

Processing efficiency vs. typology

An experimental study of weight effects
on word order in Slovak and English



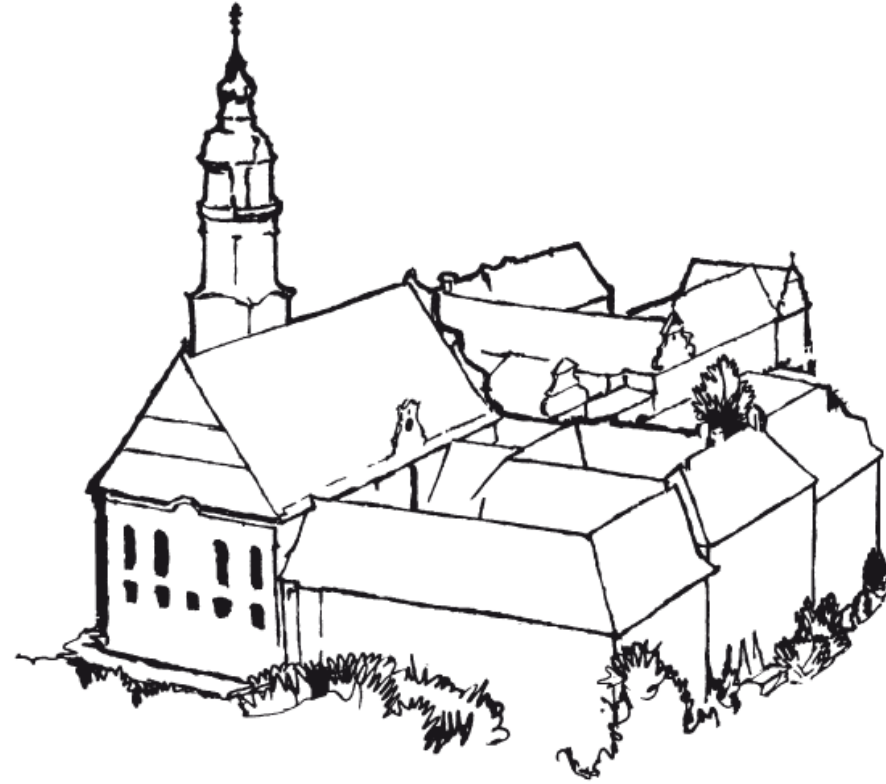
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1 The principle of end-weight (QUIRK et al. 1985)

- **light** before **heavy** constituents: easier to cognitively process (HAWKINS 1994)
- ‘light’ = short/less complex
- ‘heavy’ = long/more complex
- operationalized as number of orthographical words
(SZMRECSÁNYI 2004: 1037)

“[N]umber of words, number of nodes, and number of phrasal nodes [...] are so highly correlated that it is impossible to choose among them on empirical grounds” (WASOW and ARNOLD 2003: 121)

1 The principle of end-weight

- *John gave a book to Mary vs. John gave to Mary a book:*

(1) *John*_{VP}[*gave*_{NP}[*a book*]_{PP}[*to Mary*]]

(2) *John*_{VP}[*gave*_{PP}[*to Mary*]_{NP}[*a book*]]

- (1) cognitively preferred: **lighter (less complex) NP** before **heavier PP**
- **_{VP}[V NP PP]** is the **basic/grammaticalized** (=most frequent) English order
(HAWKINS 1994: 20)

1 The principle of end-weight

What happens when the NP becomes heavier than the PP?

➤ Speakers shift the heavy NP (Heavy NP Shift):

- *John gave a valuable book that was difficult to find to Mary*

(3) *John* _{VP}[gave _{NP}[*a valuable book that was difficult to find*] _{PP}[*to Mary*]]

(4) *John* _{VP}[gave _{PP}[*to Mary*] _{NP}[*a valuable book that was difficult to find*]]

➤ now: _{VP}[**V PP NP**] (**PP** lighter than **NP**, easier processing)

1 The principle of end-weight

Why investigate weight effects/Heavy NP Shift?

- “rare case of phrase ordering that does not affect grammatical role assignment” (STALLINGS et al. 1998: 395)
- DO NP stays DO NP when shifted (unlike other syntactic alternations, e.g. ditransitive/*to*-dative)
- perfect for cross-linguistic comparison of processing efficiency effects: triggered exclusively by cognitive factors (constituent length/complexity)
- no stylistic motivation, no effects of animacy (STALLINGS et al. 1998: 410)

1 The principle of end-weight

- principle of end-weight/HNPS well researched & acknowledged in languages such as English, German (e.g. BEHAGHEL 1910: 139; 1930: 85; QUIRK et al. 1972, QUIRK et al. 1985, HAWKINS 1994, 2004, 2014; WASOW 1997; ARNOLD et al. 2000; STALLINGS et al. 1998; STALLINGS & MACDONALD 2011, MELNICK 2017; MAINS et al. 2015; MEDEIROS et al. 2021)
- in Slavic languages? not so much (e.g. Russian, KIZACH 2012: 251)
- rather, focus on information structure: “pragmatic constituent order takes precedence over syntax” (SHORT 2002: 494)
- but: speakers “care more about complexity than about givenness” (KIZACH 2014)

1 The principle of end-weight

- Slovak: “[m]odern Slovak sources decline to refer to any unmarked order of constituents in terms of basic word order” (SHORT 2002: 566)
- constituent order in Slovak is (consistently claimed to be) conditioned by Functional Sentence Perspective (FSP) (cf. e.g. FIRBAS 1992)
- PAULINY et al. 1963; ORLOVSKÝ 1971; MISTRÍK 1983, 1988, 2003; PAULINY 1981, 1997; PAVLOVIČ 2012; IVANOVÁ 2016;
- *Jazykovedný časopis* (1954-)¹; *Slovenská reč* (1932-)²
 - **no mention of weight effects or basic order**

1 <https://www.juls.savba.sk/ediela/jc/> 2 <https://www.juls.savba.sk/ediela/sr/>

1 The principle of end-weight

But: weight effects as general cognitive restraints apply to all languages:

“*Tenet 5. Cross-linguistic generalizations are explained by appeal to general cognitive constraints [...].*” (GOLDBERG 2003: 219)

➤ **Research questions:**

- i. Light before heavy preferred in Slovak, as in English?
- ii. Basic/grammaticalized NP-PP order in Slovak, as in English?
- iii. Typological effects? (Slovak synthetic, English analytic)

➤ **Pilot study** (limited scope!)

2 Magnitude Estimation (MET)

- BARD et al. 1996; COWART 1997: 73-84, HOFFMANN 2013
- introspective acceptability ratings
- “subjects do not have to rate stimuli on a scale [...] which might artificially limit their choices” but “decide on their own scale and make as many fine-grained choices as they deem necessary” (HOFFMANN 2013: 103)
- ratings later ‘centered’ (z-scores) to make them comparable
- grammatical/ungrammatical fillers → ‘baselines’
- test items presented in isolation → minimize information structure effects

2 Magnitude Estimation (MET)

- BARD et al. 1996; COWART 1997: 73-84
- introspective acceptability ratings
- “subjects do not judge grammaticality, but acceptability”
- limit # of items → make as many fine-grained judgments as possible (HOFFMANN 2013: 103)
- rating scale: “grammatical” or not (=“ungrammatical”) → “get as close to grammaticality as possible” (HOFFMANN 2013: 104)
- grammaticality: careful design and implementation → “artificially grammatical fillers → ‘baselines’”
- test items presented in isolation → minimize information structure effects

Disclaimer: Measures acceptability, not grammaticality in the Chomskian sense (i.e., a sentence belongs to the language system (=“grammatical”) or not (=“ungrammatical”))

However: careful design and implementation → “get as close to grammaticality as possible” (HOFFMANN 2013: 104)

2 Magnitude Estimation (MET)

- 2 variables:
 - WEIGHT ORDER (levels: LIGHT-HEAVY; HEAVY-LIGHT)
 - PHRASE ORDER (levels: NP-PP; PP-NP)
- 4 conditions:
 - LIGHT NP-HEAVY PP
 - HEAVY NP-LIGHT PP
 - LIGHT PP-HEAVY NP
 - HEAVY PP-LIGHT NP

2 Magnitude Estimation (MET)

- 8 lexicalizations (each condition tested twice)
- Latin squares method: 4 material sets (MS), 8 test items each
- 16 fillers/distracters: 8 grammatical, 8 ungrammatical
(4 word order, 4 subject-verb agreement violations)
→ 24 items per questionnaire
- pen-and-paper questionnaires with 2 training sessions
- filled out on-site under supervision (**Comenius University** in Bratislava;
University of Cyril and Methodius in Trnava; **Trinity College**, Dublin)

2 Magnitude Estimation (MET)

	INTRO	NP	PP
A	Eva dala	(ten drahý) kabát(, čo jej manžel kúpil vo Viedni,)	do (profesionálnej) čistiarne(, ktorú jej odporučila suseda,)
B	Sestrička odoslala	(rôzne) vzorky(, ktoré deň predtým odobrala pani Novákovej,)	na (rozsiahlu) kontrolu(, ktorú si vyžiadal jej neurológ,)
C	Hostia položili	(svoj veľký) kufor(, ktorý s námahou vynášali po schodoch,)	pod (biely) stôl(, čo stojí pri okne v kuchyni,)
D	Marek vybral	(ten vlnený) sveter(, čo má červené a modré pruhy,)	z (mokrej) tašky(, ktorú si celú obliat kávou,)
E	Učiteľka vpustila	(malých) školákov(, ktorí sa práve vrátili z prestávky,)	do (školskej) jedálne(, ktorá príjemne voňala od palacínok,)
F	Snúbenci pozvali	(tú milú) tetu(, ktorá už dlhé roky žije v zahraničí,)	na (letnú) svadbu(, ktorá sa mala konať v júli,)
G	Janka vložila	(svoju novú) knihu(, ktorú jej daroval strýko z Rakúska,)	medzi (tie) ostatné(, ktoré už mala odložené na policičke,)
H	Katka dostala	(ten veľký) darček(, ktorý bol zabalený v zlatom papieri,)	od (najlepších) kamarátok(, ktoré pozvala na svoje narodeniny,)

2 Magnitude Estimation (MET)

	INTRO	NP	PP
A	Eve brought	the (expensive) coat (that her husband had bought in Vienna)	to the (professional) dry cleaner (that her neighbor had recommended)
B	The nurse sent	(various) blood samples (that she had taken from Ms. Smith)	to the (pathology) lab (for an analysis requested by the doctor)
C	The guests put	the (big) suitcase (that they had carried up the stairs)	under the (that big white) table (that is next to the kitchen window)
D	Mark took	the (woolen) sweater (with the red, white and blue stripes)	from the (large gym) bag (over which he had accidentally poured coffee)
E	The teacher let	the (little) pupils (who had returned from a school trip)	into the (school) canteen (that was filled with the smell of soup)
F	The bride invited	her (that nice) aunt (who had lived abroad for many years)	to her (summer) wedding (that was going to take place in July)
G	Janet placed	the (new small) book (that her uncle from Cork had given her)	between two (large) others (that were already on her bookshelf)
H	Kate got	that (large) present (that is wrapped in golden paper)	from her (best) friends (that she had invited to her birthday)

3 Results

- n=39 L1 **Slovak** speakers (30f, 7m, 2 non-binary) from Comenius University¹ Bratislava & University of Cyril and Methodius² Trnava

	MS1	MS2	MS3	MS4
COM 1	3	3	3	2
COM 2	2	2	1	1
COM 3	2	3	3	4
UCM	3	3	2	2
Totals	10	11	9	9

¹Peter Barrer | ²Monika Banášová

3 Results

- n=40 L1 **English** speakers (25f, 16m) from Trinity College, Dublin¹

	MS1	MS2	MS3	MS4
	11	9	11	10

¹Lorna Carson

3 Results

- Questionnaires, results, scans: <https://osf.io/kvrwh/>
- data analysis: mixed-effects models
(stepwise regression/backward selection; KUZNETSOVA et al. 2015, 2017, 2020)



3.1 Results: Slovak

- no significant random effects (GENDER, MS, SUBJECT, LEXICALIZATION¹, GROUP)
- both fixed effects (linguistic variables) significant:
 - WEIGHT ORDER: $p < 0.001$ ***
 - PHRASE ORDER: $p = 0.016$ *
 - WEIGHT ORDER:PHRASE ORDER: $p = 0.706$ n.s.

¹One LEXICALIZATION removed due to considerable deviation

3.1 Results: Slovak

- z-score means:
 - gramm. fillers: +0.58
 - ungramm. fillers: -0.65
 - LIGHT NP-HEAVY PP: +0.45
 - HEAVY NP-LIGHT PP: -0.08
 - LIGHT PP-HEAVY NP: +0.28
 - HEAVY PP-LIGHT NP: -0.39

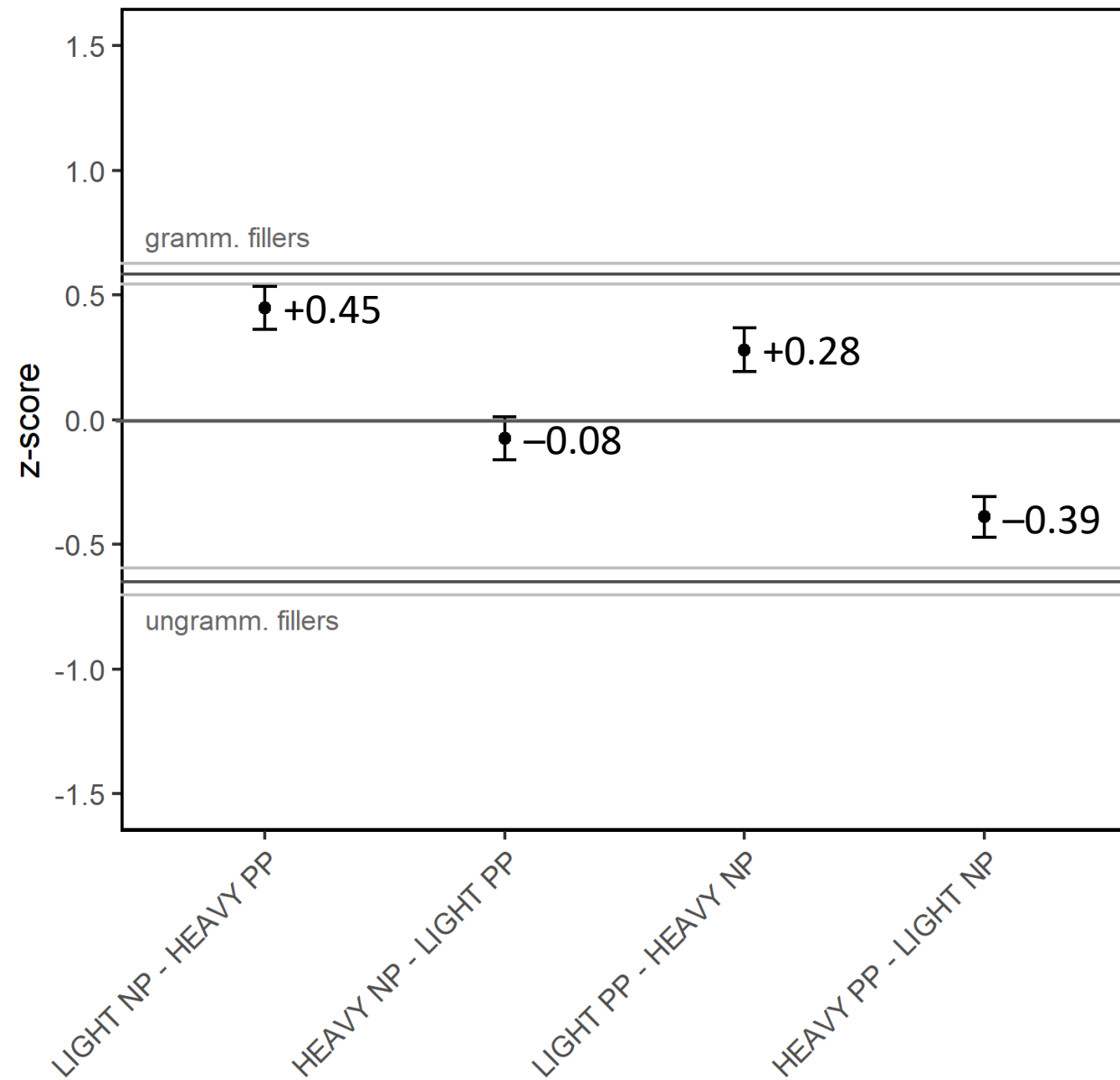


Fig. 1: Z-score means of WEIGHT ORDER:PHRASE ORDER (n=39), Slovak

3.1 Results: Slovak

- LIGHT-HEAVY always preferred
($p < 0.001^{***}$)
- LIGHT-HEAVY positive z-scores
- HEAVY-LIGHT negative z-scores
- NP-PP always preferred
($p = 0.042^*$)

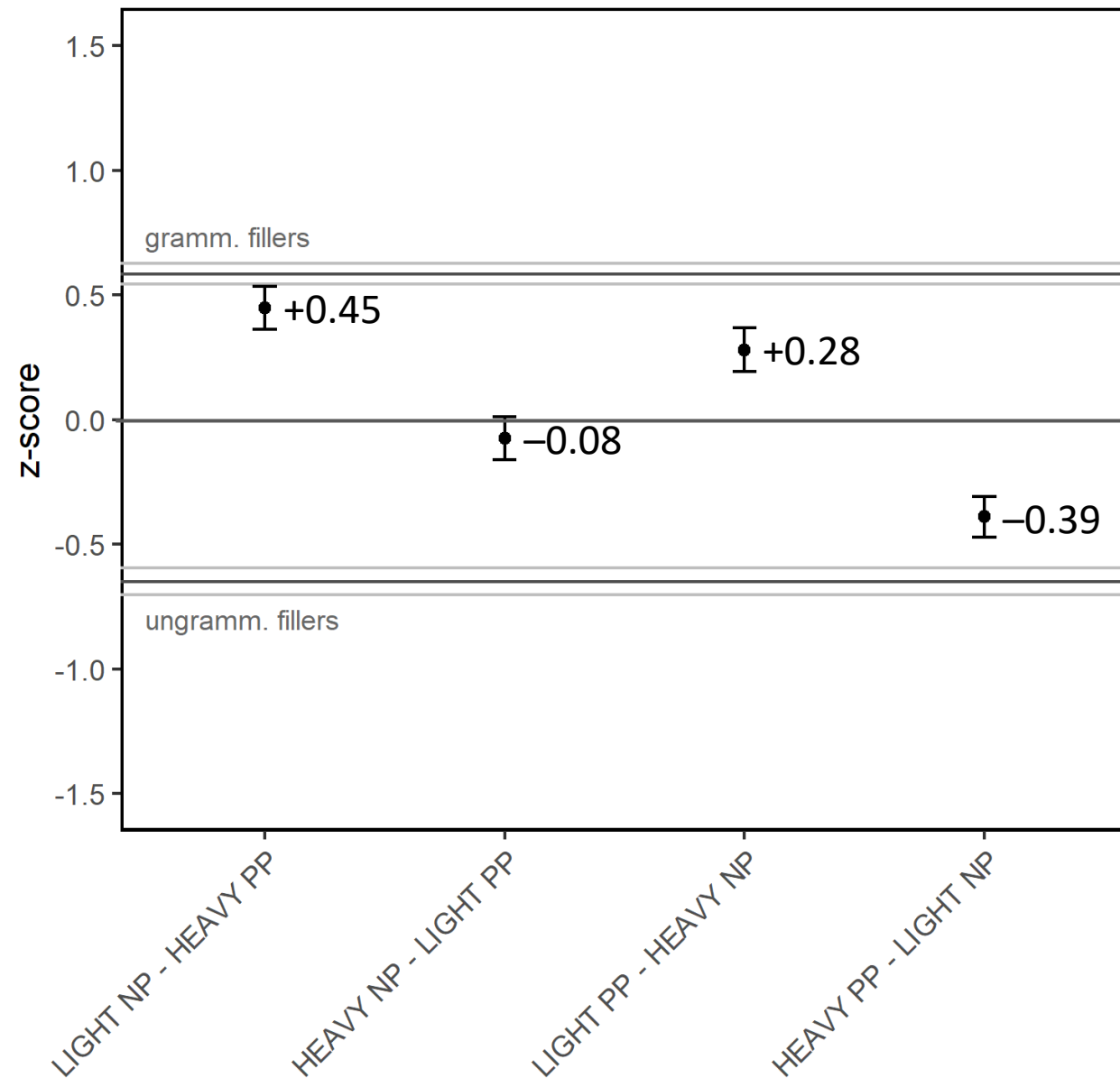


Fig. 1: Z-score means of WEIGHT ORDER:PHRASE ORDER (n=39), Slovak

3.2 Results: English

- no significant random effects (GENDER, MS, SUBJECT, LEXICALIZATION²)
- both fixed effects (linguistic variables) significant:
 - WEIGHT ORDER: $p < 0.001$ ***
 - PHRASE ORDER: $p < 0.001$ ***
 - WEIGHT ORDER:PHRASE ORDER: $p < 0.001$ ***

²Two LEXICALIZATIONS removed due to considerable deviation

3.2 Results: English

- z-score means:
 - gramm. fillers: +0.88
 - ungramm. fillers: -0.60
 - LIGHT NP-HEAVY PP: +0.22
 - HEAVY NP-LIGHT PP: +0.42
 - LIGHT PP-HEAVY NP: -0.27
 - HEAVY PP-LIGHT NP: -1.28

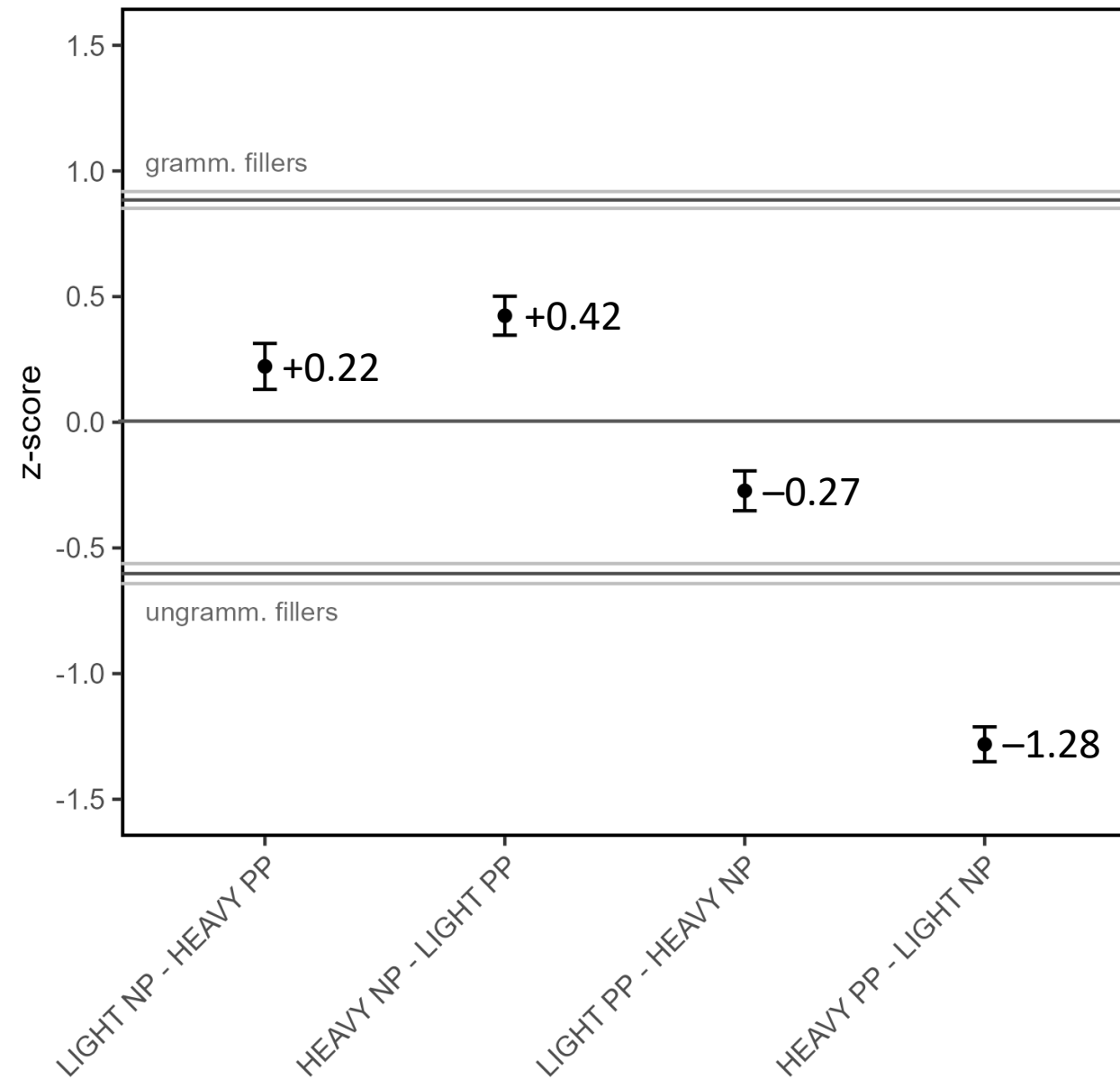


Fig. 2: Z-score means of WEIGHT ORDER:PHRASE ORDER (n=40), English

3.2 Results: English

- NP-PP always preferred
($p < 0.001^{***}$)
- NP-PP positive z-scores
- PP-NP negative z-scores
- WEIGHT ORDER:PHRASE ORDER
($p < 0.001^{***}$)

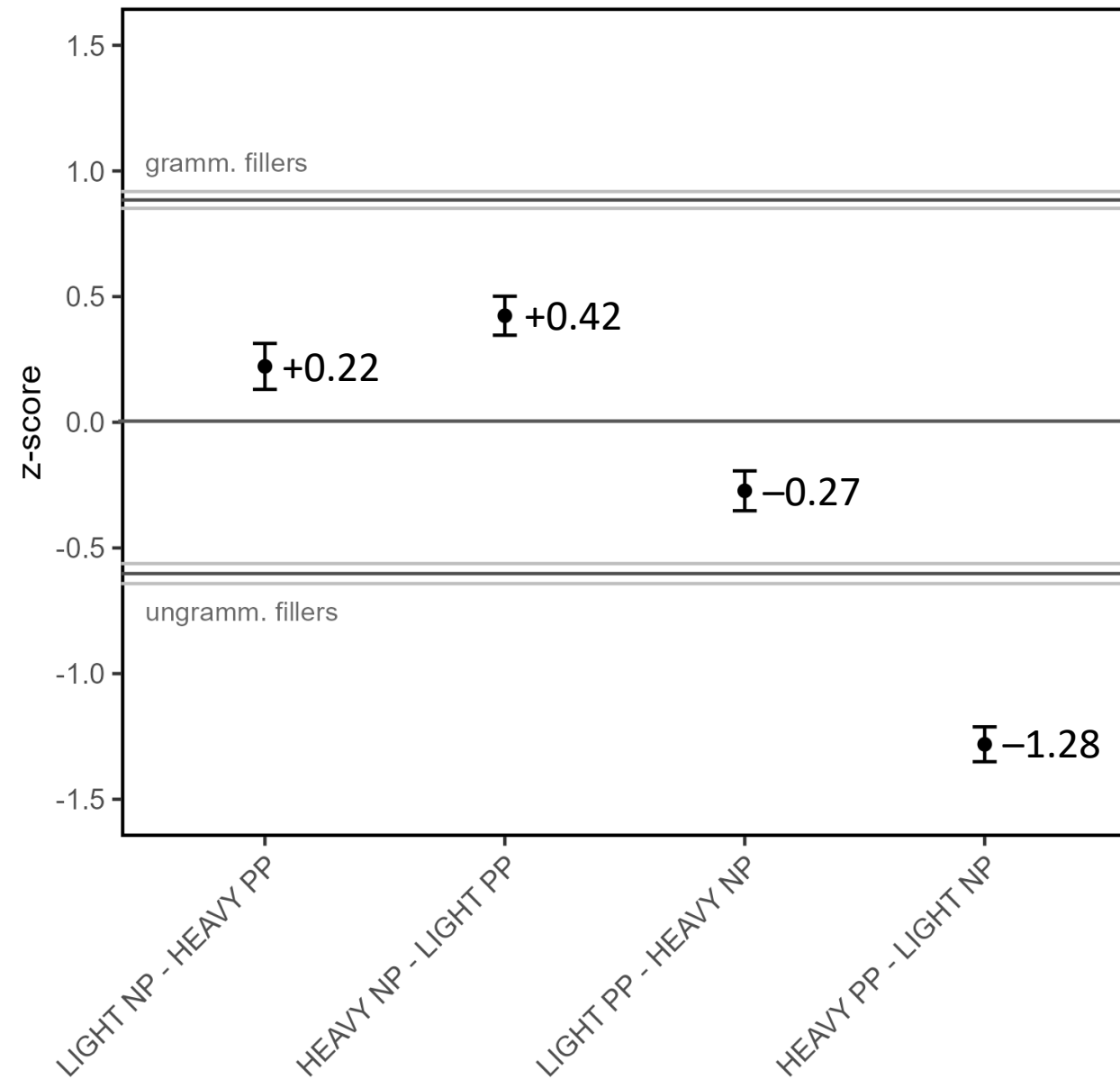


Fig. 2: Z-score means of WEIGHT ORDER:PHRASE ORDER (n=40), English

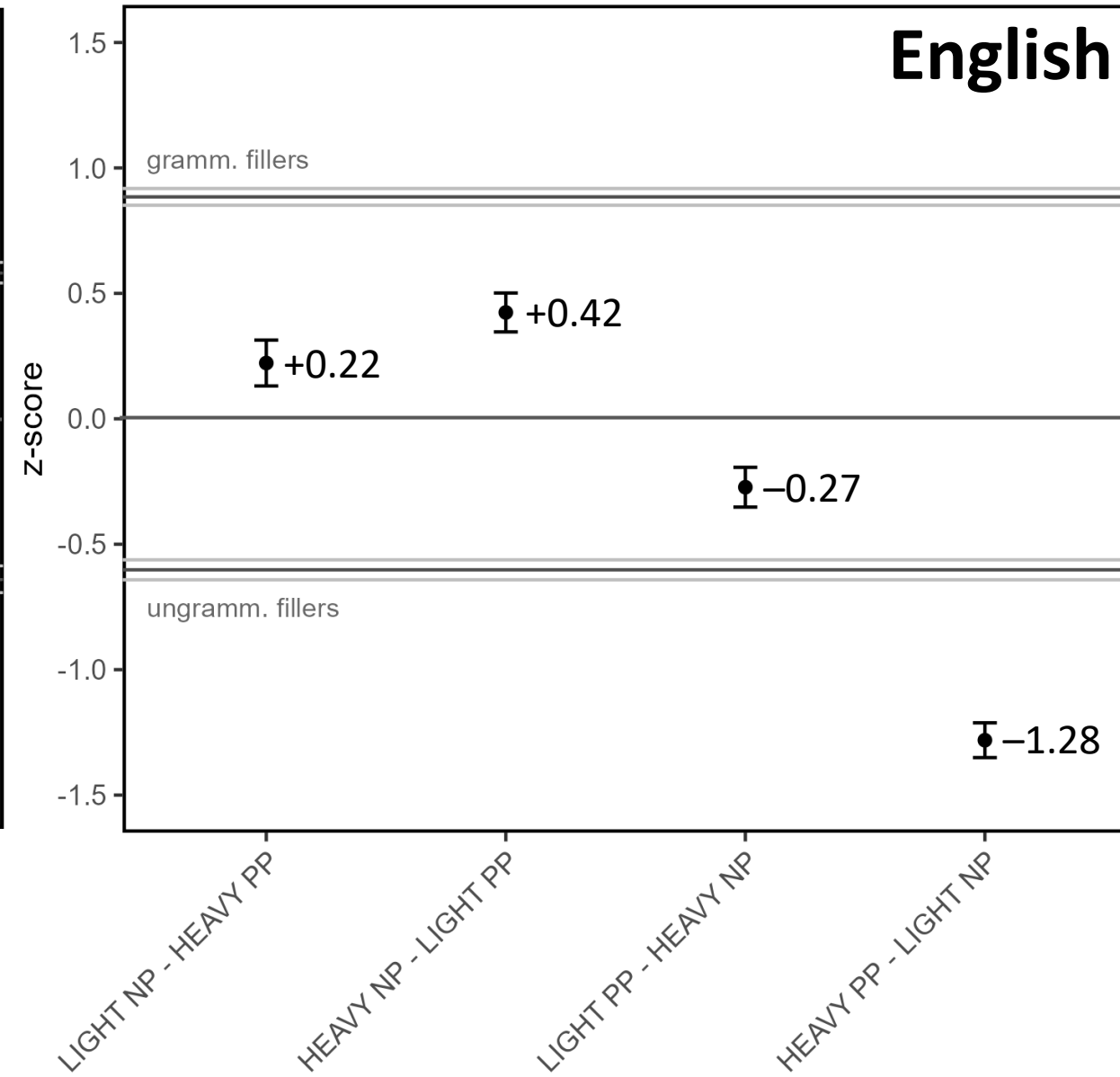
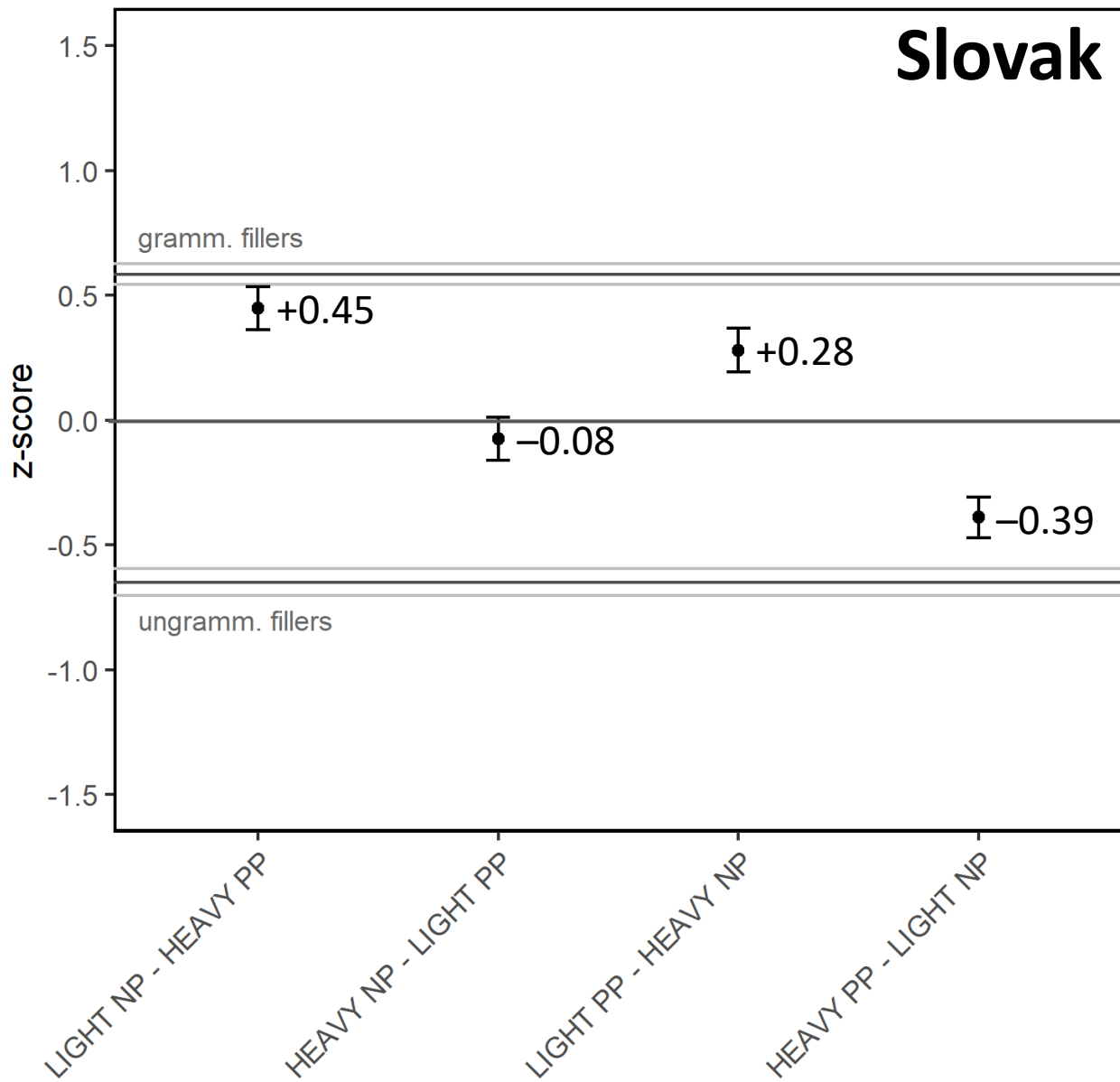


Fig. 1: Z-score means of WEIGHT ORDER:PHRASE ORDER (n=39), **SK**

Fig. 2: Z-score means of WEIGHT ORDER:PHRASE ORDER (n=40), **EN**

4 Discussion: Slovak

- LIGHT-HEAVY always preferred → GOLDBERG's Tenet #5
- weight effects have a **statistically highly significant** ($p < 0.001^{***}$) influence on constituent order
- NP-PP preferred: evidence ($p = 0.042^*$) of a basic/grammaticalized constituent order (HAWKINS 1994: 20)
- NP-PP not as strong → synthetic language, more flexible
- grain of salt: participants might implicitly construe light phrases as given/topical and heavy phrases as new/focused¹

¹Anonymous reviewer

4 Discussion: English

- NP-PP positive (+); PP-NP negative (-)
 - basic/grammaticalized (Hawkins 1994: 20)
- HEAVY PP-LIGHT NP **dispreferred** in both languages
 - GOLDBERG's Tenet #5
- ? HEAVY NP-LIGHT PP preferred over LIGHT NP-HEAVY PP ?
(but: within SE range)

4 Discussion

- **Typology** (cf. HORSCH 2021):
 - Slovak: synthetic, flexible word order (SI: 595, AI: 355)
 - English: analytic, fixed word order (SI: 210, AI: 395)
- **Processing efficiency:**
 - Slovak: LIGHT-HEAVY always preferred, PHRASE ORDER secondary
 - English: NP-PP always preferred, WEIGHT secondary
- but remember: HEAVY PP-LIGHT NP **dispreferred** in both languages

4 Discussion

- **Processing efficiency vs. typology:** English (analytic) appears to have fixed the NP-PP order to such a degree that plays a more important role to its speakers than processing efficiency
- ‘The more analytic a language, the less susceptible to weight effects it is’
- In addition to information structure (which undoubtedly plays a role in both languages, too), there are at least two more factors – i.e., processing efficiency and typology – that interact to determine word/constituent order

4 Discussion

An explanation: Performance-Grammar Correspondence Hypothesis

“when the grammar of one language is more restrictive and eliminates one or more structural options that are permitted by the grammar of another, the restriction will be in accordance with performance preferences. The *preferred structure will be retained and ‘fixed’ as a grammatical convention*, the dispreferred structures will be removed.”

(HAWKINS 2004: 5)

- fixed orders in analytic languages (e.g. ‘grammaticalized’ English v_p [V NP PP] order) are a result of performance preference (i.e. weight effects).
- they are mirrored as preferred orders in synthetic languages (e.g. Slovak)

5 Conclusion

- **there are effects beyond information structure (typology, weight effects) that influence constituent order in languages**
- Slovak (and other Slavic languages?): long-standing tradition of focusing on information structure; weight effects need to be acknowledged
 - **‘Beyond’** = in addition to information structure
 - pilot study, more research necessary:
 - different data, e.g. corpus data
 - more languages, e.g. German, Spanish (typological effects)
 - more conditions e.g. LIGHT-LIGHT, HEAVY-HEAVY
 - include INFORMATION STRUCTURE (levels: TOPICAL, FOCUSED)

References (1)

- Arnold, Jennifer, Anthony Losongeo & Ryan Ginstrom. 2000. Heaviness vs. newness: The effects of structural complexity and discourse status on constituent ordering. *Language* 76(1). 28–55.
- Bard, Ellen G., Dan Robertson & Antonella Sorace. 1996. Magnitude estimation of linguistic acceptability. *Language* 72(1). 32–68.
- Behaghel, Otto. 1909. Beziehungen zwischen Umfang und Reihenfolge von Satzgliedern [Relationships between size and ordering of constituents]. *Indogermanische Forschungen* 25. 110–142.
- Behaghel, Otto. 1930. Von deutscher Wortstellung. *Zeitschrift für Deutschkunde Jahrgang 44 der Zeitschrift für deutschen Unterricht*. 82–89.
- Cowart, Wayne. 1997. *Experimental Syntax: Applying Objective Methods to Sentence Judgements*. Thousand Oaks, CA: Sage.
- Firbas, Jan. 1992. *Functional Sentence Perspective in Written and Spoken Communication*. Cambridge: Cambridge UP.
- Goldberg, Adele E. 2003. Constructions: a new theoretical approach to language. *TRENDS in Cognitive Sciences* 7(5). 219–224.
- Hawkins, John A. 1994. *A performance theory of order and constituency* (Cambridge Studies in Linguistics 73). Cambridge: Cambridge UP.

References (2)

- Hawkins, John A. 2004. *Efficiency and complexity in grammars*. Oxford: Oxford UP.
- Hawkins, John A. 2014. *Cross-linguistic variation and efficiency*. Oxford: Oxford UP.
- Hoffmann, Thomas. 2013. Obtaining introspective acceptability judgements. In Manfred Krug & Julia Schlüter (eds.), *Research Methods in Language Variation and Change*, 99–118. Cambridge: Cambridge UP.
- Horsch, Jakob. 2021. Typological profiling of English, Spanish, German and Slovak: A corpus-based approach. *Jazykovedný časopis [Journal of Linguistics of the Slovak Academy of Sciences]* 72(2). 342–352.
- Ivanová, Martina. 2016. *Syntax slovenského jazyka*. Second edition. Prešov: Vydav. Prešovskej Univerzity.
<http://www.pulib.sk/web/kniznica/elpub/dokument/lvanova4>.
- Kizach, Johannes. 2012. Evidence for weight effects in Russian. *Russian Linguistics* 36(3). 251–270.
- Kizach, Johannes. 2014. “Complexity, givenness and g-maze”. Georg-August-Universität Göttingen.
<https://www.uni-goettingen.de/en/487714.html>
- Kuznetsova, Alexandra, Per B. Brockhoff & Rune H. B. Christensen. 2017. lmerTest Package: Tests in Linear Mixed Effects Models. *Journal of Statistical Software* 82(13). 1–26.
- Kuznetsova, Alexandra, Brockhoff, Per B. & Rune H. B. Christensen. 2020. lmerTest: Tests for random and fixed effects for linear mixed effects models (lmer objects of lme4 package). R package version 3.1-3.
<https://CRAN.R-project.org/package=lmerTest>.

References (3)

- Kuznetsova, Alexandra, Rune H. B. Christensen, Cecile Bavay & Per B. Brockhoff. 2015. Automated mixed ANOVA modeling of sensory and consumer data. *Food Quality and Preference* 40. 31–38.
- Mains, Paul, Kevin McGowan & David J. Medeiros. 2015. Gradient Acceptability by Length in Heavy NP Shift. Presented at the 89th Annual Meeting of the Linguistic Society of America, Portland OR.
- Medeiros, David, Paul Mains & Kevin B. McGowan. 2021. Ceiling Effects on Weight in Heavy NP Shift. *Linguistic Inquiry* 426–440.
- Melnick, Robin Jeffrey. 2017. *Consistency in variation: On the provenance of end-weight*. Stanford University PhD Thesis.
- Mistrík, Jozef. 1983. *Moderná Slovenčina*. Bratislava: Slovenské Pedagogické Nakladateľstvo.
- Mistrík, Jozef. 1988. *A Grammar of Contemporary Slovak*. Bratislava: Slovenské Pedagogické Nakladateľstvo.
- Mistrík, Jozef. 2003. *Gramatika Slovenčiny*. Bratislava: Slovenské Pedagogické Nakladateľstvo.
- Orlovský, Jozef. 1971. *Slovenská syntax*. Bratislava: Obzor.
- Pauliny, Eugen. 1981. *Slovenská Gramatika (Opis jazykového systému)*. Bratislava: Slovenské Pedagogické Nakladateľstvo.
- Pauliny, Eugen. 1997. *Krátka Gramatika Slovenská*. Bratislava: Národné literárne centrum - Dom slovenskej literatúry.

References (4)

- Pauliny, Eugen, Jozef Ružička & Jozef Štolc. 1963. *Slovenská Gramatika*. Bratislava: Slovenské Pedagogické Nakladateľstvo.
- Pavlovič, Jozef. 2012. *Syntax Slovenského Jazyka I*. <http://pdf.truni.sk/e-ucebnice/pavlovic/syntax-1>.
- Quirk, Randolph, Sidney Greenbaum & Geoffrey Leech. 1972. *A grammar of contemporary English*. London: Longman.
- Short, David. 2002. Slovak. In Bernard Comrie & Greville G. Corbett (eds.), *The Slavonic Languages (Routledge Language Family Descriptions)*, 533–592. London: Routledge.
- Stallings, Lynne M. & Maryellen C. MacDonald. 2011. It's not just the "heavy NP": Relative phrase length modulates the production of heavy-NP shift. *Journal of Psycholinguistic Research* 40(3). 177–187.
- Stallings, Lynne M., Maryellen C. MacDonald & Padraig G. O'Seaghdha. 1998. Phrasal ordering constraints in sentence production: Phrase length and verb disposition in heavy-NP shift. *Journal of Memory and Language* 39(3). 392–417.
- Szmrecsányi, Benedikt. 2004. On Operationalizing Syntactic Complexity. In Gérard Purnelle, Cédric Fairon & Anne Dister (eds.), *Le poids des mots. Proceedings of the 7th International Conference on Textual Data Statistical Analysis*, 1032–1039. Louvain-la-Neuve: UCL.
- Wasow, Thomas. 1997. Remarks on grammatical weight. *Language Variation and Change* 9(1). 81–105.
- Wasow, Thomas & Jennifer Arnold. 2003. Post-verbal constituent ordering in English. In *Determinants of Grammatical Variation in English*, 119–154. Berlin: De Gruyter.