

The paradox of SOV: A case for token-based typology

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DOI: https://doi.org/10.53482/2025_59_425

ABSTRACT

This study addresses a paradox in word order typology. On the one hand, the SOV order has longer dependency distances and therefore higher processing costs compared to verb-medial order. On the other hand, it is the most frequent word order in languages of the world. How come? A study of corpus data annotated with Universal Dependencies provides a simple answer: the costly long distances occur more rarely than one would assume because SOV clauses are infrequent in language use. A quantitative analysis of 150 Universal Dependencies corpora shows that the proportions of verb-final clauses with two overt core arguments are low across languages, including predominantly verb-final languages. Moreover, a series of Bayesian phylogenetic models based on comparable corpora in thirty-two languages show a negative correlation between the proportion of verb-final clauses in a language and the average number of arguments in a clause, while controlling for argument indexing and high- and low-context culture. A closer examination of argument configurations reveals a positive correlation between proportions of verb-final clauses and proportions of subjectless clauses; as for proportions of objectless clauses, the evidence is less clear. The study highlights the importance of the token-based, gradient approach to typology, which gives us insights into what kind of structures language users prefer, and what they avoid.

Keywords: dependency distances, word order, communicative efficiency, token-based typology.

1 Introduction

Efficient communication means minimizing the costs of language use, while maximizing its benefits (Hawkins 2004; Gibson et al. 2019; Levshina 2022, *inter alia*). One way of being efficient is to produce semantically and/or syntactically related units close to each other because it reduces working memory costs. According to dependency locality theory (Gibson 1998, 2000), if two syntactically linked words are far away from each other, the memory costs will be high because the processor must store too many structures and predictions about the following elements, which presents a challenge for our limited working memory (cf. Yngve 1960). Moreover, the representation of the word that appears first will be hard to retrieve by the time the second word is produced, due to interference from other words and decay of the first word's representation (Futrell et al. 2020). Although minimization of distances has

value in only 55 families (13%). It has also been claimed that SOV was the most likely order of the common ancestor of all existing languages, if one accepts the monogenesis view (Newmeyer 2000; Gell-Mann and Ruhlen 2011; Maurits and Griffiths 2013). Experiments in spontaneous gestural communication also reveal a preference for the agent-patient-action order, which corresponds to SOV (Goldin-Meadow et al. 2008), although not for all types of meanings (Hall et al. 2013; Schouwstra and de Swart 2014).

So why is SOV so widely spread, and even considered cognitively and evolutionarily basic, if it is less efficient than verb-medial order? How to explain this paradox? Some factors could be named. For example, verb-final order may bring processing benefits, due to higher predictability of the verb (Ferrer-i-Cancho 2017). Also, the cognitive costs of switching word order can be too high for language users (Ferrer-i-Cancho and Namboodiripad 2023), which is why SOV languages resist change. Jing et al. (2021) argue that the pressure for dependency distance minimization is weaker in head-final languages, which means that the principle may be less universal than many believe. There is some empirical support for this claim: for example, Futrell et al. (2020) report longer distances in head-final languages for sentences of the same length, whereas Liu (2020) finds that the relative order of adpositional phrases is not systematically constrained by dependency distance minimization in verb-final languages.

However, there may also be a simpler explanation. In a corpus-based study, Ueno and Polinsky (2009) found that spoken Japanese and Turkish (SOV) had fewer arguments than English and Spanish (SVO), due to the fact that the SOV languages contained more one-place predicates, manifesting intransitive bias. This would mean that the processing of verb-final clauses is less costly in reality than one would assume because the longer dependencies associated with two-argument clauses simply do not occur often. At the same time, pro-drop of subject and object, another strategy for reducing the number of overt arguments, was not associated with word order.

We can formulate a research hypothesis then: language users normally avoid using clauses with two overt arguments if the verb is produced at the end, across different languages and types of texts. This expectation, which is explored here using 150 diverse corpora from the Universal Dependencies collection, v2.15 (Zeman et al. 2024), is similar to the maxims of preferred argument structure (Du Bois 1987; Du Bois et al. 2003), such as “Avoid more than one lexical core argument” (Du Bois 1987: 829). However, Du Bois’ theory emphasizes cognitive effort required of the addressee when activating new referents, following Chafe’s (1987) ideas exemplified by the well-known dictum, “one new concept at a time”. In the present study, the expectation that language users avoid SOV (or OSV) clauses with two overt arguments reflects memory constraints shared by both the speaker and the addressee.

Based on Ueno and Polinsky’s (2009) observations, we can also expect that languages with a higher proportion of verb-final clauses will have on average a lower number of overt arguments in a clause. Ueno and Polinsky (2009) investigated only four languages, which is not enough for testing a cross-

linguistic correlation. The aim of the present study is to investigate the relationship between verb-final order and the number of core arguments on a larger number of languages. Moreover, the number of overt arguments may also depend on other factors, which should be controlled for in order to avoid confounding effects. One of such factors is the cultural reliance on context, known as Hall's (1976) classification of high- and low-context cultures. Communicators in some cultures may be more used to implicit communication than in others, which enables a lower level of grammatical and lexical specification. Therefore, the need for overt encoding of referents and other information may be lower. Another factor is the presence of argument indexing on the verb (also known as agreement, or cross-referencing). If it is possible to recover an argument from the verb form, it may be efficient to omit the argument as a full form (Haig 2018; Berdicevskis et al. 2020; but see Bickel 2003). Such omission would not only help to save articulatory costs and time, but also the costs of keeping the argument in working memory. In addition, the number of arguments may be influenced by the degree of formality and modality of communication. We can expect, for example, that the omission rate would be higher in informal and face-to-face communication than in formal and distant communication, because informal style allows for more reduction and the referents can be more accessible from shared linguistic and extralinguistic information, which is part of common ground. This is why it is necessary to control for the register. I use thirty-two corpora of online news from the Leipzig Corpora Collection (Goldhahn et al. 2012), parsed with Universal Dependencies (UD) (Zeman et al. 2024) to test the correlational hypothesis. Because of the phylogenetic and areal dependencies between the languages represented by the corpora, Bayesian phylogenetic models with a two-dimensional Gaussian Process were fitted (Guzmán Naranjo and Becker 2022).

To summarize, the main hypotheses of this study are as follows:

- 1) Language users disprefer verb-final clauses with two overt core arguments, across all languages and text types;
- 2) There is a negative correlation between the proportion of verb-final clauses in a language and an average number of overt arguments in a clause, other factors (more exactly, the type of culture and the presence of argument indexing) being controlled for.

These hypotheses represent a perfect case for a token-based and gradient approach to typology (Liu 2010; Levshina 2019; Levshina, Nambodiripad et al. 2023; Gerdes et al. 2021; Yan and Liu 2023). This direction of research aims to describe what people do with language frequently, and what they do only occasionally. It allows us to formulate and test new linguistic universals and explain them from a cognitive and communicative perspective.

The rest of the paper is organized as follows. Section 2 provides details about the corpus data and how the dependencies were counted. Section 3 presents exploratory analyses of the number of SOV clauses in 150 UD corpora. Sections 4 and 5 are dedicated to testing and interpreting the correlation between

the proportion of verb-final clauses and the average number of core arguments based on the newspaper data. Section 6 provides a discussion of the results and an outlook.

2 Data and method

2.1 Corpora

As mentioned in Section 1, two corpora collections were used. For the exploratory analyses of how many SOV clauses actually occur in language use, I used Universal Dependencies corpora, v2.15 (Zeman et al. 2024). The corpora are very heterogeneous, representing many different types of texts and communication modalities. Since the purpose of this exploratory analysis was to establish the upper limit of SOV proportions, the diversity of genres was advantageous, as it enabled more generalizable claims about language use. To make the statistics reliable, I only used the training datasets with the total number of verbal clauses greater than 100. There were in total 150 corpora representing 77 languages.

For testing the correlation between the number of arguments and proportion of verb-final clauses, I selected news corpora from the Leipzig Corpora Collection (Goldhahn et al. 2012) in thirty-two languages, for which Universal Dependencies annotation tools (UDPipe in R package `udpipe`, Wijffels 2020) were available. As explained above, the main reason for the use of newspaper texts was the fact that argument omission rates can vary by register and text type. Controlling for register was therefore essential to avoid confounding the results. Although the Universal Dependencies corpora include different registers and text types, there were not enough comparable corpora within similar registers. Additionally, many of the corpora consist of mixed data, further limiting comparability. Online newspaper articles were selected due to their wide availability across many languages in the Leipzig Corpora Collection. The languages represented different families and genera, according to the World Atlas of Language Structures Online (Dryer and Haspelmath 2013):

- Indo-European: Baltic (Latvian, Lithuanian), Germanic (Danish, Dutch, English, German, Norwegian, Swedish), Greek (Modern Greek), Indic (Hindi), Iranian (Persian), Romance (French, Italian, Portuguese, Romanian, Spanish) and Slavic (Bulgarian, Croatian, Czech, Russian, Slovenian);
- Afro-Asiatic: Semitic (Arabic);
- Altaic: Turkic (Turkish);
- Austro-Asiatic: Vietic (Vietnamese);
- Austronesian: Malayo-Sumbawan (Indonesian);
- Dravidian: Dravidian (Tamil);
- Japanese (Japanese);
- Korean;
- Sino-Tibetan: Chinese (Chinese [traditional]);

- Uralic: Finnic (Estonian, Finnish), Ugric (Hungarian).

Each corpus represented sentences from online news (when available) or newscrawl categories in the Leipzig Corpora Collection. For every language, 200,000 sentences were parsed and analyzed.

2.2 Extraction of dependencies

I searched for all main clauses with a verbal head (dependency relation *root* and Universal Part of Speech ‘VERB’). Main clauses were chosen because subordinate clauses often have relative pronouns as arguments, which should be overt for the sentence to be grammatical.

Two versions of identifying the core arguments were used, depending on what kind of overt arguments were allowed: a) non-clausal ones, represented by the UD dependencies *nsubj* and *obj* only, and b) non-clausal ones plus all possible types of finite and non-finite clausal complements, which are represented by the UD dependency relations *csubj*, *ccomp* and *xcomp*. More details and simplified examples are provided in Table 1.

Table 1: Two approaches to defining overt core arguments.

Approach	Possible values	Examples
Only non-clausal dependencies (<i>nsubj</i> and <i>obj</i>)	0	<i>Will do!</i>
	1	<i>She (nsubj) is running. Just do it (obj).</i>
	2	<i>The students (nsubj) do their homework (obj).</i>
Non-clausal and clausal dependencies (<i>nsubj</i> , <i>obj</i> , <i>csubj</i> , <i>ccomp</i> and <i>xcomp</i>)	0	<i>Will do!</i>
	1	<i>She (nsubj) is running. What she said (csubj) was surprising. Just do it (obj). Just try to do (xcomp) it. Remember that you have responsibilities (ccomp).</i>
	2	<i>The students (nsubj) do their homework (obj). I (nsubj) want to do it (xcomp). The students (nsubj) know they must do their homework (ccomp). That his idea was flawed (csubj) surprised me (obj).</i>

The two approaches were used because none of them was perfect on its own. If we take all arguments – clausal and non-clausal – we have a more comprehensive picture of the processing costs involved in communication. At the same time, a closer look at the data shows that not all clausal structures that look similarly are annotated in the same way. For instance, while a modal verb in English is usually annotated as an auxiliary of the following infinitive, Russian modal verbs are treated as main verbs, and the infinitive is a non-finite clausal complement. There are also discrepancies in the annotation of direct speech and parataxis. Because a full uniform re-annotation of all such cases for thirty-two corpora was not practically feasible, the decision was to combine the two approaches and see if the results converge.

Note that the sentences were analyzed in accordance with the UD annotation, which has some peculiarities that may affect the results. Agents of passive sentences, for example, were not considered core

arguments because they are normally tagged as oblique complements with the dependency relation *obl*. Also, the presence or absence of an overt argument depended fully on whether it was analyzed as a separate token or not. Moreover, according to the UD approach, content words are regarded as heads (cf. de Marneffe et al. 2021; see also the UD documentation¹). This means that in languages like German and Dutch, in which auxiliaries are often separated from lexical verbs by other constituents, we will find more verb-final clauses compared with if we treated auxiliaries as heads. For the purposes of this study, this is a desirable feature. Semantic microroles, which are relevant for the interpretation of arguments, can be assigned based on the information provided in the lexical verb (e.g., the roles of a breaker and a broken object, which are defined by the verb *break*). Therefore, the position of the lexical verb is relevant in the context of this study.

As for word order, it was operationalized as follows. In every main transitive clause with both overt subject and object, the position of the head verb was established based on the token IDs. Next, the proportions of SOV or OSV clauses were computed for every language. Two versions of the variable were computed, again: either with only non-clausal arguments, or with both non-clausal and clausal arguments.

2.3 Other factors: argument indexing, culture, genealogy and areal effects

As mentioned in Section 1, other factors that may influence the number of overt arguments were argument indexing on the verb (also known as verb agreement or cross-referencing), and high- or low-context culture. Inferring argument indexing from a corpus is not a trivial task. Most of the languages in the sample had some form of indexing in the form of person, gender or number markers, which could help to infer at least some information about the main participants. The following languages were coded as having no indexing on the verb predicate that would help to disambiguate between A and P: Chinese, Danish, Indonesian,² Japanese, Korean, Norwegian, Swedish and Vietnamese (Siewierska 2013; Skirgård et al. 2023).

As for the role of context in culture, the following languages were coded as representing low-context cultures, which have a stronger preference for explicit communication: Danish, Dutch, English, German, Swedish and Finnish. This distinction is based on the aggregated classifications in Rösch and Segler (1987) and Holtbrügge et al. (2012). The remaining languages were treated as representing high-context cultures, which have a stronger preference for implicit communication. One should mention, however, that many claims about the role of context in a specific culture are still in need of more robust empirical support, and should be taken with a grain of salt (Levshina et al. 2025).

¹ <http://universaldependencies.org/docs/u/overview/syntax.html>

² Indonesian has bound object markers that are sometimes attached to a transitive verb (Sneddon 1996: 163). However, they are analyzed as pronouns and separate tokens in the UD corpora, which means that the verb carries no formal indices.

When performing a quantitative analysis of typological data, it is necessary to control for genealogical dependencies between languages and possible areal effects, which depend on the geographic distances. To account for this, I fitted several mixed Bayesian models with genealogical and geographic dependencies between the languages as random effects, based on the data from Glottolog (Hammarström et al. 2024). In all models, weakly informative Cauchy priors were used for the fixed and random effects. The warm-up period was 2,000 and the final estimation is based on four chains with 18,000 iterations in each. The *adapt_delta* parameter was 0.9999999. All R-hat values were 1.00, which means that the chains mixed and converged well.

The datasets are freely available in the OSF directory: <https://osf.io/75wjx/>.

3 Testing the avoidance of verb-final clauses with two overt core arguments

To test the hypothesis about the avoidance of verb-final clauses with two overt core arguments, we will look at the proportions of SOV/OSV clauses in different languages represented in the UD corpora. To compute the proportions, the following frequencies were obtained for every UD corpus:

- (a) all main verbal clauses with subject and object (i.e., SOV or OSV, as explained above);
- (b) all main verbal clauses with one subject only and without any objects (i.e., SV or VS);
- (c) all main verbal clauses with one object only and without any subjects (i.e., OV or VO);
- (d) all main verbal clauses without subject or objects (i.e., V).

The proportion of (a) in the total sum of (a), (b), (c) and (d) was then computed as the SOV/OSV proportion for every corpus. Because some of the languages were represented by more than one corpus, the final proportions for every language were averaged across the corpora.

The boxplots in Figure 2 represent distributions of proportions of full SOV/OSV clauses in 77 languages. The boxplot on the left represents the first approach (non-clausal subject and object only), and the one on the right corresponds to the second approach (both clausal and non-clausal arguments). The distributions show clearly that in none of the corpora or languages is the proportion of two-argument V-final clauses higher than 30% under the first approach and higher than 40% under the second approach. The languages with relatively high values (represented as outliers) are Afrikaans (Germanic), Marathi (Indic) and Telugu (Dravidian) under the first approach. The same languages also have relatively high values under the second approach, plus Tamil (Dravidian) and Uyghur (Turkic). From this we can conclude that SOV/OSV clauses represent a minority of verbal clauses in all languages, including strongly verb-final ones.

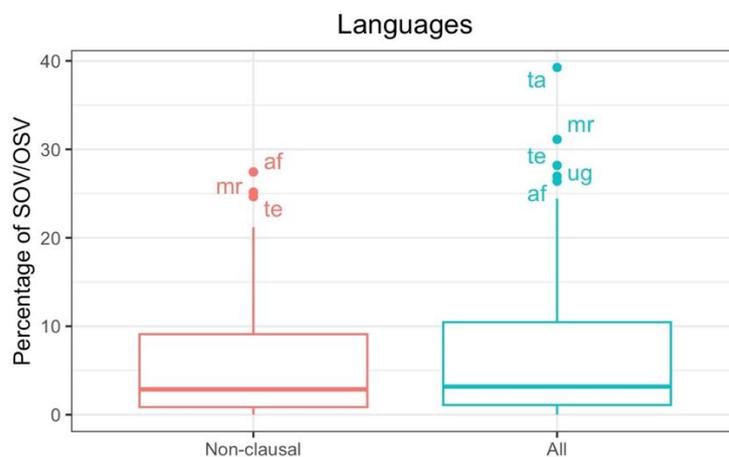


Figure 2: Distributions of percentages of SOV/OSV clauses in the languages represented by the UD corpora.

4 Testing correlation between verb-finalness and the number of overt arguments

This section tests the second research hypothesis, which predicts negative correlation between the average number of arguments in a clause, and the proportion of verb-final full transitive clauses, based on the news corpora. The relationship between the variables on the basis of non-clausal arguments only is displayed in Figure 3. Overall, the average number of overt core arguments ranges from 0.63 to 1.34. The languages on the right-hand side of the plot (Japanese, Korean, Persian, Tamil, Turkish), which have a strong preference for verb-final clauses, tend to have a low number of overt arguments compared to the languages on the left with a low proportion of verb-final clauses. Verb-medial Danish, English and Vietnamese have more than 1.3 arguments per clause on average – these are the top values. At the same time, some languages on the left-hand side also have a relatively low average number of overt arguments, less than one per clause (Chinese, Hungarian, Latvian, Lithuanian, Slovene). These languages are mostly verb-medial (SVO), but they have a fraction of verb-final clauses, especially Hungarian. Arabic, which has the highest proportion of verb-initial clauses (0.38, or 38%), according to the data, patterns together with the verb-medial languages, having a relatively high number of overt arguments.

The contrast between the strictly SOV and other languages becomes even more pronounced if we consider all possible arguments – clausal and non-clausal. These data are displayed in Figure 4. The average number of arguments is now higher, as one would expect, because clauses are counted, as well. Note that Persian has moved to the left-hand side, due to the high proportion of clausal arguments that follow the verb.

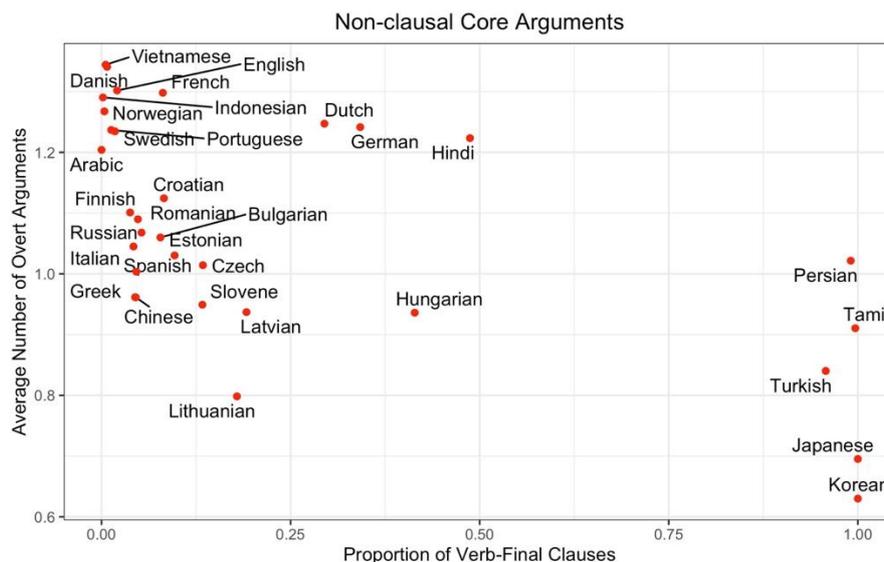


Figure 3: Relationship between the average number of arguments and the proportion of verb-final clauses. Non-clausal arguments only.

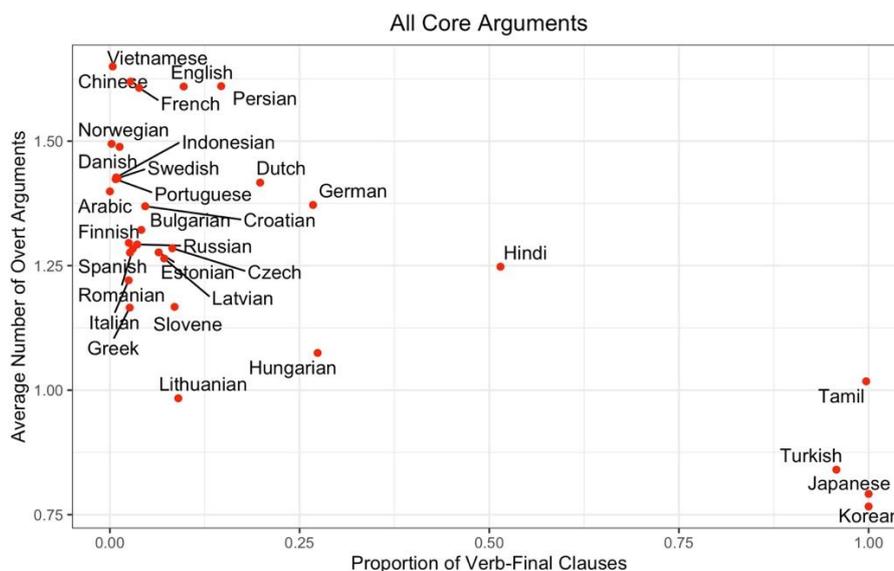


Figure 4: Relationship between the average number of arguments and the proportion of verb-final clauses. Non-clausal and clausal arguments.

To test the hypothesis more systematically, Bayesian phylogenetic regression models with a Gaussian process based on the genealogical and geographical information were fitted. The response variable was the average number of arguments. The predictors were the proportion of verb-final clauses, as well as the presence of verb indexing on verbs and the culture.

Table 2 displays the coefficients of the fixed effects. The intercept is 1.15, which represents the average number of non-clausal arguments for a language without any verb-final clauses, high context and no

indexing (controlling for the random effects) – a language similar to Vietnamese. The intercept for all kinds of arguments, clausal and non-clausal, is higher (1.46), as one can infer from the y-axis values in Figure 4.

The effect of verb-finalness is negative in both cases. When a language has exclusively verb-final full transitive clauses, all its verbal clauses will have on average 0.29 non-clausal arguments less, and 0.58 arguments of any type less, compared to a language without any verb-final full transitive clauses, the other variables controlled for. The effect is clearly supported by the data: The 95% credible interval does not include zero, and the posterior probability of a negative effect, which is computed as the proportion of the posterior distribution with a negative sign (Makowski et al. 2019), is nearly 100%. Therefore, the hypothesis about the negative correlation between verb-finalness and the average number of arguments is borne out.

As for the culture, languages from low-context cultures seem to have more overt arguments than languages from high-context cultures, but this effect is sufficiently credible when we count non-clausal arguments only. The probability of a positive effect based on the posterior distribution is then 97.5%, and the 95% credible interval includes mostly positive values. However, the effect is weaker and less credible if we count all types of arguments. The probability of a positive effect decreases to 86.6%.

The effect of argument indexing is not supported by the data. For both approaches, the 95% Credible Interval includes 0, ranging between -0.21 and 0.10, and the posterior probability of a negative effect is only 76.4% for non-clausal arguments and even less, 70.3%, for all arguments. This means a lack of evidence for this effect³.

Table 2: Table of coefficients of the Bayesian phylogenetic regression models. Without parentheses: non-clausal arguments only. In parentheses: clausal and non-clausal arguments.

Regression term	Posterior mean coefficient	Lower boundary of 95% Credible Interval	Upper boundary of 95% Credible Interval	P of an effect in given direction
Intercept	1.15 (1.46)	0.74 (1.19)	1.42 (1.68)	99.4% (99.9%)
Proportion of verb-final clauses	-0.29 (-0.58)	-0.45 (-0.79)	-0.14 (-0.38)	99.9% (\approx 100%)
Culture = Low-context	0.13 (0.09)	0.00 (-0.07)	0.26 (0.24)	97.5% (86.6%)
Indexing = Yes	-0.06 (-0.04)	-0.21 (-0.20)	0.10 (0.13)	76.4% (70.3%)

Note that the role of verb-initial clauses for processing is not completely clear. On the one hand, the sum dependencies should be as long in verb-initial clauses as in verb-final clauses. On the other hand, the assignment of thematic roles to the arguments in verb-initial clauses can happen very early because

³ This measure often concentrates around 70% under the null hypothesis of no effect (Kelter 2020).

the verb is already there, which may facilitate processing. An important question is whether the verb-final word order only, or verb-final AND verb-initial orders are difficult for processing. We can answer this question by comparing the predictive power of the models with different sets of independent variables. The models with proportions of verb-final clauses, which are reported in above, had the following performance: the Bayesian R^2 of the model with non-clausal arguments only was 0.85, with the 95% credible interval [0.63, 0.99], whereas the model with all arguments had 0.82 [0.63, 0.98]. I also fit models with proportions of verb-medial clauses (thus treating verb-initial and verb-final clauses together), which had somewhat weaker performance: the Bayesian R^2 was 0.79 [0.55, 0.98] for the model with non-clausal arguments only, and 0.80 [0.58, 0.99] for the model with all arguments. Although the credible intervals are very wide, this suggests that the verb-final order has a stronger correlation with the number of arguments and is therefore more relevant for processing effort. Model comparisons using the Leave-One-Out and Watanabe Information Criteria also suggest that the models with the verb-final proportions are slightly better than the models with the verb-medial proportions, although the difference is very small. In any event, there is no evidence of the models with verb-medial proportions outperforming the models with verb-final proportions only. Note, however, that the sample did not contain predominantly verb-initial languages, and the proportions of verb-initial clauses were generally low (with the exception of Arabic), which means that no final conclusion can be drawn at the moment about the effects of verb-initial order.

To summarize, the analyses presented in this section provide support for the cross-linguistic correlation: the proportion of verb-final clauses is negatively correlated with the average number of arguments. More exactly, verb-final languages tend to have on average one overt core argument per clause, whereas the other languages display more variation. This means that users of SOV languages experience long dependencies between the verb and core arguments only rarely, which saves their memory costs. But which arguments are usually omitted? This question is addressed in next section.

5 How to keep the number of arguments low

5.1 Clauses without subject

This section digs deeper into the data from the newspaper corpora, with the aim of understanding better the strategies that help language users to keep the number of overt arguments low in verb-final languages. We begin with the proportions of clauses without subject. Is there a correlation between verb-finalness and preference for subjectless clauses? Figures 5 and 6 show that there is a positive correlation between proportions of verb-final full transitive clauses and proportions of subjectless clauses, both for non-clausal arguments and for all kinds of arguments.

To test these correlations, Bayesian phylogenetic beta regressions were fitted. The response variable was the proportion of subjectless verbal clauses, and the predictors were the proportion of the verb-final

full transitive clauses, the culture type and the presence or absence of argument indexing in a language. The beta family was chosen because the response variable is a proportion, which can only be between 0 and 1. The coefficients are displayed in Table 3. According to the model based on the data with non-clausal arguments only, the log-odds is 1.06, which corresponds to the factor of 2.89. The 95% credible interval [0.26, 1.83] does not contain zero, and the probability of a positive effect is 99.4%. In addition, low-context culture has a negative effect with a probability of almost 95%. As for agreement, it does not play any important role, again.

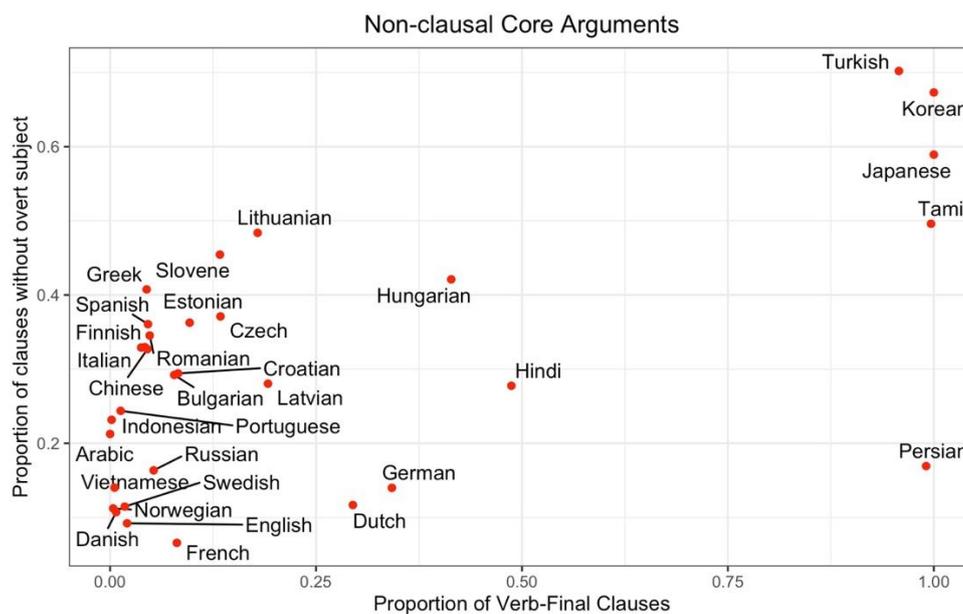


Figure 5: Relationship between the proportion of clauses without overt subject and the proportion of verb-final clauses. Non-clausal arguments only.

If we consider all types of arguments, clausal and non-clausal, the effect of verb-finalness is again positive and credible. It is even stronger than in the previous model: the log-odds is 1.59 (factor of 4.9) with the 95% credible interval [0.83, 2.35]. The probability of a positive effect is almost 100%. There is also a credible negative effect of low-context culture with a probability of 97%, somewhat higher than in the previous model. As in the previous case, indexing does not play any important role.

To summarize, we observe a credible positive correlation between the proportion of verb-final full transitive clauses and the proportion of clauses without overt subject. This suggests that subject omission (e.g., due to high accessibility) can be a strategy for saving processing costs when the verb comes at the end of a clause. Since the verb-final languages in the sample are predominantly SOV languages, omission of a clause-initial subject in such cases provides a substantial reduction of costs in terms of both sum and mean dependency distances.

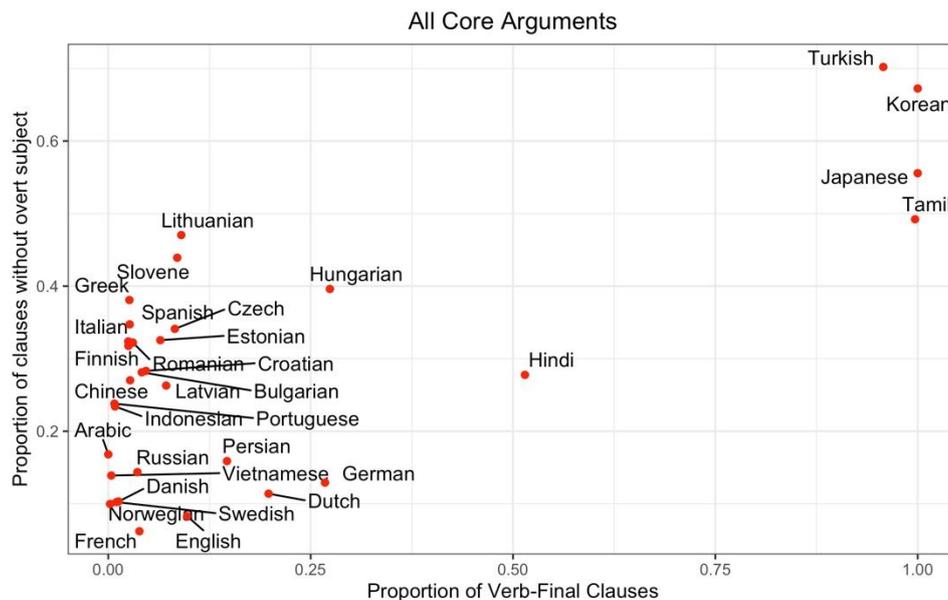


Figure 6: Relationship between the proportion of clauses without overt subject and the proportion of verb-final clauses. Clausal and non-clausal arguments.

Table 3: Coefficients of the Bayesian phylogenetic beta regression models with proportion of clauses without overt subject as the response variable. Units: log-odds. Without parentheses: non-clausal arguments only. In parentheses: clausal and non-clausal arguments.

Regression term	Posterior mean coefficient	Lower boundary of 95% Credible Interval	Upper boundary of 95% Credible Interval	P of an effect in given direction
Intercept	-1.17 (-1.41)	-1.97 (-2.13)	-0.38 (-0.73)	99.2% (99.8%)
Proportion of verb-final clauses	1.06 (1.59)	0.26 (0.83)	1.83 (2.35)	99.4% (≈100%)
Culture = Low-context	-0.55 (-0.60)	-1.25 (-1.23)	0.13 (0.03)	94.5% (97%)
Indexing = Yes	0.15 (0.22)	-0.56 (-0.40)	0.92 (0.89)	66.1% (76.1%)

5.2 Clauses without object

This subsection zooms in on the proportions of clauses without overt object. Figure 7 displays the proportion of verb-final full transitive clauses against the proportion of clauses without an overt non-clausal object. The picture is not very clear. As one can see in Table 4, the Bayesian regression model reveals only a weak positive effect of word order: 0.26 in log-odds (or the factor of 1.3). However, the 95% credible interval from -0.2 to 0.75 includes zero, and the posterior probability of a positive effect is 0.87, which does not represent strong evidence.

However, if we include all arguments, clausal and non-clausal, we see an expected credible effect with 0.91 log-odds (the factor of 2.5), a very high probability based on the posterior distribution (99.7%) and a 95% credible interval that does not include zero. Figure 8 illustrates the correlation. The strongly verb-

final languages have a high proportion of objectless clauses. In neither model, the type of culture or indexing have any substantial effect.

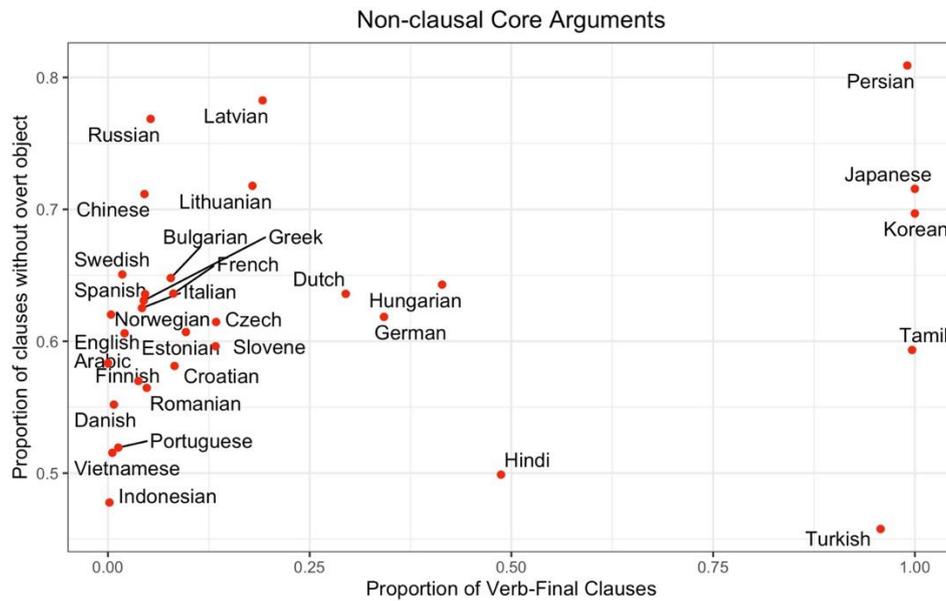


Figure 7: Relationship between the proportion of clauses without overt object and the proportion of verb-final clauses. Non-clausal arguments only.

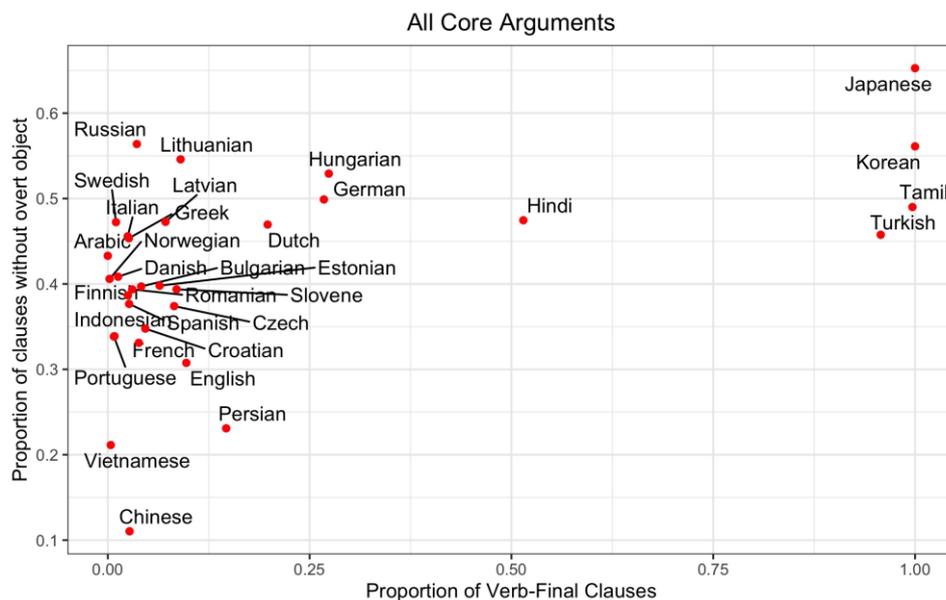


Figure 8: Relationship between the proportion of clauses without overt object and the proportion of verb-final clauses. Clausal and non-clausal arguments only.

To conclude, there is no clear support for a correlation between the proportion of verb-final full transitive clauses and the proportion of clauses without overt object. Only when we include clausal arguments can we see a credible positive correlation. Also, the effect sizes are smaller than in the case of subjectless

clauses. This may be due to the mixture of two different strategies – object pro-drop and intransitivization (e.g., due to passivization, reflexivization and other types of A-demotion), which may obscure the patterns. For example, a preliminary analysis of the Russian data reveals an abundance of intransitive clauses with reflexive constructions, in which the A-argument is demoted.

Table 4: Table of coefficients of the Bayesian phylogenetic beta regression models with proportion of clauses without overt objects as the response variable. Units: log-odds. Without parentheses: non-clausal arguments only. In parentheses: clausal and non-clausal arguments.

Regression term	Posterior mean coefficient	Lower boundary of 95% Credible Interval	Upper boundary of 95% Credible Interval	P of an effect in given direction
Intercept	0.35 (-0.79)	-0.52 (-1.33)	1.05 (-0.17)	90.5% (98.7%)
Proportion of verb-final clauses	0.26 (0.91)	-0.20 (0.29)	0.75 (1.53)	86.9% (99.7%)
Culture = Low-context	-0.09 (0.13)	-0.47 (-0.31)	0.30 (0.55)	68.4% (72.5%)
Indexing = Yes	0.03 (0.15)	-0.38 (-0.35)	0.46 (0.63)	54.8% (73.5%)

This section has demonstrated that the main strategy for reduction of memory costs in verb-final languages is the use of transitive clauses without subjects. The most likely scenario in this case is omission of subjects due to their high accessibility. As for the expression of objects, the differences between verb-final and other languages are less clear. This is not surprising, as objects usually represent new information and cannot be easily omitted.

6 Discussion

The goal of this study was to explain the paradoxical popularity of SOV order, given the fact that verb-final order means greater processing costs due to longer sum dependency distances, compared to verb-medial orders. The main expectation was that actual SOV clauses with two overt arguments are not frequently used and therefore cause no significant processing costs. The analysis of the 150 UD corpora supports this hypothesis: verb-final clauses with two overt arguments constitute less than 30% of all verbal main clauses if we count only non-clausal arguments, and less than 40% if we count both non-clausal and clausal ones. In the main bulk of languages, however, these numbers are much lower. Of course, we should keep in mind that the UD corpora are biased towards European languages, which tend to have SVO as the dominant word order. Still, verb-final clauses with long dependencies due to overt subject and object are clearly in the minority in all the languages.

The quantitative analyses of news corpora in thirty-two languages also reveal that languages with a high proportion of verb-final clauses (SOV or OSV) have on average a smaller number of overt core arguments (subject and object) in a verbal main clause. The negative correlation between the proportion of verb-final clauses and the average number of overt arguments, tested in a series of Bayesian spatiophylogenetic regression models, is stable and independent from the type of core arguments – only non-

clausal (nominal and pronominal) or both clausal and non-clausal. The correlation holds in the presence of other covariates – high- or low-context culture, and argument indexing on the verb. If a language is spoken in a low-context culture, which relies more on explicit communication, it also seems to have more overt arguments, although the effect is weaker if one counts all types of core arguments, clausal and non-clausal. There was no convincing effect of argument indexing on the number of overt arguments. This may be explained by the scarceness of languages with object indexing, which may be more likely to be in a trade-off relationship with overt objects (Haig 2018), in the sample.

At the same time, we see from the plots that languages with a low proportion of verb-final clauses have substantial variation in the number of core arguments. It seems that the relationship is implicational, rather than correlational: if the verb comes late in the clause, relatively few overt core arguments are expected, but if the verb is in the middle, as in most languages in our sample, the language can have many or few core arguments.

Zooming in on the specific arguments, there is a positive correlation between verb-finalness and the proportion of clauses without subject in a language. The expression of subject also seems to depend on the type of culture: there are fewer subjectless clauses in low-context cultures, which sounds plausible. As for objectless clauses, the pattern is less clear: The correlation with word order is observed only when we count both clausal and non-clausal core arguments. When analyzing large corpora, it is impossible to establish whether an object is absent because the predicate is one-place, or because of pro-drop. A more detailed analysis with manual annotation of individual clauses would be necessary for a precise identification of the strategies that help language users save processing effort.

Therefore, we find evidence of the pressure for maximization of accessibility, or rather, minimization of inaccessibility associated with longer dependencies. A use of an SV or OV clause instead of SVO means that both sum dependency distances and mean dependency distances are lower. Also, a lower number of arguments can also reduce the total costs of language use, including articulation, processing and time costs. The question arises then, why use two-argument clauses if one can do very well with only one core argument? As discussed above, one potential booster for the number of arguments may be a low-context culture. Another possible explanation may have to do with the fact that two-argument clauses in my dataset are mostly observed in languages with loose associations between the grammatical roles and the semantics of the arguments (Hawkins 1986; Levshina 2021), such as English and Indonesian, which may allow for greater semantic flexibility of a transitive clause.

The results of this study have implications not only for the study of communicative efficiency, but also for typology. There is a certain irony in the fact that the SOV order, which is claimed to be the most frequent in human languages, is relatively rare in actual language use. Given the low number of arguments, especially in verb-final languages, one may wonder if it makes sense to use the six-way typology of word order with SOV, SVO, OSV, and so on, if only one core argument is typically overt in verb-

final languages and some verb-medial ones. Although this problem was made clear already by Dryer (1997), who discussed the rarity of transitive clauses with nominal subject and object, alongside with other issues, the six-way typology remains very popular nowadays. Even if one includes pronominal and clausal arguments, the six-way typology does not do justice to most languages, failing verb-final ones particularly badly, as one can see from the results of this study. The recent advances in token-based typology will hopefully speed up the movement towards comparative concepts that are closer to actual language use.

The results of this study may be relevant for explaining variation in referential density described by Bickel (2003) and Stoll and Bickel (2009). Referential density is the number of overt lexical/NP arguments in comparison with the total number of possible arguments in a clause. The present study shows that the number of overtly expressed referents may depend on word order, *pace* Bickel (2003). We can also add another maxim of preferred argument structure similar to the ones formulated by Du Bois (1987): “Avoid more than one overt core argument if the verb comes at the end”.

There remain many open questions to be addressed in future research. First, the results of the correlational analyses, which are based on the formal register of online news, should be corroborated on data from other registers and text types, most importantly, informal spontaneous conversations. Finding a sufficient number of comparable UD-annotated spoken corpora is not easy, however. More languages from different parts of the world should be tested, especially languages with verb-initial clauses, as well as the dependency relations beyond subject and object. Crucially, we should understand better how the processing pressures affect the language user’s choices at the level of a clause in contextualized language use. Finally, it is also important to investigate the interaction between memory constraints and other cognitive and communicative pressures, such as the need for disambiguation between core arguments. It has been shown that verb-finalness is correlated with nominal case marking and constraints on argument semantics (Greenberg 1966; Hawkins 1986, 2004; Dryer 2002; Sinnemäki 2010; Levshina 2021). How different pressures interact in language use, making it communicatively efficient and adjusting it to the Now-or-Never bottleneck, remains an open question.

In conclusion, this study highlights the importance of examining actual use of linguistic patterns in communication, which is the focus of the token-based, gradient approach to typology. It demonstrates how this approach can help us solve paradoxes and identify problematic categories in language comparison.

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