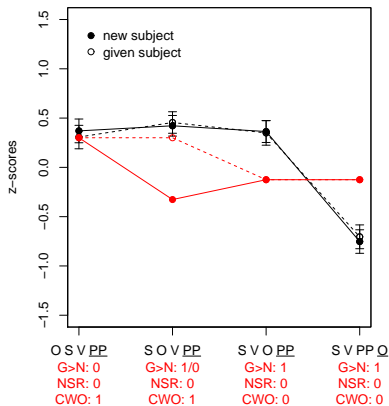

Experiment 'all new', Czech
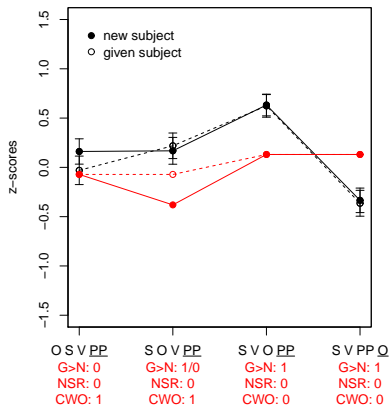
Experiment 'all new', Polish
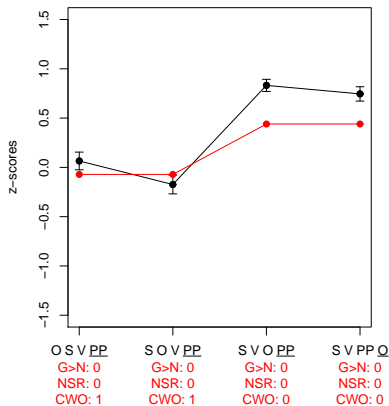
Word order model: exp 2 (given object)
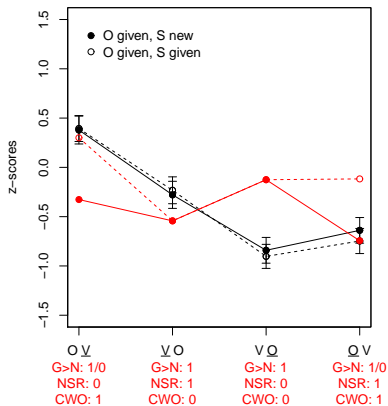

Experiment 'given object', Czech

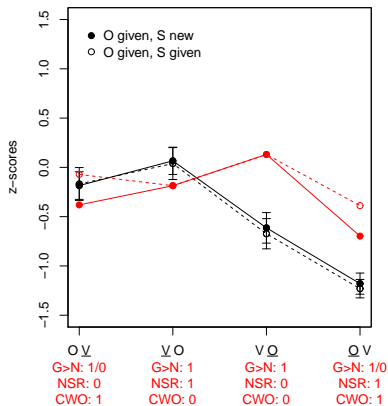**Experiment 'given object', Polish**

Word order model: exp 3a (stress shift, given O)

Experiment 'stress shift' (given O), Czech

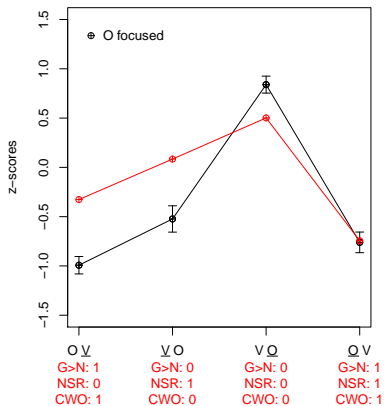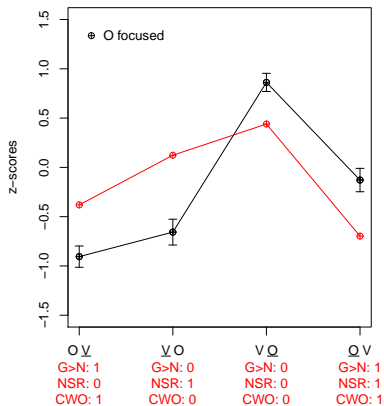**Experiment 'stress shift' (given O), Polish**

Word order model: exp 3b (stress shift, focused O)

Experiment 'stress shift' (focused O), Czech

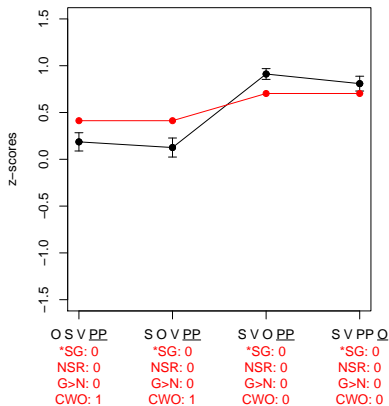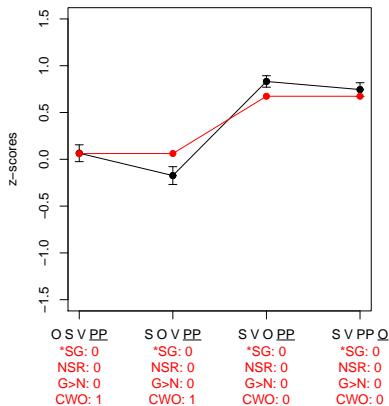**Experiment 'stress shift' (focused O), Polish**

- The word order model predicts an effect of subject givenness, which is absent in the results.
- No consistent estimate can be found for G>N: some structures in which it is violated are perfectly acceptable (e.g., S V O PP in experiment 2), whereas others are completely inacceptable (e.g., S V PP O).
- The model does not provide any means to capture the influence of the position of sentence stress.

Combined model: exp 1 (all new)
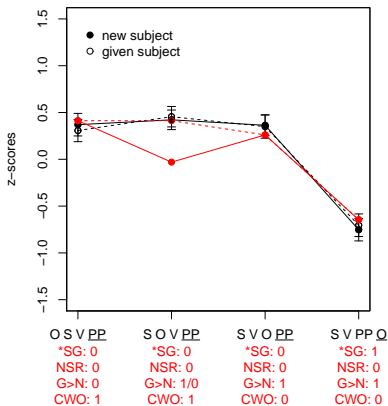

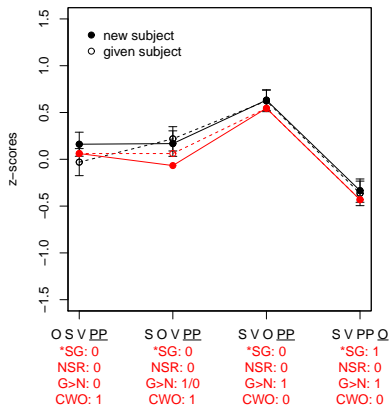Experiment 'all new', Czech

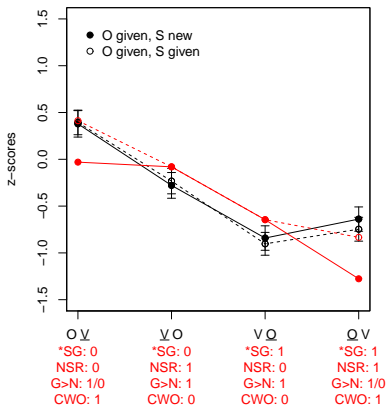Experiment 'all new', Polish

Combined model: exp 2 (given object)

Combined model: exp 3a (stress shift, given O)
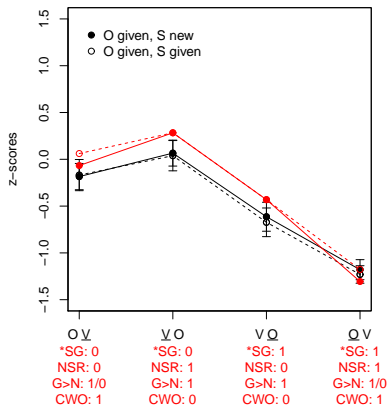
Combined model: exp 3b (stress shift, focused O)
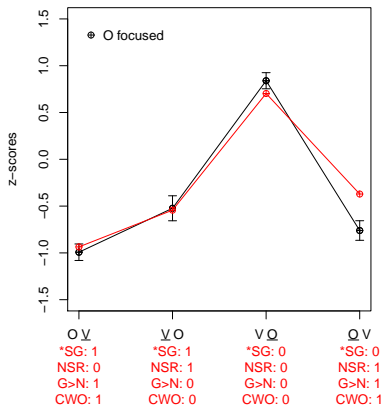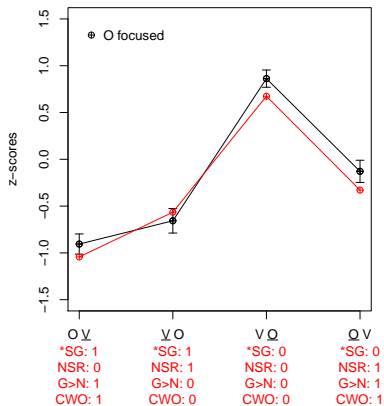
Combined model: discussion

- Adding G>N to the prosodic approach comes with benefits and problems. It improves the fit for the stress shift experiments in Czech: it provides a handle on the lower acceptability of the OV conditions in the stress shift (focused O) experiment and the VO conditions in the stress shift (given O) experiment, where the predictions of the prosodic model alone were too high. However, it introduces some of the problems of the word order model, namely the prediction that S givenness should have an effect.

- For Polish, the improvement in comparison to the prosodic model is not so pronounced because the estimated weight of G>N is very low.

Comparison of the models

Prosodic model

	Czech ($R^2 = 0.28$)		Slovak ($R^2 = 0.19$)		Polish ($R^2 = 0.30$)	
	estimate	SE	estimate	SE	estimate	SE
(Intercept)	0.40	0.02	0.29	0.02	0.32	0.02
*SG	-1.00	0.03	-0.82	0.03	-1.00	0.03
NSR	-0.38	0.03	-0.32	0.03	-0.27	0.03
CWO	-0.21	0.02	-0.30	0.03	-0.59	0.02

Word order model

	Czech ($R^2 = 0.16$)		Slovak ($R^2 = 0.09$)		Polish ($R^2 = 0.10$)	
	estimate	SE	estimate	SE	estimate	SE
(Intercept)	0.50	0.03	0.39	0.04	0.44	0.04
G>N	-0.63	0.03	-0.41	0.03	-0.31	0.03
NSR	-0.42	0.04	-0.36	0.04	-0.32	0.04
CWO	-0.20	0.03	-0.27	0.03	-0.51	0.03

Combined model

	Czech ($R^2 = 0.34$)		Slovak ($R^2 = 0.22$)		Polish ($R^2 = 0.31$)	
	estimate	SE	estimate	SE	estimate	SE
(Intercept)	0.40	0.02	0.29	0.02	0.32	0.02
*SG	-0.91	0.03	-0.76	0.03	-0.98	0.03
G>N	-0.44	0.03	-0.26	0.03	-0.13	0.03
NSR	-0.34	0.03	-0.30	0.04	-0.26	0.03
CWO	-0.29	0.02	-0.35	0.03	-0.61	0.02

Note: For each model all constraints had a significant influence.

Comparison of the models: discussion

- The prosodic hypothesis allows to model the data quite successfully in all three languages. It accounts for 28% of the variance in Czech, 19% in Slovak, and 30% in Polish.
- The word order model is significantly less successful (16% / 9% / 10%), suggesting that *SG is a necessary part of an adequate model for all three languages.
- The combined model is in turn significantly better than the prosodic model in all languages. However, the proportion of variance explained by the combined model increases by only 1% for Polish; in Czech and Slovak, the difference is more pronounced (3% / 6%).

Conclusions

- The expression of information structure is primarily prosodic in West Slavic, contrary to the prevalent view in the literature.
- In Polish, a prosodic model seems to be sufficient, whereas in Czech and Slovak, complementing it by a word order related constraint improves the results considerably.
- The effect of *SG is consistent across the experiments, but there are conflicting requirements on G>N.
- Statistical model comparison can help to see whether a complex data pattern can be fully accounted for by one out of several competing hypotheses, or whether more of them are contributing to the empirical picture.

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