

Agreement attraction in Czech and what it tells us about typology and processing

Jakub Dotlačil
(joint work with Jan Chromý and Radim Lacina)

FDSL, 2024



Take-home message

- ▶ Some syntactic phenomena are not simply present or absent in a language.
- ▶ Rather, there is a continuum of how “strongly” a phenomenon is present in language.
- ▶ The continuum arises not because of language contact/bilingualism and is not caused by lexical variation.



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- ▶ Reading experiments on sentence processing can tap into the continuum.
- ▶ Reading experiments can inform us about the nature of an effect beyond just the strength of the effect.



The phenomenon

Agreement attraction:¹

A verb agrees with a different noun than the canonical argument.

The noun causing the faulty agreement is called *attractor*.

I focus on **number** agreement attraction (for gender agreement attraction, see Radim Lacina's talk).

¹(Jespersen, 1924; Zandvoort, 1961; Bock and Miller, 1991; Bock and Cutting, 1992)

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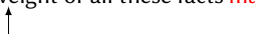
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(1) The **key** to the **cabinets** is/are...

Around 10% of wrong agreement forms in production tasks.²

¹(Jespersen, 1924; Zandvoort, 1961; Bock and Miller, 1991; Bock and Cutting, 1992)

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The findings

Agreement attraction effects can be tested experimentally...

- ▶ ...in production studies;
- ▶ ...in reading studies on sentence processing.



The findings

Agreement attraction effects can be tested experimentally...

- ▶ ...in production studies;
- ▶ ...in reading studies on sentence processing.

An example of a reading study:³

- (2) a. The key to the cell unsurprisingly *was/were rusty* from many years of disuse.
- b. The key to the cells unsurprisingly *was/were rusty* from many years of disuse.

The verb form either matches or mismatches the subject.

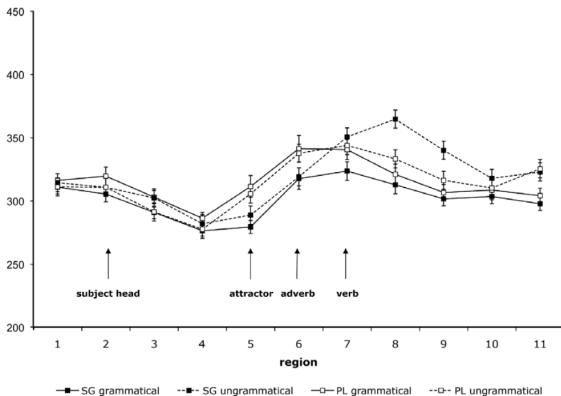
The attractor either matches or mismatches the verb form.

Does the attractor match affects reading profiles?

³(Wagers et al., 2009)



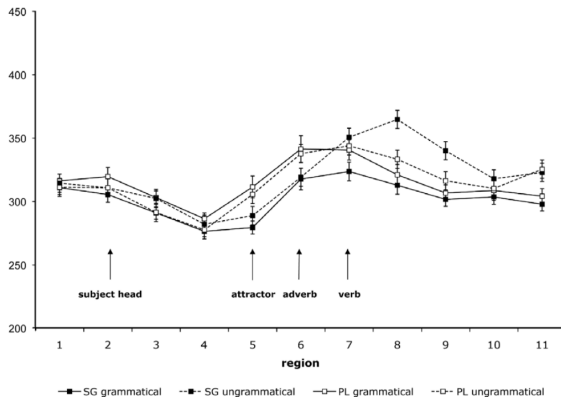
Wagers et al, 2009: results



- (3)
- The key to the cell unsurprisingly *was* rusty...
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Wagers et al, 2009: results



- ▶ Slowdown due to ungrammatical agreement on the regions following the verb.
- ⇒ The effect of ungrammaticality.
- ▶ Relative speedup when the attractor agrees with the verb.
- ⇒ The effect of agreement attraction.



Agreement attraction: theory

Agreement attraction is explained theoretically as a consequence of a (faulty) encoding⁴ and/or an incorrect recall.⁵

⁴ (Bock and Eberhard, 1993; Eberhard et al., 2005; Smith et al., 2021)

⁵ (Vasishth and Lewis, 2006; Vasishth et al., 2019)



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The faulty-encoding approaches: the subject is wrongly marked as plural due to the plural number of the attractor.

The wrong-recall approaches: when reading the verb, people recall the attractor, instead of the actual subject.

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The faulty-encoding approaches: the subject is wrongly marked as plural due to the plural number of the attractor.

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Both approaches: agreement attraction is an interaction of a grammatical phenomenon with general cognitive capacities.

⁴ (Bock and Eberhard, 1993; Eberhard et al., 2005; Smith et al., 2021)

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Agreement attraction: theory

Is agreement attraction a linear order effect?

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⁷ (Haskell and MacDonald, 2005)

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No.⁶

(4) Is/are **the helicopter** for **the flights** safe?

(5) The threat to the president(s) of the company/ies was/were...

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Yes.⁷

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If yes: agreement attraction like local coherence effects:⁸

(7) The coach smiled at *the player tossed a frisbee* by the opposing team.

⁶ (Franck et al., 2002)

⁷ (Haskell and MacDonald, 2005)

⁸ (Tabor et al., 2004)



Language variation and agreement attraction

Is agreement attraction universal?

1. The theory posits general cognitive mechanisms that are at fault.

2. Empirical studies show that it is widespread:

Agreement attraction was found in English,⁹ French¹⁰, Spanish¹¹, German,¹² Arabic,¹³ Russian,¹⁴ Armenian,¹⁵ Turkish,¹⁶ Greek.¹⁷ The presence of agreement attraction was confirmed in a meta-analysis of agreement-attraction studies.¹⁸

⁹ (Wagers et al., 2009; Parker and An, 2018)

¹⁰ (Franck et al., 2015; Franck and Wagers, 2020)

¹¹ (Acuña-Fariña et al., 2014; Lago et al., 2015)

¹² (Lago and Felser, 2018)

¹³ (Tucker et al., 2015, 2021)

¹⁴ (Slioussar, 2018)

¹⁵ (Avetisyan et al., 2020)

¹⁶ (Lago et al., 2019)

¹⁷ (Paspali and Marinis, 2020)

¹⁸ (Jäger et al., 2017)



Czech and number agreement attraction

I will present four experiments (three published¹⁹) in Czech showing null to negligible effects of agreement attraction. We will look at:

¹⁹ (Chromý et al., 2023)



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I will present four experiments (three published¹⁹) in Czech showing null to negligible effects of agreement attraction. We will look at:

- ▶ prepositional phrases;
- ▶ relative clauses;
- ▶ prepositional phrases with syncretism (nominative-genitive form syncretic);
- ▶ (somewhat) complex structures;

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- ▶ prepositional phrases;
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- ▶ prepositional phrases with syncretism (nominative-genitive form syncretic);
- ▶ (somewhat) complex structures;

We will see:

- ▶ There is hardly any effect of number agreement attraction in Czech.
- ▶ The effect can be detected under specific circumstances, but it is very small.
- ▶ What's going on? We will look into a possible explanation that captures not just the absence of the effect, but why it is so small.

¹⁹

(Chromý et al., 2023)



Czech and number agreement attraction, experiment I

We start with a simple design similar to the classic studies on attractions:

(8) the postcard from the friend/friends was/were...



Czech and number agreement attraction, experiment 1

1	2	3	4	5	6–8
Pohled	od	kamarád-a	určitě	bud-e	probouzet krásné vzpomínky
postcard[NOM.SG]	from	friend-GEN.SG	surely	will-SG	arouse nice memories
Pohled	od	kamarád-ů	určitě	bud-e	probouzet krásné vzpomínky
postcard[NOM.SG]	from	friend-GEN.PL	surely	will-SG	arouse nice memories
*Pohled	od	kamarád-a	určitě	bud-ou	probouzet krásné vzpomínky
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postcard[NOM.SG]	from	friend-GEN.PL	surely	will-PL	arouse nice memories

‘The postcard from the friend(s) surely will-SG/PL form nice memories.’

Tested on 24 items, 120 fillers, 134 participants, an online self-paced reading study.

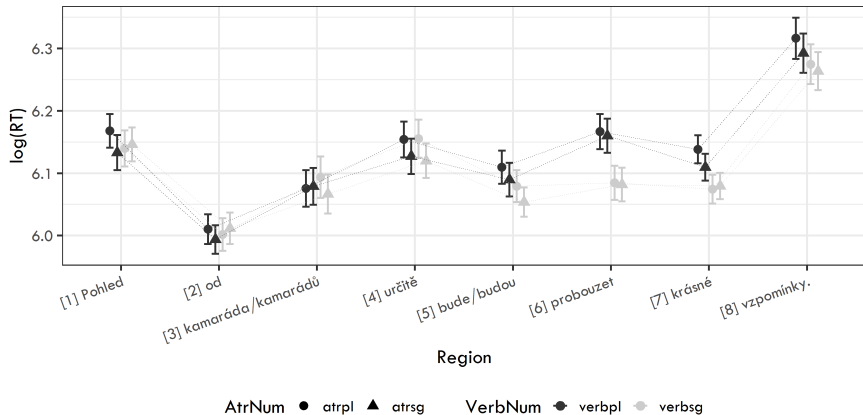
Predictions:

Ungrammaticality \Rightarrow slower RTs for the plural verb case.

Agreement attraction \Rightarrow faster RTs for the plural verb when the attractor is plural.

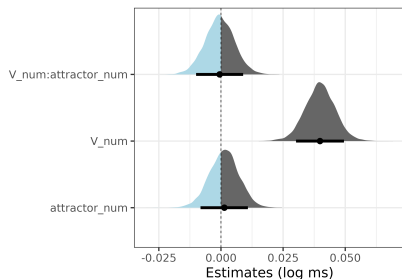


Reading study I: results



Reading study I: Bayesian analysis on the postcritical region

Agreement attraction would make us expect a negative interaction between VerbNumber and AttractorNumber.



Mixed-effects models with log-normal link with the full subject, item random effect structure.

Fixed effects:

- ▶ Verb number
- ▶ Attractor number
- ▶ Verb number:Attractor number



Reading study I: Bayesian analysis on the postcritical region

Bayes factor analysis comparing two models on the ungrammatical subset:

- ▶ H1: a model **with** the attractor number as the fixed effect.
- ▶ H0: a model **without** the attractor number as the fixed effect.

Ratio of the likelihood of H0 and H1 \Rightarrow Values higher than 1 = support (evidence) for the null model.



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Testing different a priori assumptions about the size of the attractor number effect in H1, all give evidence for H0.

μ	σ	BF ₀₁
0	0.01	1.53
0	0.03	3.81
-0.03	0.009	32.5
-0.015	0.0045	4.54



Czech and number agreement attraction, experiment II

It has been noted that number agreement attraction is common in relative clauses.²⁰

(9) **The driver(s) who** **the runner** wave(s) to each morning ...

²⁰

(Wagers et al., 2009)



Czech and number agreement attraction, experiment II

1	2	3	4	5	6	7-11
Závodník, racer[NOM.SG]	kter-ého who-ACC.SG	fanoušek fan[NOM.SG]	nezřídka often	natáče-l record-PST[SG]	kamerou, with camera	...
Závodníci, racer[NOM.PL]	kter-é who-ACC.PL	fanoušek fan[NOM.SG]	nezřídka often	natáče-l record-PST[SG]	kamerou, with camera	...
*Závodník, racer[NOM.SG]	kter-ého who-ACC.SG	fanoušek fan[NOM.SG]	nezřídka often	natáče-l-i record-PST-PL	kamerou, with camera	...
*Závodníci, racer[NOM.PL]	kter-é who-ACC.PL	fanoušek fan[NOM.SG]	nezřídka often	natáče-l-i record-PST-PL	kamerou, with camera	...

'The racer(s) who the fan often recorded-SG/PL with a camera, was/were very popular in the country.'

28 items, 98 fillers, 212 participants, an online self-paced reading study.

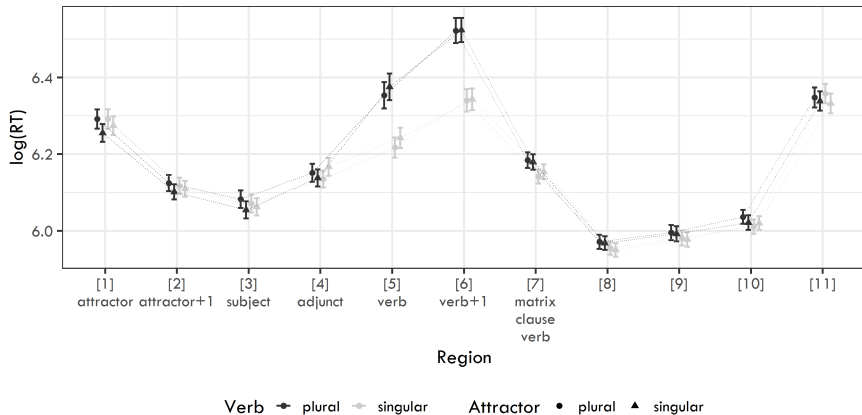
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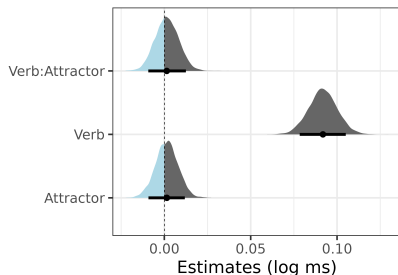


Reading study II: results



Reading study II: Bayesian analysis on the postcritical region

Agreement attraction would make us expect a negative interaction between VerbNumber and AttractorNumber.



BF analysis:

μ	σ	BF_{01}
0	0.01	1.47
0	0.03	3.44
-0.03	0.009	25.1
-0.015	0.0045	3.68



Czech and number agreement attraction, experiment III

It has been noted for some, but not all, languages (Russian,²¹ contra Armenian²²) that the morphological form matters (for agreement attraction, it should be syncretic with nominative).

Nom.PI kamarád-i
Acc.PI kamarád-y
friends

- ▶ Exp 1: attractors as in the first column;

²¹ (Slioussar, 2018)

²² (Avetisyan et al., 2020)



Czech and number agreement attraction, experiment III

It has been noted for some, but not all, languages (Russian,²¹ contra Armenian²²) that the morphological form matters (for agreement attraction, it should be syncretic with nominative).

Nom.PI	kamarád-i	archivářk-y
Acc.PI	kamarád-y	archivářk-y
	friends	archivers

- ▶ Exp 1: attractors as in the first column;
- ▶ Exp 3: attractors as in the second column (syncretic)

²¹ (Slioussar, 2018)

²² (Avetisyan et al., 2020)



Czech and number agreement attraction, experiment III

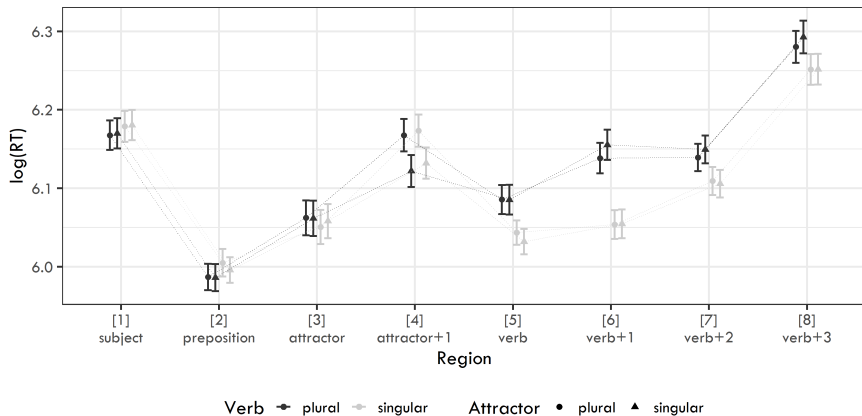
1	2	3	4	5	6–8
Složk-a	pro	archivářk-u	nejspíš	bud-e	zahrnovat veškeré nálezy
file-NOM.SG	for	archiver-ACC.SG	probably	will-SG	include all findings
Složk-a	pro	archivářk-y	nejspíš	bud-e	zahrnovat veškeré nálezy
file-NOM.SG	orm	archiver-ACC.PL=NOM.PL	probably	will-SG	include all findings
*Složk-a	pro	archivářk-u	nejspíš	bud-ou	zahrnovat veškeré nálezy
file-NOM.SG	orm	archiver-ACC.SG	probably	will-PL	include all findings
*Složk-a	pro	archivářk-y	nejspíš	bud-ou	zahrnovat veškeré nálezy
file-NOM.SG	orm	archiver-ACC.PL=NOM.PL	probably	will-PL	include all findings

‘A file for an archiver(s) will(-SG/PL) probably include all findings.’

32 items, 96 fillers, 263 participants, an online self-paced reading study.

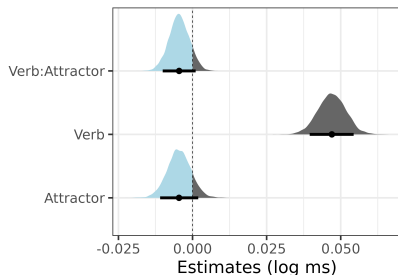


Reading study III: results



Reading study III: Bayesian analysis on the postcritical region

Agreement attraction would make us expect a negative interaction between VerbNumber and AttractorNumber.



BF analysis:

μ	σ	BF ₀₁
0	0.01	0.58
0	0.03	1.25
-0.03	0.009	3.19
-0.015	0.0045	0.43



Czech agreement attraction in comparison to other languages

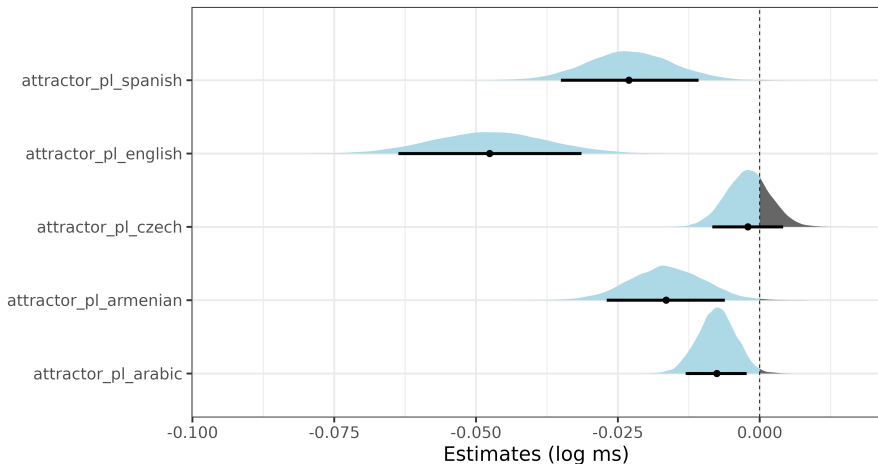
Does Czech lack agreement attraction? Or does it have it?

In my view, that's the **wrong** question to ask.



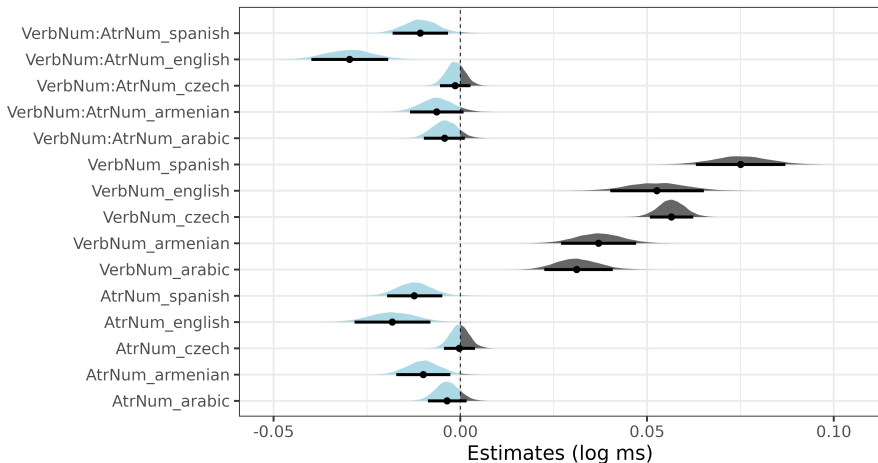
Czech agreement attraction in comparison to other languages

Meta-analysis: comparison of reading profiles of agreement attraction across 5 languages: reading times on the word after the verb (just the attraction effect)



Czech agreement attraction in comparison to other languages

Meta-analysis: comparison of reading profiles of agreement attraction across 5 languages: reading times on the word after the verb (full picture)



Czech, experiment IV

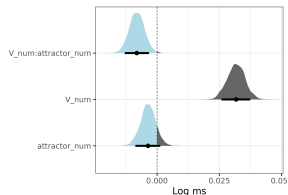
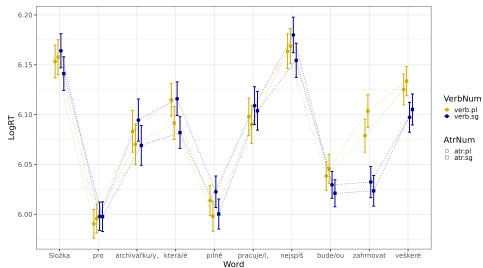
1	2	3	4	5	6-8
Zpráv-a	pro	archivářk-u, která pilně pracuje	nejspíš	bud-e	...
report-NOM.SG	from	archiver-ACC.SG who works diligently	probably	will-SG	...
Zpráv-a	pro	archivářk-y, které pilně pracuje	nejspíš	bud-e	...
report-NOM.SG	from	archiver-ACC.PL=NOM.PL who work diligently	probably	will-SG	...
*Zpráv-a	pro	archivářk-u, která pilně pracuje	nejspíš	bud-ou	...
report-NOM.SG	from	archiver-ACC.SG who works diligently	probably	will-PL	...
*Zpráv-a	pro	archivářk-y, které pilně pracuje	nejspíš	bud-ou	...
report-NOM.SG	from	archiver-ACC.PL=NOM.PL who work diligently	probably	will-PL	...

'The report for the archiver/s, who work diligently, will (SG/PL) most likely contain all findings.'

24 experimental items, 322 participants, an online self-paced reading study.



Reading study IV: results



Interim summary

The phenomenon that seems universal reveals variation not wrt presence or absence, but wrt how robust it is.



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To uncover the variation, the methods like reading time studies, which give us a continuous measure of the effect size, are useful.

Such reading times studies need to be combined with considerations of the size of the experiment.



Theoretical explanation

- ▶ Why is the effect in Czech so small?

- ▶ Why is syncretism relevant for number agreement attraction in Czech (but not, say, Armenian)?



Syncretism and languages: Russian vs. Armenian

Recall: Syncretism is claimed to be relevant in Russian, but not in Armenian.

Armenian: tested on attraction using relative clause structures (proactive interference):

(10) **The driver(s)** who **the runner** wave(s) to each morning ...

Russian: tested on attraction using PPs (retroactive interference):

(11) **The key** to **the cabinets** usually are rusty.

Thus, there might be differences in constructions, not languages.



Syncretism and languages

In fact, our Czech experiment on proactive interference included nominative attractors:

Repetition item in one condition from Exp 2						
1	2	3	4	5	6	7-
*Závodníci, racer[NOM.PL]	kter-é who-ACC.PL	fanoušek fan[NOM.SG]	nezřídka often	natáče-l-i record-PST-PL	kamerou, with camera	...
‘The racer(s) who the fan often recorded-PL with a camera, were very popular in the country.’						



Czech explained

There are two sources of agreement attraction:

1. retrieval/encoding interference.
2. local coherence (linear order effect).

Retroactive interference:

(12) The key to the cabinets usually are rusty.

Both options derive agreement attraction, but the second only under syncretism.

Proactive interference:

(13) The driver(s) who the runner wave(s) to each morning ...

Only option 1 derives agreement attraction.



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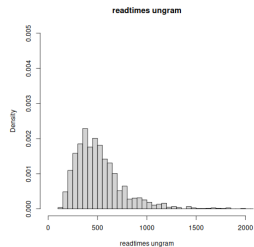
Only option 1 derives agreement attraction.

Detected Czech agreement attraction is due to Option 2.



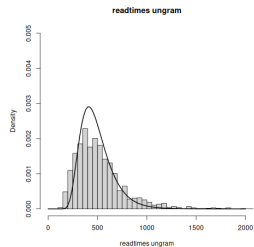
Why is the effect so small in Czech?

Why do we observe speed-up in reading?



Why is the effect so small in Czech?

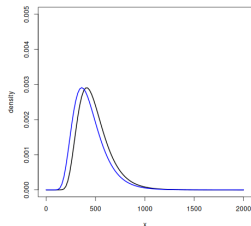
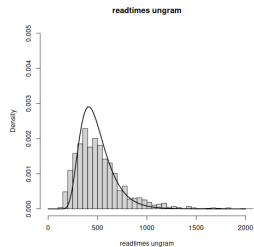
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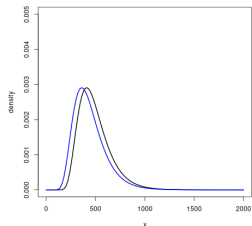
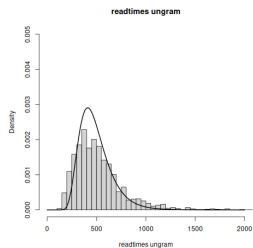
The distribution is shifted.



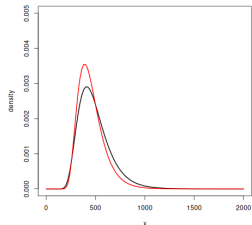
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Why do we observe speed-up in reading?

The distribution is shifted.



The distribution has a shorter tail.



Shifted log normal distribution and RTs

We can study both changes using shifted log-normal distribution.

- ▶ Parameter **shift**: shift the whole distribution
- ▶ Parameter **location**: move the tail

A plea for shifted log-normal distribution



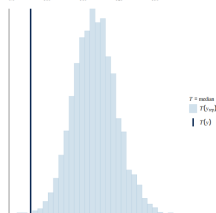
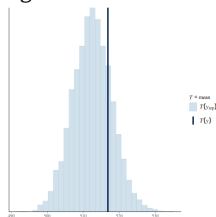
Shifted log normal distribution and RTs

We can study both changes using shifted log-normal distribution.

- ▶ Parameter **shift**: shift the whole distribution
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A plea for shifted log-normal distribution

Log-normal distribution



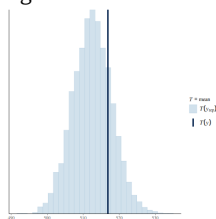
Shifted log normal distribution and RTs

We can study both changes using shifted log-normal distribution.

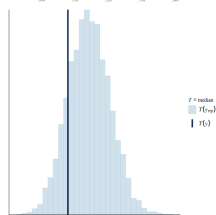
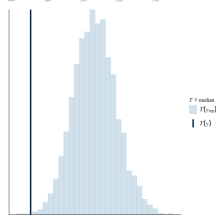
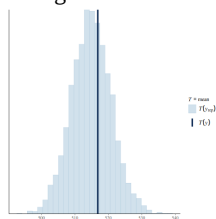
- ▶ Parameter **shift**: shift the whole distribution
- ▶ Parameter **location**: move the tail

A plea for shifted log-normal distribution

Log-normal distribution



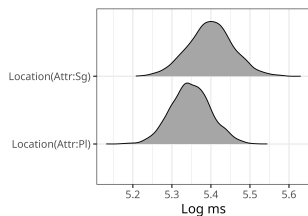
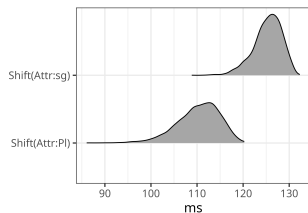
Shifted log-normal distribution



Czech vs. English agreement attraction

We use shifted log-normal and inspect the parameters.

- ▶ Parameter **shift**
- ▶ Parameter **location**
English^a



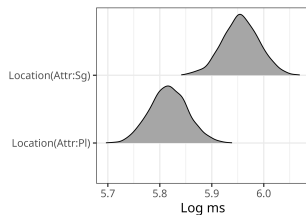
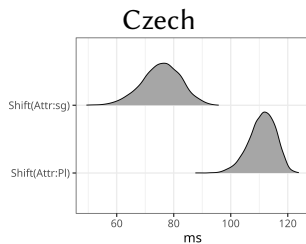
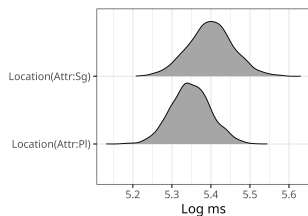
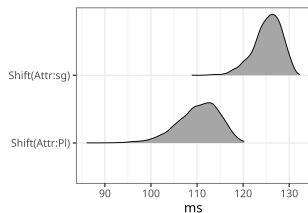
^a (Wagers et al., 2009)



Czech vs. English agreement attraction

We use shifted log-normal and inspect the parameters.

- ▶ Parameter **shift**
- ▶ Parameter **location**
English^a



^a (Wagers et al., 2009)



Agreement attraction in Czech and other languages

(At least) two sources of agreement attraction.

Only one present/dominant in Czech (local coherence), which explains:

- ▶ why syncretism relevant;
- ▶ why only retroactive interference;
- ▶ why agreement attraction only changes location, not shift.

The last point is the reason for the small size of the effect.



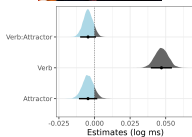
Summary



Agreement attraction,



Summary

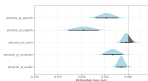
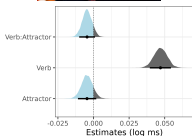


Agreement attraction,

its almost null, but not quite so, effect in
Czech,



Summary



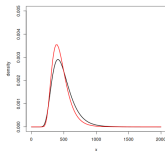
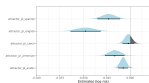
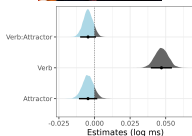
Agreement attraction,

its almost null, but not quite so, effect in
Czech,

its small effect in comparison to other
languages,



Summary



Agreement attraction,

its almost null, but not quite so, effect in Czech,

its small effect in comparison to other languages,

my explanation in terms of two sources of agreement attraction, one of which absent/minimized in Czech.



Thank you!








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- ▶ Jan Chromý
- ▶ Radim Lacina



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