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'Lost' in interpreting and 'found' in translation: using an intermodal, multidirectional parallel corpus to investigate the rendition of numbers

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‘Lost’ in interpreting and ‘found’ in translation: using an intermodal, multidirectional parallel corpus to investigate the rendition of numbers

This paper investigates the rendition of numbers in simultaneously interpreted and translated texts, under the assumption that their processing differs in the two language mediation modes. Exploiting the affordances of EPTIC (European Parliament Translation and Interpreting Corpus), a multialigned, multidirectional, intermodal parallel corpus, we examine accuracy of rendition of numbers in simultaneous interpretations with respect to several source speech parameters: type of number, amount of numerical expressions in the source sentence, delivery rate, language direction, mode of delivery and nativeness of the speaker. Interpreters’ renditions are then compared with those found in translations of the same source texts, to assess similarities and differences in coping with the same source text triggers in the two mediation modes. Conclusions are drawn about the implications of the findings for the education of language professionals.

Keywords: interpreting, translation, numbers, multilingual multidirectional corpus, parallel corpus

1. Introduction

Numbers can be defined as “arithmetical value[s], expressed by a word, symbol, or figure, representing a particular quantity and used in counting and making calculations”³. Identifying equivalents of numbers in another language is usually relatively easy, as modern languages generally display one-to-one correspondences in their linguistic structure (Piccinini et al. 2015, 184). Still, several types of numbers (e.g. ordinal numbers and decimals) are used in texts that interpreters and translators encounter in their practice, and these may vary in terms of the difficulty they pose in their processing and rendition across languages, especially when they display a complex referential meaning (e.g. units of measurement that need to be converted).

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² Order of the first two authors is arbitrary.

³ Oxford Dictionaries, s.v. “number,” accessed January 10, 2019.

In this paper we look at the rendition of numbers in simultaneously interpreted and translated texts, under the assumption that their processing differs in the two language mediation modes. We first discuss the differences in interpreting and translation that might have a bearing on the rendition of numbers (Sections 2 to 4), and then proceed to the description of the objectives and method of our study (Section 5). This is based on the European Parliament Translation and Interpreting Corpus (EPTIC; Ferraresi et al 2019), an intermodal parallel corpus of European Parliament debates featuring translations and interpretations in English, French, Italian and Polish, as well as the corresponding written and spoken source texts (STs). Section 6 presents our results, followed by conclusions and implications for the training of language professionals in Section 7.

2. Cognitive differences between interpreting and translation

From the cognitive perspective, interpreting and translation share many characteristics, but some key aspects set them apart. Padilla et al. (1999, 62) point to the fact that both involve three phases: analysis, translation/reformulation, and production, but that these vary across the two tasks.

In the analysis phase, simultaneous interpreting and translation involve examining the phonological/orthographic aspect of the input, creating a corresponding lexical and semantic representation of it, segmenting discourse and creating a propositional structure and a representation of the text. Both interpreters and translators create mental models of the text. Yet, they differ in temporal parameters, conditions of simultaneity, the processing unit and “[t]he structure of expectations or the mental model that orients comprehension and subsequent translation” (Padilla et al. 1999, 65). The issues of simultaneity and processing unit can have a key impact on rendering numbers. Interpreters hear information only once and cannot access the full context, while translators can get back to specific text fragments and look at them from the perspective of the entire message in the course of the entire translation process.

These discrepancies lead to different steps and behaviour in the production stage. Rendition involves segmenting text into processing units, structuring objectives and choosing a rendition strategy for the target text (TT). In simultaneous interpreting, the ST is mostly unavailable for consultation in its entirety (unless the speaker makes the written version of the speech available beforehand, which may happen). Therefore, in highly challenging contexts, interpreters are advised to reformulate shorter segments, not wait for the entire

sentence (Gile 1997), and to “infer, seek consistency, omit, change the level of segmentation” (Tijus 1997). As referential information important for the understanding of a number may be scattered across the text, interpreters need to store all the relevant segments in their working memory (WM) or take notes. Translators have the chance to try out multiple attempts to successfully render a specific segment.

Moreover, the treatment of errors varies. While translators can compare the ST and TT and correct errors, in interpreting, corrections are only possible if the listening and temporal conditions permit it (Tijus 1997). Hence, when speakers deliver their speech at a high rate, interpreters may not have the chance to self-correct, even when they are aware of erroneous renditions. If the temporal conditions allow for corrections, these are easily noticeable for the recipients, unlike in the case of translation, where corrections go unnoticed.

The WM is normally thought to have a limited capacity, which is reported to be approximately 6 digits for interpreters, and 1 digit less for non-interpreters (tested in a digit recall task by Stavrakaki et al 2012, 629). According to Padilla et al. (1999, 68), capacity can also be compromised by such features as “syntactic complexity, lexical ambiguity, allocation of references” and the need to make inferences. The same factors make interpreting and translation even more demanding, due to the handling of two languages at a time and the need to produce an output that is adequate for the communicative goals. Still, simultaneous interpreting is more taxing because interpreters simultaneously engaged in production are subject to articulatory suppression (i.e. cannot subvocally rehearse the material to facilitate retention) which has a detrimental effect on memory performance (Christoffels 2006).

According to Gile (2009, 159), interpreting “takes up almost all of [...] mental energy, and sometimes requires more than is available, at which time performance deteriorates”. In line with Gile’s Effort Model, this energy is consumed by key efforts that involve: (1) listening and analysis, (2) short term memory (3) speech production and (4) the effort put in coordinating the former three components. Seeber’s Cognitive Load Model (2011, 187) stresses even more the importance of the “real-time combination” of the comprehension and production tasks, which is absent in written translation. Gile hypothesizes that interpreters often work at the top of their processing capacity, and any elements of the task requiring greater processing effort, or a mismanagement of cognitive resources, can affect the interpreting quality. These elements might be ‘problem triggers’ and include, among other, unfamiliar names, delivery rate, a foreign accent and, crucially, enumerations and numbers (Gile 2009, 171).

Summing up, interpreting and translation share the fundamental phases of text analysis, comprehension and production. Still, the temporal constraints and the simultaneity requirement make them more demanding in interpreting. Thus, the same ST elements may pose a different degree of difficulty for interpreters and translators: numbers seem to be an exemplary case in point.

3. Numbers in simultaneous interpreting

3.1 Numbers as problem triggers

The difficulty of interpreting numbers is acknowledged by interpreting practitioners and scholars (Pellatt 2006, 352), and has been investigated in several experimental studies.

Numbers are challenging for many reasons, the most important being high informational content, low predictability and low redundancy (Mazza 2001; Pinochi 2010). In most cases, it is difficult to reconstruct numbers based on context. As a result, numbers put a strain on WM, which can vary depending on the type of number. Pinochi (2010, 41) claims that longer numerical expressions require more processing time and that “[t]he effect of large numbers on WM is (...) likely to be greater than that of small numbers”. Even more demanding are series of numbers (Jones 2014) or dense speech excerpts. Such “sections increase processing capacity demands for all efforts, because the interpreter must process, retain and translate more information per unit of time” (Mazza 2001, 90).

From a cognitive perspective, Plevoets and Defrancq (2016, 217-18) report that when “the source text contains more numerals, the interpreter has significantly more difficulty with it and produces more uh(m)’s”, which points to higher cognitive load. At the same time, their outcomes indicate that the more numerals in the target rendition, the fewer filled pauses. In a later paper, the relationship between numbers and cognitive load is not confirmed, possibly due to insufficient data (Plevoets and Defrancq 2018, 24). Still the authors suggest “a possible role of omission in the reduction of cognitive load, particularly in the case of numbers”. Similarly, Kajzer-Wietrzny et al. (submitted) report that several numbers occurring closer to each other in the ST predict more disfluencies in the interpretation (indicating greater cognitive effort), but that range expressions – i.e. sequences of two or more numbers indicating the lower and upper bounds of a numerical range – are less prone to disfluencies than other types of numbers. The latter could be seen as relating to the fact that the first number

of a range gives a contextual cue regarding the other(s), which is probably one of the very few situations where numbers can be partially anticipated.

3.2 Reported accuracy rates

Experiments on interpreting numbers with professional or trainee participants report error rates of up to 50%. Braun and Clarici (1996, 95) mention a 47% error score, Mazza (2001) claims that about 30% of numbers are omitted and Pinochi (2010) finds approximately 40% of numbers to be rendered erroneously. Korpál (2016, 148) adds that, on average, around 35% of numbers are not delivered accurately even at a slow delivery rate. Desmet et al. (2018) indicate that the interpreters' error rate when working without technological support is around 43%. Error rates drop with the use of notes (Mazza 2001) or technological support (Desmet, Vandierendonck, and Defrancq 2018).

A corpus-based study of French-Dutch interpretations at the European Parliament by Collard and Defrancq (2019) reports a lower error rate of about 18%, which the authors attribute to booth collaboration. Indeed, in experimental studies, interpreters work in isolation and do not receive materials that could facilitate the task.

3.3 Factors affecting accuracy in interpreting

Interpreting accuracy may be linked to the type of number. According to Mazza (2001, 102) numbers with four or more digits are most difficult, followed by decimals, ranges, small whole numbers and dates. This is reflected in Pellat's study (2006, 364), where "low, simple numerical values are more easily interpreted than higher, complex values". Moreover, it might be the case that the time needed to pronounce numerals reduces the average short-term memory span⁴. Another study points to a significant effect of "word length" (of numbers) on SI when processing numbers with 4 or more digits read in two blocks (e.g. 928,346) compared with numbers with less than 4 digits or 4 or more digits read in one block (e.g. 920,000) (Pinochi 2010, 46).

Context also plays a role, as rendering numbers anchored in text is more difficult than doing the same with numerals presented in lists (Braun and Clarici 1996). This ties in with the detrimental effect of switching between literal hearing and intelligent hearing (Pinochi

⁴ As explained by Christoffels (2006: 207), since 'subvocal rehearsal [...] is supposed to take place in real time and long words take longer to articulate than short words, the refreshment rate of these items in the store is lower, and hence fewer items can be recalled.'

2009 after Seleskovitch 1975)⁵, and with Jones' (2014) observations regarding the substantial information load encoded in numbers. Hence, even if numbers are rendered accurately, interpreters might make errors related to the neighbouring information (Pellatt 2006, 351).

Number syntax, pertaining to the way numerals are encoded might also affect the interpreting difficulty, but not in all language pairs. While Braun and Clarici (1996, 93) report significantly more errors in interpreting from German into Italian than vice versa, Pinochi (2010) does not find language to be a relevant factor in a bidirectional analysis of German/English interpreting.

Delivery rate is important. Korpál (2016, 147) observes the detrimental effect of fast speech on interpreting accuracy of professionals and trainees. The result is confirmed in a later study (Korpál and Stachowiak-Szymczyk 2020, 139), which also points at the facilitating role that visual prompts (slides) may have on accuracy.

Finally, a recent study points to the importance of individual interpreters' skills, which turns out to be a better predictor than other causes of potential difficulty (Fritella 2019: 95).

4. Numbers in translation

Unlike in interpreting, numbers are rarely, if ever, a topic in translation research. Just by way of example, two of the most recent reference works on Translation and Interpreting Studies do not mention numbers in connection with research on translation (Baker and Saldanha 2019; Malmkjær and Windle 2011). In the same volumes, they are mentioned instead in connection with interpreting research, as problem triggers in note taking for consecutive interpreting (Albl-Mikasa, 2019: 381), and as problem triggers "tout court" in simultaneous interpreting (Pöschhacker, 2011: 4).

The issue of the rendition of numbers in written translation is sometimes mentioned in translation handbooks, like in the classic work by Newmark (1988: 212-213; but see also, e.g., Munõz Martín 1995: 66, Hasegawa 2012: 227). There, numbers are discussed as potentially problematic when asymmetries exist between systems and conventions adopted in different lingua-cultures to refer to, e.g., weights, quantities and dates. And yet, the increasing uptake of CAT tools has greatly facilitated the task of translating numbers. As argued by Kenny (2011: 7-8):

"Most TM tools also have the ability to automatically recognize 'placeables' in the source text, i.e. elements such as numbers, currency amounts, dates, and sometimes proper names [...], that do

⁵ As reported by Desmet et al (2018) in the context of numbers Pinochi (2009) "advocates a switch from intelligent hearing, i.e. taking into account the context to draw inferences, to literal hearing, i.e. paying attention to the item in isolation".

not need to be translated and so can simply be ‘placed’ in the target segment, although they may need to be manipulated in certain systematic ways. A decimal point in a number may need to be changed to a decimal comma, for example, and this kind of manipulation can be done automatically.”

Although numbers have not received much attention in Translation Studies as an object of study, comparing their renditions in translation and interpreting seems a worthwhile effort. In the words of Shlesinger and Ordan (2012: 44), “interpreting scholars can infer about this high-pressure form of translation by observing the slower, more readily observable process and product of (written) translation”, a quote that inspired much current work on intermodal differences between the two forms of language mediation (Ferraresi et al. 2019, Defrancq et al. 2020). Along similar lines, our study will compare renditions of demanding fragments by interpreters with renditions by translators. It will observe the output of highly skilled professionals involved in a similar mediation activity but under different constraints, particularly as concerns the possibility to monitor and revise their input and output.

5. Data and method

As argued in the literature review, rendering numbers is likely to be more complex in interpreting than in translation, and may be affected by many factors. Previous studies are experimental in nature and involve relatively small data samples, usually in one language pair. Thus, there is a need to test the reported observations based on a larger sample of authentic data, with more language pairs. From an intermodal perspective, it is also interesting to compare the output of the most demanding fragments for interpreters with the output of translators, whose task is likely to be subject to substantially fewer constraints.

An analysis of this kind crucially relies on a corpus including source and target texts produced in the two different modes, and matched in most other respects, notably topic areas and context of production. The corpus used in the present study is EPTIC⁶, a multilingual, intermodal parallel corpus comprised of speeches delivered at the European Parliament, their corresponding written-up versions, as well as their interpretations and translations. We make use of the language combinations English<>French, English<>Italian and Polish>English, each of them including the following subcorpora:

- spoken sources: orthographic transcripts of the original speeches;

⁶ <https://corpora.dipintra.it/eptic/>

- written sources: official verbatim reports of the source speeches;
- interpreted targets: transcripts of the interpretations;
- translated targets: translations of the verbatim reports.

The corpus has been compiled based on data collected from the official website of the European Parliament⁷. Sub-corpora are aligned at sentence level and transcripts of speeches and interpretations are time-aligned with the corresponding videos.

Table 1. Word count of individual subcorpora of the EPTIC corpus.

Source	Targets			
	<i>Spoken</i>	<i>Written</i>	<i>Interpretations</i>	<i>Translations</i>
English	24,136	22,782	53,615	58,561
French	27,713	26,674	23,185	25,855
Italian	20,016	19,591	20,352	23,234
Polish	11,011	10,616	-	-

The first stage of the analysis, which is quantitative in nature, is based on scrutiny of the aligned original speeches and transcripts of their interpretations. Specifically, we investigate the impact that several parameters selected on the basis of the literature review (Section 3) have on accuracy in interpretations. Relying on the annotation of the corpus, we extracted all the occurrences of numbers in the original speeches in all the source languages considered and their immediate co-text (7 preceding and 7 following words) together with the aligned interpretations in all the target languages considered (French and Italian for original speeches in English; English for original speeches in French, Italian and Polish). Each extracted number expression was automatically annotated in terms of background variables (see Table 2). Data extraction and annotation were performed using ad hoc scripts written in java⁸.

⁷ <http://www.europarl.europa.eu/plenary/en/home.html>

⁸ Data are available at https://osf.io/vtr6q/?view_only=e3ae9c1a9cd24e678cd5717fde97e813

We then checked manually all the automatically extracted numbers, annotating each of them in terms of its type, the proximity of other numbers, as well as the accuracy of its rendition in the interpretation. We adopted a fourfold categorization of accuracy/inaccuracy: the “accurate” pole is accounted for by the “completely accurate” (when the number is rendered accurately with the same degree of precision) and “good approximations” (when the value is approximated or generalized, without an attempt to render the exact number produced in the ST; e.g. “in 1995” becomes “in the nineties” or “in the last 2 years” is translated as “in recent years”) categories, and the “inaccurate” pole is accounted for by the “omissions” (when the value is not rendered at all) and “completely inaccurate” (when the value is rendered with a specific number that does not match the one in the ST; e.g. “170 thousand” becomes “150 thousand”) categories. We split the annotation task among all the authors and had two meetings in which we created guidelines for annotation and discussed unclear cases. The investigated fixed variables and their possible values can be seen in Table 2 (for annotation details, see Appendix 1).

Table 2. Dependent and independent fixed variables of the generalized linear models.

Variable	Type and possible values	Provenance
- Completely inaccurate renditions (dependent variable in Model 1) - Omissions (dependent variable in Model 2)	Binary: Yes / no	Manual
Language pair (in interaction with speed, see below)	Categorical: en-fr / en-it / fr-en / it-en / pl-en	Automatic: EPTIC
Nativeness of the original speaker	Binary: native / non-native	Automatic: EPTIC
Speed of the original speech (in interaction with language pair, see above)	Numeric: words / min	Automatic: EPTIC
Mode of delivery	Categorical: read, mixed, impromptu	Automatic: EPTIC
Type of number	Categorical: small whole numbers (0 to 99) and large round numbers with single leading digit (9 thousand, 9 million, 9 billion etc.) / date / part of name / range /	Manual

	decimal / large non-round numbers	
Amount of numbers in the same source sentence	Binary: one number / more than one number	Manual

We conducted a statistical analysis by means of two multifactorial regression models with fixed and random effects, one with inaccurate renditions and the other with omissions as dependent variables. We modelled inaccuracies and omissions as a function of the following independent variables: language pair, nativeness of the original speaker, speed of the original speech, mode of delivery, type of number, and amount of numbers in the same sentence. As the speed measured in words can be expected to be language-specific, we included an interaction between the speed and language direction (details in Table 2). Speaker-specific random intercepts and random slopes were also included for the effect of type of number and amount of numbers, i.e. those variables that pertain directly to the difficulty specific for numbers.

The nature of our statistical analysis is confirmatory rather than exploratory and all the included variables were theoretically motivated, and therefore we did not conduct any model optimization. Instead, for each fixed predicting variable and interaction we compared the full model with one where the respective variable or interaction was left out. All statistical analyses were conducted in R using the *lme4* package for the model fitting (Bates et al. 2015), the *effects* package for plotting the effects (Fox and Hong 2009), and the *MuMIn* package for pseudo- R^2 (Bartoń 2018).

The second stage of the analysis zooms in on the content of interpretations and translations in a more qualitative-oriented way. Drawing on the multi-parallel nature of the corpus, we first look at renditions by French and Italian interpreters working on the same English ST, and analyse all cases of inaccurate renditions, omissions and approximations: this allows us to establish whether they occur at the same potentially challenging fragments of the English ST. We then move on to the analysis of translations of these excerpts. The aim is to assess whether renditions of numbers that are not completely accurate in the interpreted TTs are caused by a content-related difficulty in the ST that translators need to explain to target recipients, or whether they are caused by interpreting-specific difficulties. It is assumed that content-related ST difficulties could result in more explicit renditions in translation, while

numbers omitted due to interpreting-specific demands would be rendered literally by translators.

6. Results

6.1 Numbers in interpreting

The first part of our analysis aims at identifying the key factors affecting the accuracy of renditions of numbers in interpreting. Before moving on to illustrate the results of the statistical models, Figure 1 presents an overview of rendition accuracy percentages (rounded values), split by sub-categories of accuracy/inaccuracy and language direction. The vast majority, in general around 70%, of the analysed interpretations of numbers in the speeches included in the EPTIC corpus is delivered accurately and a far smaller portion is rendered with a good approximation. Around 20% of the numbers are omitted, and from 4 to 7% are rendered incorrectly. Interestingly the highest percentage of completely accurate renditions was observed in PL-EN interpretations, i.e. the only ones carried into L2.

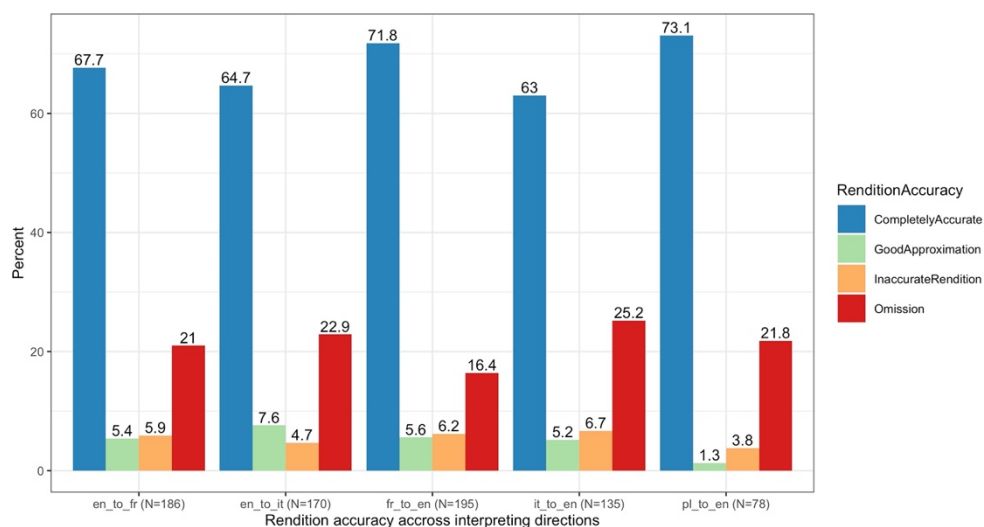


Figure 1. Accuracy by language direction. Number of numerical expressions in individual corpora stated in brackets.

6.1.1 Completely inaccurate renditions (Model 1)

The first of the fitted models covers the variance in the data reasonably well ($R^2_{\text{marginal}} = 0.29$ and $R^2_{\text{conditional}} = 0.68$). Furthermore, the variance inflation factors do not indicate any problem

regarding multicollinearity of the variables (details in Appendix 2). In what follows, we discuss our findings in terms of each variable considered. The statistical significance levels reported result from ANOVAs where the full model is contrasted with a reduced model without the respective variable.

Type of number The analysis of interpreted numbers with respect to their type shows a statistically significant effect (LRT $X(5)=11.685$, $p=0.03502$). Observing the partial effects of the full model further reveals that this is due to both non-round large numbers ($p=0.00603$) as well as decimals ($p=0.00162$) being less accurately rendered than the small numbers. On the other hand, ranges are rendered more accurately than any other type of number ($p=0.02977$). **Figure 2** shows the partial effects.

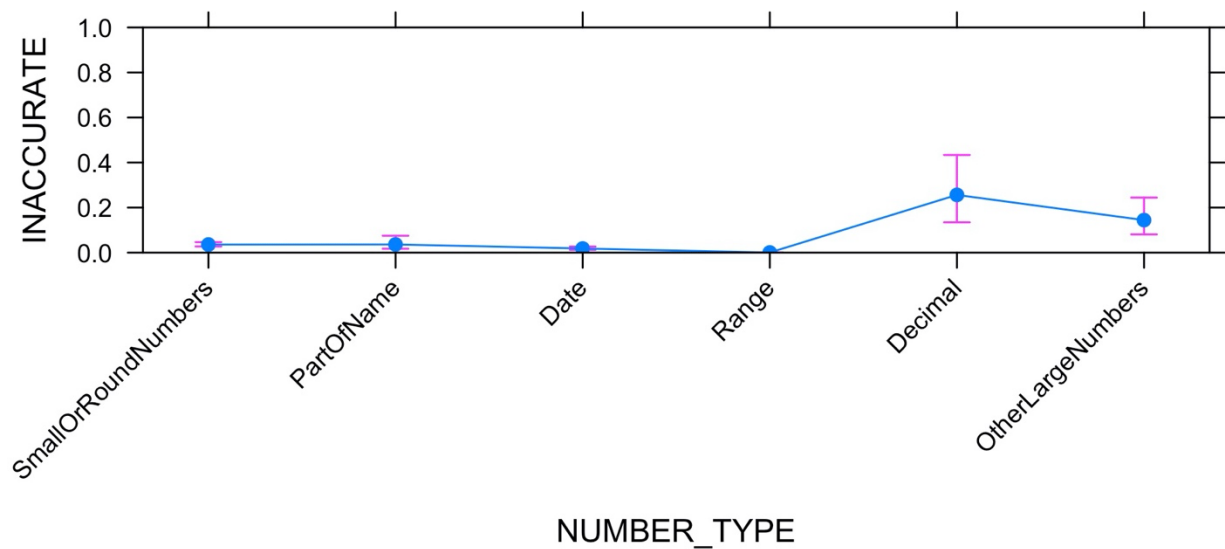


Figure 2. Partial effects of the type of number with regard to the rendition inaccuracy.

Amount of numbers In our dataset, the occurrence of numbers close to other numbers does not have a statistically significant effect to the rendition accuracy (LRT $X(1)=0.639$, $p=0.4241$). Hence, our results do not lend support to Jones' (2014) earlier non-experimental observations (see Section 3.1).

Delivery rate and interpreting direction Neither the delivery rate (LRT $X(5)=9.1562$, $p=0.103$) nor the interpreting direction (LRT $X(8)=10.285$, $p=0.2456$) affect the interpreting accuracy in a statistically significant fashion. However, the interaction between these two variables shows a statistically recognizable tendency (LRT $X(4)=9.208$, $p=0.05611$), even

though it does not quite reach the threshold of statistical significance ($p=0.05$). This corroborates only partially earlier experimental findings (Korpál 2016) on higher delivery rate reducing accuracy of numbers in interpreting. As can be seen in the partial effects, the observed phenomenon is chiefly due to only one interpreting direction, from Italian to English, which is the only one that differs in a statistically significant fashion from the intercept – from English to French – both in general ($p=0.01614$) and in interaction with the delivery rate ($p=0.01252$, see **Figure 3**). Inaccuracies tend to increase together with delivery rate also in interpretations from Polish into English. However, due to few observations and large variance (reflected by large confidence intervals) this partial effect does not reach statistical significance ($p=0.47671$). It is possible that in some cases interpreters had access to some form of written material containing the discussed numbers referred to in the speech. As read out speeches may have faster delivery rate, and as interpreters are more likely to have support material for such speeches, this scenario may lead to numbers being rendered more accurately.

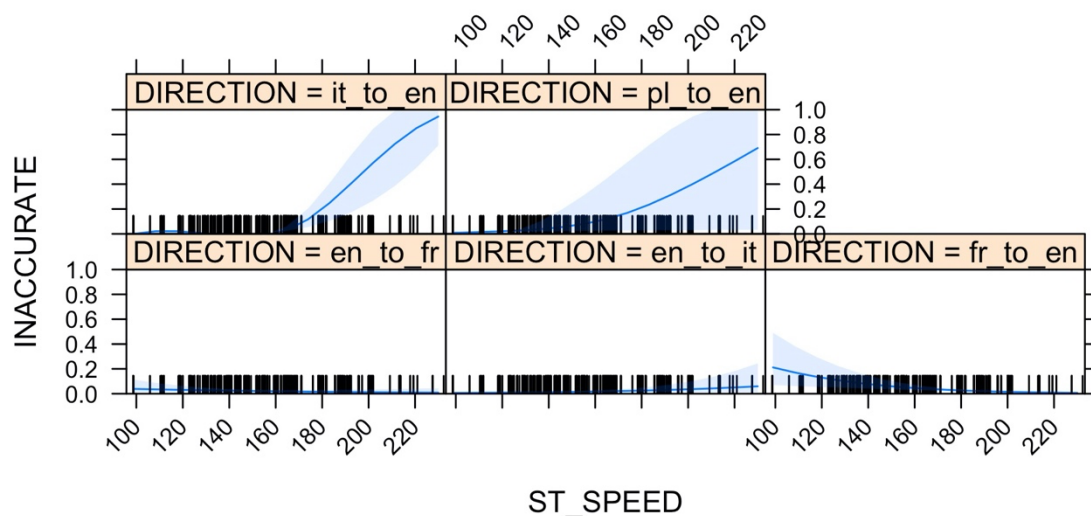


Figure 3. Partial effects of the delivery rate in interaction with the interpreting direction.

Mode of delivery of the source Numbers in speeches delivered impromptu are rendered less accurately than in read out and mixed speeches (when speakers used notes, but did not read out the entire speech), a result which ties in with the one pertaining to the effect of delivery rate. However, the observation is not statistically significant (LRT $X(2)=2.2766$, $p=0.3204$).

Nativeness of the speaker The nativeness of the speaker does not quite reach the level of statistical significance, but it portrays a noteworthy tendency (LRT $X(1)=2.9137$,

$p=0.08783$). As the partial effects show (see **Figure 4**), numbers in speeches delivered by native speakers (519 instances, 89 individual speakers) are rendered more accurately than those by non-native speakers (245 instances, 19 individual speakers) ($p=0.07462$), which suggests that numbers uttered by non-native speakers might be more difficult for interpreters to grasp.

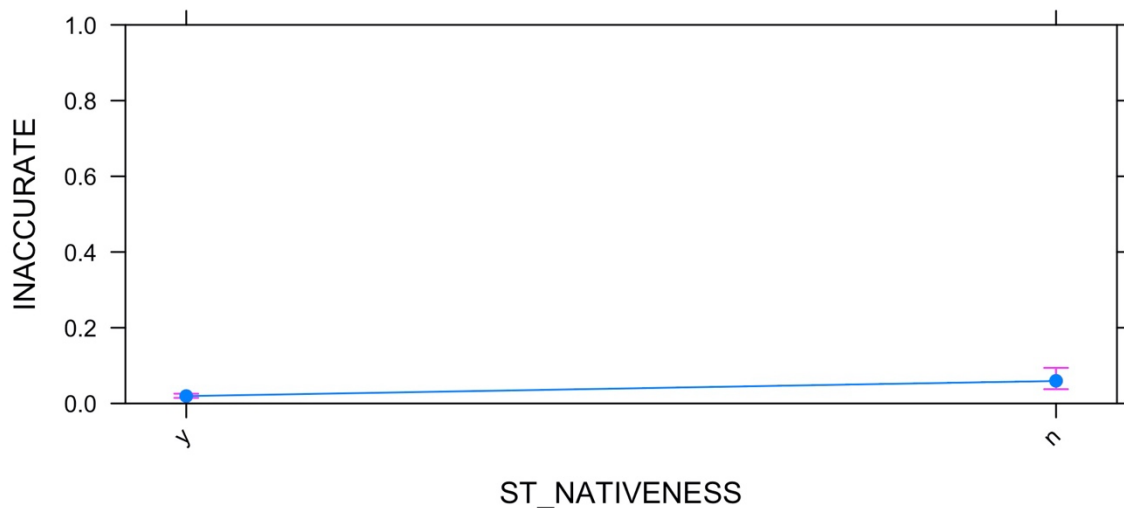


Figure 4. Partial effects of the nativeness of the speaker (“y” = native, n = “non-native”)

Speaker As for the random effects, the random slopes for the type of number or amount of numbers conditioned by speaker do not reach statistical significance, nor does the random intercept by speaker. However, leaving out the random slopes for the type of number drops the $R^2_{\text{conditional}}$ to 0.47, and leaving the random slopes for the amount of numbers to 0.66 (full model $R^2_{\text{conditional}} = 0.68$). Furthermore, leaving them both out and keeping only the random intercepts by speaker drops the $R^2_{\text{conditional}}$ to mere 0.21. In other words, there is a notable variation between speakers. The reason for this is unknown. One can only hypothesize that the way the speakers utter numbers affects the accuracy of interpretation or the way they formulate sentences with numbers (e.g. placing it in broader context vs. in a list of numbers or short sentences with numbers). It might also be the case that some speakers provide interpreters with complementary materials and some do not. As the variances and the standard deviations of the random effects show (see **Appendix 2**), the rendition accuracy of non-round large numbers has less by-speaker variation than any other type or the amount of numbers, effectively indicating that the variable with a strong partial effect is also the one where there is the least variation between speakers.

6.1.2 Omissions (Model 2)

The second of the fitted models regarding omissions covers the variance in the data very well ($R^2_{\text{marginal}} = 0.06$ and $R^2_{\text{conditional}} = 0.87$), and the variable inflation factors do not reveal any problems regarding multicollinearity between variables. However, as can be seen from the pseudo- R^2 values, this is almost exclusively due to the random effects. Indeed, none of the ANOVAs contrasting the full model with ones where each fixed variable has in turn been left out yields statistical significance. The same holds for the random effects but especially leaving out the random slopes for the type of number by the speaker drops the conditional pseudo- R^2 drastically (from 0.87 to 0.26). The variances and the standard deviations (**Appendix 3**) reveal that especially omitting the numbers as part of names varies dramatically by the speaker, whereas the use of large numbers in general does not. It can thus be concluded that omitting numbers in interpretation does not seem to be affected by the constraints indicated in earlier literature, but that it happens mostly due to variation related to speaker behaviour. Furthermore, these results suggest that omitting numbers and rendering them inaccurately are two fundamentally distinct phenomena.

6.2 Zooming in on interpretations vs. translations

6.2.1 Rationale

In this section we follow up on the statistical analysis by investigating how numbers in English sources are rendered in Italian and French interpretations and comparing them to the renditions observed in the corresponding translated texts, used as a baseline. The aim is to qualitatively assess whether interpreters for the two languages cope similarly or differently with the same ST problem triggers, i.e. numbers, and how these are rendered in the slower-pace task of translation.

6.2.2 Interpretations of the same sources into two different languages

Correct renditions in Italian and French interpretations overlap in more than half of the cases (55%; see Table 3). When it comes to inaccuracies or omissions, it is quite striking that in less than 12% of the cases the same ST numbers are rendered incorrectly or omitted by both Italian and French interpreters, while the remaining 33% of cases display a mismatch in terms of accuracy between the interpretations.

Table 3. Rendition accuracy in Italian and French interpretations of the same English ST triggers. Grey cells indicate mismatches in terms of accuracy in the two language directions.

	Completely Accurate EN > IT	Good Approximation EN > IT	Completely Inaccurate EN > IT	Omission EN > IT
Completely Accurate EN > FR	54.5%	0.5%	2.6%	11.7%
Good Approximation EN > FR	—	0.5%	0.5%	1.1%
Completely Inaccurate EN > FR	4.8%	—	0.5%	0.5%
Omission EN > FR	9.0%	3.2%	1.6%	9.0%

Zooming in on the different types of rendition, in only 9% of cases Italian and French interpreters omit the same number, and only a single case (0.5%) is observed where both utter a number but do so incorrectly. A few cases are observed in which Italian interpreters produce a completely inaccurate rendition for a ST trigger that French interpreters render correctly, or vice versa (less than 8% of cases). Most mismatches, however, involve interpreters in one language direction omitting a number that interpreters in the other direction render accurately (25.5%).

It follows that different interpreters, working with different language combinations, cope differently with the same potential problem triggers, and tend to omit rather than produce completely inaccurate renditions. We can speculate that in particularly demanding situations, different interpreters manage to comprehend, process and render different pieces of information differently, even when confronted with the same source text. This observation goes against the hypothesis that inaccuracies or omissions are triggered by the same ST problems, and is thus consistent with Fritella's (2019) finding that idiosyncratic factors play a major role in explaining rendition errors of numbers in interpreting.

6.2.3 Translations and interpretations of the same sources into two different languages

For each number rendered incorrectly, omitted or approximated in either Italian or French interpretations or both, parallel concordances were generated to check how the same number was rendered in the Italian and French translations. With exceptions discussed below, nearly all numbers in English sources (94.1%) are rendered with literal equivalents in the translations. This applies to all types of numbers. There are no cases in which translators add information regarding the numbers.

It thus seems that numbers are rendered literally by translators even in the cases where interpreters fail to do so, and that numbers are usually not explicitated on in order to facilitate recipients' understanding. This might provide support for the hypothesis that omissions, incorrect renditions and approximations in interpreting result from conscious or subconscious behaviour related to the management of cognitive resources – an issue which is less likely to affect translators. Specifically, it may point to interpreters' insufficient resources to cope with particularly difficult passages during the very demanding task of interpreting at international institutions.

The fact that almost all the numbers are rendered with literal translations in the written TTs is likely to be due to the use of CAT tools and the possibility they afford to copy the number from the source (see also Section 4). The translation process for the European institutions, external or in-house, is bound to be a multi-level operation aiming at the highest quality standards (Biel 2017), which is why numbers are probably the object of careful controls.

There are three cases where translators' solutions drew our attention. In **Figure 5**, portraying parallel concordances from EPTIC, a small whole number is used as a discourse organizer in the ST ("And 3"). The Italian interpretation and the French translation substitute the number with different discourse organizing expressions. By contrast, the French interpreter omits it altogether, and the Italian translator opts for a more formal rendering, which however still includes a number ("terzo"). Such a stylistic shift is not a major one and does not result in a change of meaning.

EPTIC English spoken sources	EPTIC French interpretations	EPTIC Italian interpretations	EPTIC French translations	EPTIC Italian translations
#19028 And 3 , by ensuring coherence and that means working, with the External Action Service, eh with military actors to make to to make sure that principled... humanitarian approaches is safeguard and it promotes, eh it is promoted in everything we, in Europe, do.	#17913 Il faut travailler dans un souci de cohérence en bonne coordination avec le service extérieur eh service européen d'action extérieure avec ce qui se fait dans le cadre de l'aide militaire. Bon je pense effectivement qu'il faut toujours assurer la plus grande cohérence possible.	#15876 E poi dobbiamo dar prova di coerenza, cioè lavorare con i nostri servizi esterni, anche con gli attori militari per far sì che l'approccio umanitario sia sempre tutelato e promosso in qualsiasi cosa l'Europa faccia in questo campo.	#20496 Enfin , nous devons garantir une cohérence, ce qui signifie travailler ensemble avec le service pour l'action extérieure et avec les acteurs militaires afin de garantir la sauvegarde d'une approche humanitaire basée sur des principes et également la promotion de cette approche en Europe.	#18228 In terzo luogo, dobbiamo assicurare la coerenza, il che significa lavorare, assieme al servizio europeo per l'azione esterna, con gli operatori militari per garantire la difesa, nonché la promozione in Europa, di un approccio fondato su principi umanitari.

Figure 5. Parallel concordances from the EPTIC corpus: example 1.

In Example 2 (**Figure 6**), the case of “2 billion” is a curious one as *billion* requires the interpreters and translators to focus slightly more on choosing the right equivalent than in the case of other numerals. As observed by Gamow (1968, 765) “one enters the tower of Babel looking for the name of 1,000,000,000 or 10^9 . In the United States it is known as one billion, in France as un trillion, [...] the Italian bilione [...] mean[s] 1,000,000,000,000 or 10^{12} ”. This time, despite this challenge, all interpreters chose the right equivalent *milliards* (fr) and *miliardi* (it), but the Italian translation is wrong: occasional errors in the rendition of numbers happen even in the translation process, where the translator or a reviser could have corrected the error.

EPTIC English spoken sources	EPTIC French interpretations	EPTIC Italian interpretations	EPTIC French translations	EPTIC Italian translations
#10760 It's important that a fair and equitable share of the sl- of the 2 billion set aside in the 2007 Aid for Trade strategy is directed towards the Pacific region.	#10078 Une part des 2 milliards ehm mis de coté dans la stratégie "Aid for Trade" doit être accordée à cette région.	#8910 È fondamentale che ehm i 2 miliardi stanziati vengano distribuiti in maniera equa nell'ambito della strategia commerciale per la regione Pacifico.	#11717 Il est important qu'une part juste et équitable des 2 milliards d'euros inscrits dans la stratégie "Aide pour le commerce 2007" soit consacrée à la région Pacifique.	#10818 È importante convogliare direttamente verso l'area del Pacifico una quota equa e non discriminatoria dei 2 milioni di euro accantonati nel 2007 per la strategia di aiuti al commercio.

Figure 6. Parallel concordances from the EPTIC corpus: example 2.

In Example 3 (**Figure 7**) the original speaker mistakenly refers to the year 2000, instead of 2009. The speaker’s error is corrected in all analysed language versions, probably relying on co-textual hints. In this case, interpreters are able to successfully manage the cognitive load, to the point of omitting the error in the ST.⁹ Translators did not have to do that, as the erroneous date had already been corrected in the verbatim report, which was the source of the translations.

EPTIC English spoken sources	EPTIC French interpretations	EPTIC Italian interpretations	EPTIC French translations	EPTIC Italian translations
#14769 This being said, the Commission is following closely the issue of international adoption within the European Union, given the link between adoption and children's li- ehm rights, and the Commission has... taken steps to... assess in com- in ehm to see how c- countries are implementing ehm the ehm... convention on adoption, and providing a forum for exchange of views on that... ehm just a year ago... in November 2000 , a little bit more than a year ago, in November 2009.	#13728 Ceci étant dit, la Commission suit de près ce dossier de l'adoption internationale dans l'Union européenne étant donné le lien entre l'adoption et le droit des enfants, et la Commission a pris des mesures pour... évaluer... la mise en oeuvre par les différents pays de la Convention ehm concernant l'adoption et en prévoyant une enceinte pour échange de vues il y a 1 an à peine, en novembre... 2009. Donc il y a un peu plus d'un an, nous ehm avons ehm prévu ehm cette enceinte.	#12112 Tutto ciò premesso, la Commissione segue con grande attenzione la questione dell'adozione internazionale all'interno dell'Unione europea, sempre ehm nel considerazione dei diritti dei minori. La Commissione, inoltre, ha anche adottato delle misu- ha adottato delle misure per vedere in che modo gli Stati membri applicano la Convenzione sulle adozioni e fornisce anche le sedi adeguate per degli scambi di opinione a riguardo. Ad esempio, un anno fa... ovvero nel novembre del 2009... il Libro verde della Commissione sulla libera circolazione dei documenti... che sarà presentato che è stato presentato il 14 dicembre del 2010, ehm considera anche quello che è ehm è l'effetto di tali norme sulla libera circolazione dei cittadini europei e quindi in particolare si occupa proprio della questione che è sollevata oggi.	#15935 Cela étant dit, la Commission suit de près la question de l'adoption internationale au sein de l'Union européenne, étant donné le lien existant entre l'adoption et les droits des enfants. La Commission a pris des initiatives pour voir de quelle manière les pays mettent en oeuvre la Convention sur l'adoption, et a créé, en novembre 2009, un forum destiné à un échange de points de vue sur la question.	#14493 Con queste premesse, la Commissione segue attentamente la problematica dell'adozione internazionale all'interno dell'Unione, dato lo stretto legame fra adozione e diritti dell'infanzia, e si adopererà per verificare l'attuazione data alla Convenzione. Nel novembre 2009 ha organizzato un foro di discussione in materia.

Figure 7. Parallel concordances from the EPTIC corpus: example 3.

⁹ These instances were classified as good approximations.

It transpires from the detailed analysis that numbers are not equally challenging for interpreters and translators: in almost all cases, numbers omitted in interpreting are translated literally in the written target texts, which suggests that numbers are less of a problem trigger in written translation than they are in interpreting.

7. Conclusions and implications for interpreter training and development of CAIT tools

The outcomes of this study have shown that the accuracy of the analysed interpretations is higher than in many experimental conditions reported in the literature, possibly due to interpreters employed at the EP being top experts in the field. Additionally, in this specific setting it is also possible for interpreters to rely on written documents but to what extent it was the case in our data is impossible to establish. Still, up to 25% of the numbers are omitted and up to 7% are rendered incorrectly, which again points to the highly demanding nature of the interpreting task. The factors resulting in the lowest interpreting accuracy rates with respect to numbers include interpretation of numbers with four or more digits, while ranges are rendered most accurately. Furthermore, the regression modelling results suggest that omitting numbers and rendering them inaccurately in interpretation are fundamentally two distinct phenomena. While some of the expected fixed effects e.g. type of number, delivery rate or nativeness of the speaker indeed have a recognizable impact on how accurately numbers are rendered in interpreting, the variance in data regarding omissions is covered almost exclusively by the speaker-specific random effect. As shown in the more qualitative analysis, even when confronted with the same ST trigger, different interpreters render inaccurately or omit different numbers. This might hypothetically be linked to the fact that inaccuracies happen rather subconsciously and are likely to be an effect of too high demands on cognitive processing, e.g. in the case of numbers that are particularly hard to process in the input. Omissions, on the other hand, may occur due to individual choices related to speaker-specific phenomena, and used as a conscious strategy to reduce cognitive load (cf. Plevoets and Defrancq 2018, 24). The results may thus be useful to sensitize interpreting trainers to the need to direct their attention to these problematic areas. It can also be used to convince speakers that structuring their message in a specific way and delivering it at a moderate pace might facilitate the process of getting the content across more accurately to those who rely on the interpretation.

Plenary sessions of the European Parliament are highly demanding for the interpreters for various reasons. The speeches frequently deal with highly specialized topics, delivered at fast pace, read and given by speakers whose communicative skills and objectives vary

considerably. The level of difficulty is so high that Seeber (2018, 86) calls it the Olympics of conference interpreting. Different topics may have been discussed over many sessions, in which case some details of the speech may be better known both to the MEPs and the interpreters, such that omitting them might be justified in a specific interpreting situation.

By comparing interpretations and translations with respect to numbers we can also observe that the difficulty of rendering numbers in both tasks is completely different. The condition of simultaneity imposes high demands on cognitive resources, which makes rendering numbers difficult. In interpreting once a number is inaccurately rendered, unlike in translation, it is difficult to correct, which increases the rate of observed inaccuracies.

Additionally, there is a huge gap between the two professions with respect to the use of computer assisted translation/interpreting tools, which may facilitate practice and help lift some of the cognitive burden. Today, translators are supported by a number of different tools, integrated usually into one piece of software, but it has not always been the case. A few decades back, a wrongly rendered number in translation would have been much more likely. Interpreters do not rely on technological support to such a great extent and good speech recognition tools could greatly facilitate interpreters in rendering numbers, e.g. by recognizing numbers in the source text and displaying them on a screen (Desmet et al. 2018, 14). Admittedly, compared to the market of CAT tools, not many CAIT tools are available, which points to the need to develop them and encourage interpreters to actively use such tools. Also, translator and interpreter training differ with this respect. While CAT tools have been usually taught within dedicated courses at translator training programs for at least a decade, dedicated IT courses for interpreters are only starting to emerge.

The study does have some methodological limitations. From the point of view of corpus studies, the EPTIC corpus analysed here is relatively small and it did not guarantee enough observations for all combinations of examined variables. Moreover, the corpus is relatively rich in read and mixed speeches, while only a smaller proportion are impromptu. Furthermore, the data does not provide a means to identify individual interpreters. As shown in the qualitative part of the analysis, different interpreters omit different numbers stemming from the same source texts. Hence, including that information would allow one to take into account also interpreter-specific preferences, which can be hypothesized to affect especially the conscious choices of omitting numbers in interpretation. Finally, especially in the light of the outcomes of exploratory analysis pointing to interpreting into L2 as most accurate, the nativeness of the interpreter should be further tested as a factor impacting accuracy in future research. In the current analysis this has been impossible as the interpretations made in the

English>French and English >Italian language pairs have been carried out mostly into the mother tongue, while only interpretations from Polish to English into the foreign language (L2). This and the remaining limitations in particular should be revisited in the future studies on the interpretation of numbers.

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Appendix 1

Annotation categories with clarifications and examples.

Small and round numbers

Numbers below 100 and round numbers with one leading digit (1–9 hundred, 1–9 thousand etc.) that do not fall to any of the other categories. Percentages are also included in this category. If the word *one* performs a text organizing function it is treated as a number, whereas if it performs as a pronoun it is not.

In the last ehm 7 days, there's been [...]

Parliament managed to secure 75 percent of the amendments [...]

*[...] you address **one** concrete case [...]*

Dates

Numbers that occur as part of a date expression. Multiple numbers in the same date expression are counted and treated separately.

*[...] manufacturer notified the German competent authorities on **22nd** December **2010** [...]*

Other large numbers

Numbers above 99 that are not round (see above).

38 million people rely on the construction sector [...]

Numbers as part of name

Numbers that act as part of a name (e.g. of an article or legislation).

*[...] on which the success of ehm **Europe 2020** Strategy is hinged [...]*

*[...] that any use of new **Article 61 bis** of the Penal Code would be [...]*

Numbers expressing range

Numbers expressing range are considered as such irrespective of the other categories they represent. Each number of the range expression is counted and treated separately.

*Between **2002** and **2008**, the EU contributed 544 million euro [...]*

*Each year, **10** to **15 billion** dollars are lost to revenues [...]*

Decimals

Decimal numbers and fractions. Percentages that contain decimals are considered decimals. In the case of split fractions (e.g. *one person in ten*) both numbers are considered decimals, and they are counted and treated separately.

*[...] whole of the Pacific region is just **0.06** percent, and yet some areas have [...]*

[...] and imported into the EU constitutes almost **one fifth** of the timber products on our [...]
[...] importing Scottish haggis, yet **1 in 3** Americans claim Scottish ehm ancestry [...]

Appendix 2

Summary of the Inaccuracy model (Model 1)

Formula: INACCURATE ~ ST_SPEED * DIRECTION + ST_DELIVERY + ST_NATIVENESS + NUMBER_TYPE + AMOUNT + (1 + NUMBER_TYPE + AMOUNT | SPEAKER)
Data: dat_for_accuracy
Control: glmerControl(optimizer = "bobyqa")

	AIC	BIC	logLik	deviance	df.resid
	377.6	595.6	-141.8	283.6	717

Scaled residuals:

	Min	1Q	Median	3Q	Max
	-0.7698	-0.2467	-0.1481	-0.0951	8.4589

Random effects:

Groups	Name	Variance	Std.Dev.	Corr
SPEAKER	(Intercept)	0.000	0.0000	
	NUMBER_TYPEPartOfName	1.564	1.2506	NaN
	NUMBER_TYPEDate	1.140	1.0677	NaN -1.00
	NUMBER_TYPEDRange	9.116	3.0192	NaN 1.00 -1.00
	NUMBER_TYPEDecimal	2.361	1.5366	NaN -1.00 1.00 -1.00
	NUMBER_TYPEOtherLargeNumbers	0.551	0.7423	NaN -1.00 1.00 -1.00 1.00
	AMOUNTMoreThanOneNumber	5.318	2.3061	NaN 1.00 -1.00 1.00 -1.00 -1.00
	Number of obs: 764, groups: SPEAKER, 108			

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	-2.08282	3.31624	-0.628	0.52996
ST_SPEED	-0.01149	0.02090	-0.550	0.58253
DIRECTIONen_to_it	-4.81383	3.61460	-1.332	0.18293
DIRECTIONfr_to_en	3.56065	4.61925	0.771	0.44081
DIRECTIONit_to_en	-15.68387	6.51941	-2.406	0.01614 *
DIRECTIONpl_to_en	-6.98816	9.82020	-0.712	0.47671
ST_DELIVERYmixed	-0.27411	0.52245	-0.525	0.59982
ST_DELIVERYimpromptu	0.98239	0.71248	1.379	0.16795
ST_NATIVENESSn	1.16571	0.65387	1.783	0.07462 .
NUMBER_TYPEPartOfName	0.01681	0.94450	0.018	0.98580
NUMBER_TYPEDate	-0.69018	0.60133	-1.148	0.25107
NUMBER_TYPEDRange	-4.25210	1.95672	-2.173	0.02977 *
NUMBER_TYPEDecimal	2.22748	0.70652	3.153	0.00162 **
NUMBER_TYPEOtherLargeNumbers	1.51395	0.55129	2.746	0.00603 **
AMOUNTMoreThanOneNumber	-0.19098	0.54676	-0.349	0.72687
ST_SPEED:DIRECTIONen_to_it	0.02946	0.02380	1.238	0.21586
ST_SPEED:DIRECTIONfr_to_en	-0.01682	0.02839	-0.592	0.55362
ST_SPEED:DIRECTIONit_to_en	0.10103	0.04046	2.497	0.01252 *
ST_SPEED:DIRECTIONpl_to_en	0.05439	0.07258	0.749	0.45366

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
R2m R2c
0.2885223 0.6842955

Appendix 3

Summary of the Omissions model (Model 2)

Formula: OMISSION ~ ST_SPEED * DIRECTION + ST_DELIVERY + ST_NATIVENESS + NUMBER_TYPE + AMOUNT + (1 + NUMBER_TYPE + AMOUNT | SPEAKER)
Data: dat_for_accuracy
Control: glmerControl(optimizer = "bobyqa")

AIC	BIC	logLik	deviance	df.resid
814.5	1032.6	-360.3	720.5	717

Scaled residuals:

Min	1Q	Median	3Q	Max
-1.2817	-0.4681	-0.3658	-0.1620	3.0085

Random effects:

Groups	Name	Variance	Std.Dev.	Corr
SPEAKER	(Intercept)	0.6141	0.7836	
	NUMBER_TYPEPartOfName	337.1130	18.3606	0.83
	NUMBER_TYPEDate	3.6291	1.9050	-0.47 -0.84
	NUMBER_TYPERange	5.0223	2.2410	0.05 -0.44 0.85
	NUMBER_TYPEDecimal	3.0266	1.7397	-0.73 -0.73 0.60 0.35
	NUMBER_TYPEOtherLargeNumbers	2.3183	1.5226	-0.35 0.14 -0.38 -0.52 0.43
	AMOUNTMoreThanOneNumber	0.7556	0.8693	-0.09 0.38 -0.72 -0.92 -0.47 0.38

Number of obs: 764, groups: SPEAKER, 108

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	1.323044	2.331557	0.567	0.5704
ST_SPEED	-0.017976	0.014506	-1.239	0.2153
DIRECTIONen_to_it	-1.376544	2.096796	-0.656	0.5115
DIRECTIONfr_to_en	-2.947554	2.977985	-0.990	0.3223
DIRECTIONit_to_en	-6.682471	3.258860	-2.051	0.0403 *
DIRECTIONpl_to_en	-0.981888	3.996193	-0.246	0.8059
ST_DELIVERYmixed	0.169123	0.266393	0.635	0.5255
ST_DELIVERYimpromptu	0.360190	0.462272	0.779	0.4359
ST_NATIVENESSn	-0.099420	0.454352	-0.219	0.8268
NUMBER_TYPEPartOfName	-5.452495	5.907663	-0.923	0.3560
NUMBER_TYPEDate	-0.724062	0.389759	-1.858	0.0632 .
NUMBER_TYPERange	-0.147520	0.662485	-0.223	0.8238
NUMBER_TYPEDecimal	-0.070188	0.582615	-0.120	0.9041
NUMBER_TYPEOtherLargeNumbers	-0.389208	0.529485	-0.735	0.4623
AMOUNTMoreThanOneNumber	0.181902	0.254543	0.715	0.4748
ST_SPEED:DIRECTIONen_to_it	0.010225	0.014088	0.726	0.4679
ST_SPEED:DIRECTIONfr_to_en	0.017295	0.017790	0.972	0.3309
ST_SPEED:DIRECTIONit_to_en	0.045893	0.021094	2.176	0.0296 *
ST_SPEED:DIRECTIONpl_to_en	0.003805	0.029832	0.128	0.8985

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

convergence code: 1

R2m	R2c
0.05921314	0.86750691