Cross-linguistic variation in the meaning of quantifiers: Implications for pragmatic enrichment

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Abstract

One of the most studied scales in the literature on scalar implicatures is the quantifier scale. While the truth of *some* is entailed by the truth of *all*, *some* is felicitous only when *all* is false. This opens the possibility that *some* would be felicitous if, e.g., almost all of the objects in the restriction of the quantifier have the property ascribed by the nuclear scope. This prediction from the standard theory of quantifier interpretation clashes with native speakers' intuitions. In Experiment 1 we report a questionnaire study on the perception of quantifier meanings in English, French, Slovenian and German which points to a cross-linguistic variation with respect to the perception of numerical bounds of the existential quantifier. In Experiment 2, using a picture choice task, we further examine whether the numerical bound differences correlate with differences in pragmatic interpretations of the quantifier *some* in English and *quelques* in French and interpret the results as supporting our hypothesis that *some* and its cross-linguistic counterparts are subjected to different processes of pragmatic enrichment.

Keywords
quantifier, numerical bound, scalar implicature, R/I-implicature, M-implicature

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1. Introduction

In a broad sense natural language quantification includes expressions of explicit quantities or numerical proportions (e.g. 50%), as well as a set of expressions that do not directly refer to numbers but express quantities or proportions as more or less vague estimations thereof. Such are the quantificational determiners *some, few, many, half, most,* (*at least/at most/as many as*) *n* (for a natural number n), *all*, among others. The standard approach in formal semantics that goes back to Barwise and Cooper's (1981) seminal work, treats these determiners as relations between sets of individuals. In this framework, for instance, the determiner *some*, as in *Some balloons are red*, relates the set of balloons and the set of relevant red objects in a way which requires that the intersection of the two sets is not empty for the sentence to be True in a given situation. Similar semantic definitions are offered for the whole class of other determiners. They are all defined as relations between two sets of individuals. Some examples are given in (1):

(1) a. $[\![some]\!]$ = {<A,B>: A∩B ≠ ∅}
b. $[\![no]\!]$ = {<A,B>: A∩B = ∅}
c. $[\![every]\!]$ = {<A,B>: A⊆B}
d. $[\![most]\!]$ = {<A,B>: |A ∩ B| > ½ |A|}
e. $[\![many]\!]$ = {<A,B>: $\frac{|A \cap B|}{|A|} > n_c$, for some number n in a context c}

In addition, pragmatic theories which come in some varieties (cf. the classical theory of Grice 1989; the neo-Gricean theory of Horn 1984, 2004, Levinson 2000, the grammatical theory of Chierchia et al 2012, Chierchia 2013, the Relevance theory of Sperber and Willson 1995) specify a further component (through a different mechanism for each theory) in the meaning of the quantificational expressions that enriches the proposition of which it is part with some pragmatic inference. The most typical example involves enrichment through scalar implicatures. In Horn's terminology, these implicatures result from i) the fact that quantifiers are part of a set that forms an entailment scale (see de Carvalho et al 2016 for evidence of the psychological reality of scales) and as such are always under consideration as possible alternatives and ii) speakers' adherence to a pragmatic principle that requires maximal informativeness (Quantity Maxim of Grice/Q-Principle of neo-Griceans) or to the requirements of the exhaustivity operator in the grammatical theory of implicatures. As an illustration we can consider again the example with *some*. The literal meaning of *Some balloons are red* is complemented by a pragmatic inference that *Not all balloons are red* so that the resulting meaning is *Some <u>but not all</u> balloons are red.* The scalar implicature is derived by negating the scalar alternative *All balloons are red* to the sentence containing *some* because it is stronger/more informative since it asymmetrically entails the original sentence but was not chosen by the cooperative speaker. A similar meaning enrichment process applies to all items on the closed quantificational scale which do not occupy its end-points.

However, even if we assume that literal meanings of quantifiers are often strengthened by scalar implicatures, speakers who evaluate the truth of sentences like *Some balloons are red* are expected to always judge as well acceptable the sentence in all contexts in which the size of the set of red balloons relates to the size of the whole set of balloons by a proportion which could be expressed by any number between 0 and 1. That means that situations in which red balloons are 1% or 99% of all balloons are predicted to be just as good as situations in which

red balloons are 20% of all balloons in terms of verifying that sentence. This prediction is not always borne out by speakers' reported intuitions concerning respective contexts. Moreover, according to the standard theories, no cross-linguistic variation is expected in the evaluation of translational equivalents. In other words, quantifiers like *some* or *most* are expected to cover exactly the same range of proportions in different languages.

The goal of this paper is to subject to scrutiny these predictions of the standard semantic-pragmatic treatment of quantifiers. To this end we report the results of two experiments. Experiment 1 is a cross-language questionnaire study spanning the Germanic, Romance and Slavic language groups. Two main findings of this experiment are the following: i) meaning strengthening through scalar implicatures is not sufficient to account for the observed numerical bounds of quantifiers, and ii) at least the English quantifier *some* is not conceptualized in the same manner cross-linguistically and should not, therefore, receive the same analysis as its counterparts in other languages. In Experiment 2, using a picture-choice test, we further experimentally explore the implications of these results for the theory of scalar implicatures. Specifically, we observe a different pattern of comprehension of sentences containing the English *some* and its French counterpart *quelques*. We interpret the difference as supporting our claim that the meanings of *some* and its crosslinguistic variants result from applying different mechanisms of pragmatic enrichment.

2. Quantifiers and numerical bounds

2.1. The psychometric approach

Quantifier perception has also been in the focus of cognitive psychology. Previous experimental research on the "psychometric" dimension of quantifiers established that the meanings of quantifiers lie on some sort of scale, and suggested that a mapping should hold between a quantifier and its respective range of numerical values (Moxey and Sanford 2000). Furthermore, the respective numerical range-referring representations of quantifier meanings have been formulated as membership functions used in fuzzy logic, whereby different values pertaining to the quantifier are graded, e.g. between 0, meaning no fit, to 1, implying a perfect fit (Wallsten et al, 1986). For instance, the probability quantifier *likely* might be given a value of 0 for $p = 0.2$, one of 0.1 for $p = 0.3$, and 1.0 for $p = 0.8$. Membership functions encode information about the form of the mapping from an expression to amounts (e.g. variance, skew, kurtosis) as well as central tendency information. These membership functions were found to be stable for a given individual and suggested to be a good substitution for an internalized scale (Wallsten et al 1993).

However, it was soon recognized that the "psychometric" approach in this form faces serious difficulties, in that that direct assignment of the empirically established range to the respective quantificational expression is very difficult or impossible to implement. Membership functions were found to depend greatly on the number of potentially confounding factors. One such factor is contrast effects that arise because of the within-subject experimental design, whereby subjects are asked to provide values for different quantifiers in a single trial (e.g. Daamen and de Bie 1991). Another factor has to do with the set size from which proportions are drawn: e.g. low-quantity determiners such as *few* were found to denote a greater proportion when they described small set sizes, compared to larger ones (Newstead et al 1987). Yet another problem arises from the conflict with base-rate expectations concerning the event described by the quantifier-bearing sentence. For instance, the values assigned to *many* in *Many people enjoyed the party* is higher than in *many doctors are female*, because

the former (people enjoying parties), but not the latter, event has a higher base-rate expectation (Moxey and Sanford 1993). One also faces a serious methodological problem when trying to marry the "psychometric" approach in its present form to the currently standard truth-conditional formal semantics, which interprets sentence meanings in terms of binary truth values 0 and 1. This binary system is in conflict with the rationale behind the membership function allowing an intermediate degree of fit. Irrespective of these shortcomings, it is important to note, however, that the psychometric approach was based on the valid observation that quantifier meanings predicted by the standard semantic-pragmatic approach are not strictly validated by speakers' intuitions. There is no controversy as to the numerical bounds and set-theoretic meaning of the universal quantifier *every/all* and of the negative one *no* but the rest of the quantifiers apparently need to be reanalyzed.

2.1. The typicality approach

The interpretation of quantifiers has recently been reconsidered within a framework based on typicality measures (van Tiel 2014, van Tiel and Geurts 2014). This line of research relies on a distinction between typicality and category membership (cf. Fuhrmann 1991, a.o.). The typicality theory of quantifier interpretation is related to a general mechanism of ascribing typicality differences among members of the same category. One example discussed in van Tiel (2014) regards an experimental study reported in Rosch (1975) where results point to a stable ordering of members of the category BIRD with the robin being evaluated as the most typical in comparison to the rest of the birds denoted by relevant hyponyms of *bird*. In a similar vein, the typicality approach to quantifier interpretation assumes that quantified statements are assigned functions from situations to typicality values. As the authors argue, typicality values can be related to probability values but only if the cardinality of the total set is known. This makes the typicality-based proposal more advantageous than similar proposals of interpreting quantified statements as functions from situations to probability values (cf. Yildirim et al 2013) since speakers need not necessarily have knowledge about the relevant set cardinality in all situations in which quantifiers are used.

Van Tiel and Geurts (2014) investigate typicality judgments associated with the quantifiers *all*, *every*, *few*, *many*, *more than half*, *most*, *some*, *none not all*, *not many* in a large-scale study involving 340 English-speaking participants. They construct visual contexts with 10 black or white circles. The number of black and white circles in each context was manipulated to represent all 11 different possibilities. Using a 7-point Likert scale, participants evaluated the fit between respective quantified sentences and each context. This task was intended to provide typicality judgments. These were contrasted to truth-value judgments which were elicited by using the same material and a task to provide a binary judgment (True/False). The results were interpreted to indicate that typicality judgments were influenced by two factors: set-theoretic definitions and distance from prototype. A necessary condition for a prototype is to be a situation in which the quantified sentence is true according to the respective set-theoretic definition. But, they were also found to depend on competing quantifiers, i.e. a prototypical situation related to a quantifier *q* must be maximally distinct from a prototypical situation related to any competing quantifier *q'*.

Here we focus on three important consequences of the typicality-based analysis of quantifiers. First, the proposal does not make a clear prediction about the interaction between typicality inferences and pragmatic inferences resulting from quantifier alternative competition, i.e. scalar implicatures in non-embedded contexts (see also Cummins 2014). Second, the proposal leaves no obvious space for cross-linguistic variation. Inasmuch as quantifier numerical

bounds are related to prototypes, these are expected to have general cognitive foundations. And finally, if all of the quantifiers in the reported studies involve the same mechanism of association with prototypical values, prototypes should be relatively stable and clearly distinguished even for quantifiers with partially overlapping set-theoretic definitions. This last expectation was not borne out in some cases in the study reported in van Tiel and Geurts. In addition, the claim that prototypes depend on competing quantifiers might need a more detailed formulation given that the study does not distinguish between cases with linguistically provided alternatives and cases with implicitly available alternatives. The last consideration is validated by en experimental study on the processing of two Slovenian counterparts of the determiner *many*, namely *precej* and *veliko* (see Stateva and Stepanov 2017) and by reported experimental work on processing implicatures within a paradigm that provides alternatives explicitly (cf. Felicity Judgment Task in Foppolo et al 2012, a.o.)

2.2. Quantifier processing: an experimental study[1]

We examine the interpretation of quantifiers in two experiments whose aim is to shed further light on a number of relevant questions given the discussion so far. In particular, we aim to identify the main pragmatic factors that influence the processing of quantifiers cross-linguistically. Toward this goal, we address the following questions:

- Is it possible to identify the numerical ranges assigned to different quantifiers and their translational equivalents in other languages? Are numerical ranges encoded in meanings or are they epiphenomenal?
- Are cross-linguistically related quantifiers processed identically? Can we maintain a universal theory of quantifiers on the basis of similarities in the respective numerical values?
- Which pragmatic processes are relevant for the interpretation of quantifiers?
- How are quantifiers with overlapping lexical meanings distinguished?

The main predictions of the present study are rather straightforward. If the classical theories of Barwise and Cooper (1981) and others are on the right track, then, with respect to the quantifier *some*, we should not expect to encounter any specific numerical limitations in the range of evaluated proportions, in English as well as in other tested languages. As pointed out in Section 1, given the definition in (1a), situations in which quantified objects constitute between 1% or 99% are predicted to be more or less appropriate for the use of this quantifier. This is not the case for the use of *most* where the definition (1d) restricts the use to the numerical proportions over 50%: therefore, its use in proportions less than 50% should be unacceptable. With respect to quantifier *half*, we obviously expect a peak in acceptability around 50%, while lower and higher proportions should not be acceptable. With respect to *few*, following the standard theory, we view *few* as a negative counterpart of *many* (cf. 1e.) and therefore expect, its upper bound to be well below 50%. In line with neo-Grician reasoning, we assign *few* to the negative scale <*none*, *hardly any*, *few*> and predict that its lower bound is affected by a scalar implicature negating the two stronger alternatives in the ordered set. Finally, following Penka (2006) which defines *almost* as a member of a Horn-set

[1] The experiments in this study were carried out in accordance with the Declaration of Helsinki and the existing European and international regulations concerning ethics in research. Online informed consent was obtained from all participants prior to the beginning of testing. Experiment 1 without the English portion and Experiment 2 were carried out in accordance with the recommendations of the Comité de Protection des Personnes Sud Est II, who gave it its agreement (IRB number: 11263). The English portion of Experiment 1 was approved by the IRB at Rutgers, the State University of New Jersey, Protocol #: E11-079.

on a par with *most*, we expect a numerical range for *almost* above that for *most* and excluding the top of the proportional scale.

The predictions concerning the scalar implicature component of the quantifier's meaning are important in one additional aspect. As both neo-Gricean and Relevance theories predict, meaning strengthening through scalar implicatures should be sufficient to account for the numerical ranges of the quantifier *some* and its crosslinguistic counterparts, that is, the numerical range of *some* must not overlap with numerical range of other quantifiers like *few, half, most* or *almost all* if pragmatic enrichment applies..

We were also interested in testing the prediction made by the typicality approach that, inasmuch as quantifier numerical bounds are related to prototypes, the latter are expected to have general cognitive foundations and therefore, no cross-linguistic variation is expected in the meaning of the respective quantifiers, including their numerical ranges.

3. Experiment 1

Experiment 1 addresses a similar question to the one of van Tiel and Geurts (2014), namely whether speakers make reference to particular numerical values in their use of different quantifiers. The experimental design is therefore similar to theirs but it, nevertheless, bears some important differences. The main one is that this is a cross-linguistic study involving 4 languages belonging to different language groups within the Indo-European family: Germanic, Romance and Slavic. We thus have a possibility to compare how close or different respective lexical counterparts are. The second difference is that we use verbal contexts making reference to a relatively big cardinality of the respective total sets to avoid interference of possible world knowledge.

3.1. Design and materials

We investigate the cross-linguistic distribution of quantificational determiners by running a series of similarly designed experiments in four languages: English, French, German and Slovenian. The quantifiers used in the questionnaires per language are listed in Table 1: [2]

English	*few*	*some*	*half*	*Most*	*almost (all)*
French	*un peu*	*quelques*	*la moitié*	*la plupart*	*presque(tous)*
German	*wenige*	*einige*	*halbe*	*moisten*	*fast (alle)*
Slovenian		*nekaj*	*polovica*	*Večina*	*skoraj (vse)*

Table 1. Quantifiers per language used in target sentences, Experiment 1.

Several clarifications concerning the choice of the target items are in order. First, the reader might wonder why *almost* and its translational equivalents were included in the experimental paradigm given that the classical theory of quantifiers does not normally extend to this

[2] The German data were collected by Penka Stateva and Remus Gergel for a study published as Gergel and Stateva (2014) focusing on the differences between the German determiners *allermeisten* ('most') and *fast alle* ('almost all'). Except for *fast alle*, the data collected on the German quantifiers as in Table 1 were not discussed in that study and were largely treated there as filler conditions.

determiner. Our decision was partly influenced by a proposal in Penka (2006) based on the argument that *almost* is part of the entailment (Horn-) scale along with determiners like *all* and *most*. If this is the case, then it must belong to that natural class. In addition, we wanted to find out if *almost* acts as an alternative to *most* in forcing it to be restricted to a lower interval than the one predicted by its set-theoretic meaning. Yet another reason for including this item was that we are not familiar with experimental studies (if such exist at all) about the numerical bounds of *almost*.

Second, it should be noted that the Slovenian counterpart of 'few', *malo*, has a very low corpus frequency. We therefore decided not to include it in the questionnaire. Instead, the Slovenian questionnaire contained sentences with the quantifier 'precej' to match the general cross-language design. These sentences were treated as fillers for the purposes of the present study. This quantifier, however, was in the focus of a similarly designed experiment in Stateva and Stepanov (2017); see this work for details.

Third, we did not include in our testing universal quantifiers such as *all* or *no*, because of their extremely narrow-ranged associated proportions namely 100% in one case and 0% in the other, and therefore trivial (or close to trivial) associated intuitions. We did, however, include the quantifier 'half' which is also associated a fairly trivial proportional range (around 50%) but, because of the more complex actual numerical proportions that we used in this experiment, speakers do not necessarily have a direct access to the result of the respective calculation; as a result, a limited amount of vagueness can also be expected.

50 items were prepared as experimental materials. Each item contained a two-sentence context. The first sentence established an event and made reference to the cardinality of a set of individuals. The second sentence referred to one of its subsets. The numbers used in all first sentences of the contexts ranged from 100 to 200. The ratio between first and second number in contexts was manipulated in order for the proportion scale to be covered from 1% to 99% with an increment of 2 within the 50 contexts.[3] Each context was accompanied by 5 sentences describing it by using a different quantifier. The task for participants was to evaluate how well each of the sentences described the respective context by using a 5-point Likert scale ranging from *not well* to *very well*.

An example of the stimulus materials is given in Figure 1.

3.2. Participants

108 (24 males) adult native speakers of English (N=28), French (N=30), German (N=25) and Slovenian (N=25) were recruited for this experiment, and gave an informed consent to participate in the study. The distribution of participants by age groups is shown in Table 2. The English and German participants were undergraduate students at Rutgers University (USA) and the University of Graz (Austria), respectively, and they received course credit. The Slovenian and French participants were students and employees at the University of Nova Gorica (Slovenia) and The University of Lyon (France), respectively. They participated

[3] We avoided the use of round numbers in the contexts for two reasons. First, we wanted the participants not to be tempted to provide judgments with the help of explicit ratio calculations. Second, since it has been shown that round numbers invite more approximate interpretations (Krifka 2007b), we believed that by avoiding round numbers, we prompt as precise interpretations as possible, especially in view of the task to evaluate vague quantifiers.

voluntarily and received no compensation. All participants had normal or corrected to normal vision and they were naïve as to the purpose of the study and the research question.

Language/Age group	18-20	21-24	25-30	30-35	>35
English	9	18	1	0	0
French	1	17	3	2	7
German	4	11	6	4	0
Slovenian	1	3	18	3	0

Table 2. Participation by age group and language, Experiment 1

3.3. Procedure

The participants were instructed to read carefully each context and then evaluate separately the sentences from the block following their first intuition. Each screen contained a scale with annotated end-points *not well* and *very well* in the English, French and Slovenian version of the questionnaire in order to make it clear for participants that these labels correspond to scores from 1 and 5, respectively. German participants had the labels *not well* and *very well* correspond to the scale from 5 to 1, respectively, following a convention in education where the lowest numbers are associated with the positive evaluation.[4] All participants received all 50 items in this task. The experiment was administered via the web-based software SoSciSurvey (https://www.soscisurvey.de/). The contexts and the order of the five sentences in each context were presented in a pseudo-randomized order for each participant. They were allowed to take a break, if necessary, after completing the evaluation of a whole context. There were no time limits on finishing the task or evaluation a particular context. For each participant the task lasted approximately 30 min.

3.4. Results

For the data analysis, we assumed the mid-scale judgment of 3 points as a threshold for a positive judgment on appropriateness of the respective contexts and excluded datapoints below this threshold. The rationale for not using the set of datapoints collected over the entire set of conditions comes from the perspective seeing quantifiers as markers of numerical proportions. To illustrate the point informally, consider the determiner *half*. It is clear that when an expression such as "half of the dots are red" is evaluated against a finite set of red dots within a particular range, it is only within a very narrow subrange of conditions that this expression will receive high scores, whereas in the vast majority of other cases, it will receive low scores (this was, in fact, the case in our study). Taking the entire set of data points into consideration in this case would lead to the misleading conclusion that speakers generally dislike this determiner, whereas in fact the scores simply reflect the natural situation that the use of this determiner is licensed within a very narrow numerical range. Similar considerations apply in the case of the determiner *all*, as well as for all cardinal quantificational determiners. By analogy, we believe this holds also in the case of the other quantifiers, even though the particular numerical range for this determiner may be hard to establish a-priori because of their vague character. Thus it would not be appropriate to compare the alleged differences in the use of quantifiers across numerical ranges in which their use is not licensed in principle. In contrast, dividing the Likert acceptability scale in half

[4] For the purposes of the analysis of the German data, scores were reassigned in the following pattern: 1→5, 2→4, 4→2 and 5→1. This allowed us to compare cross-linguistic patterns of quantifier processing more easily.

provides at least a rough estimation of the acceptability boundary. Doing so thus extends the usual tradition of collecting speakers' evaluations in terms of binary judgments, but also adds the functionality for estimation of the size of the observed differences across different conditions.

The results of Experiment 1 are graphically represented in Figures 2-6 in Appendix A. The graphs in the figures summarize acceptability scores in the upper half of the Likert scale per language and per respective quantifier together with respective polynomial fit curves and confidence intervals. Regression models in the R environment 3.5.1 were used to fit the data using polynomial functions. As can be seen from the figures, different quantifiers were judged acceptable in different ranges of proportions. In particular, the numerical proportions characterized by respective cross-linguistic counterparts of *few* appear to be restricted well below 50%, with the score peaking in the first quarter (<25%) of the proportional range. On the other hand, *most* and *almost all* are predictably evaluated higher with proportions of 50% and above. The scores on *most* tend to a plateau in the upper part of the numerical range (>50%), whereas the acceptability on *almost all* increases more steeply towards the last quarter (>75%). The determiner *half* received most of the acceptable scores midrange, peaking around 50% and sharply dropping before and after that.

The results of Experiment 1 revealed that speakers of all four languages follow largely similar patterns of evaluating the quantifiers with the meaning of *few, half, most* and *almost all*. An important exception in this picture concerns the English quantifier *some* (Figure 3). The numerical proportions whose characterization by non-English counterparts of *some* was acceptable ranged from 3% to slightly less than 50% of the total number of items in the three languages under consideration, namely, German, French and Slovenian. In contrast, English speakers found proportions in the range between 3 and about 80% of the total number of items at issue, as acceptable to be characterized by *some.* In other words, the range of proportions that can be characterized by the meaning of *some* is 60% larger in English than in the other three tested languages.

Another, somewhat surprising, result of this experiment was an observed robust negative correlation (Pearson's $R < -0.75$, $p < .001$) between mean scores and respective standard deviations (as an indicator of pooled variance) obtained for all quantifiers and all tested languages, with an exception of *half*, for which, because of its extremely narrow acceptability range, not enough datapoints were available for reliable modeling. Another important exception was English *some,* for which the correlation is much less robust, if at all ($R=-0.53$). The observed negative correlations per quantifier per language are illustrated in Figure 7. The correlations can also be visually tracked in Figures 2-6 as mirror image patterns of mean scores and respective standard deviations, observed in the relevant acceptability range between 3 and 5 (on the latter, see above). In other words, within the acceptability range, the higher the mean score, the lower the standard deviation, and conversely (we stress that the observed correlation limited to the 3-5 score range is posthoc and as such could not have affected our choice of the threshhold acceptabilty value; a similar threshholding methodology was also used in an earlier study of Stateva and Stepanov 2017).

We also checked whether the relationship between the mean and standard deviation was truly linear or close to linear, by applying the one-sample Wald–Wolfowitz runs test to the data pertaining to each individual quantifier. This algorithm makes use of 'runs' defined as sequences of adjacent equal observations that are followed and preceded by different observations or by no observation at all. The algorithm thus counts the number of runs and

compares the result to the expected value under the null hypothesis - namely that of independence. The test was implemented via the respective function in the R *pracma* package.

The residuals were obtained via running a linear regression of standard deviation on mean scores for each individual quantifier per language. To control for a familywise error, that is, to keep the chance of making a Type I error at about 5% within each quantifier / language data set, we applied Bonferroni's correction by using a significance level of .05 divided by the respective number of participants in the given data set. The results of the test supported our hypothesis that the relationship between mean and standard deviation is linear: out of 19 tested quantifiers, only one data set demonstrated a violation from the null hypothesis, namely, pertaining to the English (only) *some*.

3.5 Discussion

The reported study demonstrated a lot of unanimous decisions of quantifier evaluation across languages. In most cases it looks like participants intuitively follow a similar mechanism of rough estimation of the proportions and match the outcome against a given quantifier. We can hypothesize that if numerical bounds are related to these determiners are stable, these bounds have a universal character (as much as such a generalization is warranted with observation from a small language sample of 4 languages). However, we believe that the point of divergence related to *some* could serve as a basis for a more general evaluation of the nature of quantifiers and a focus on the properties of *some* and its counterparts in the other languages will ultimately shed light on the four questions which motivated this study.

In order to get a clearer understanding of peculiar difference between *some*, on the one hand and the other existential quantifiers in French, Slovenian and German, on the other we will look for other patterns of divergence. Recall that the standard semantic-pragmatic theory views the existential quantifier as a trigger of the quantity related implicature. Below we report the results of a second experiment which juxtaposes English and French, as a representative of the group of languages that showed a similar processing pattern of their existential quantifier in Experiment 1.

4. Experiment 2

4.1. Implications for the derivation of scalar implicatures

As we saw, there seems to be a difference between English *some* and its counterpart in French, Slovenian and German. While in the other languages the quantifier is best used for an interval between *a few* and *half*, English *some* is best used for an interval between *a few* and *almost all*. This opens a lot of interesting questions, which have to do with whether this should be seen as a refutation of Grice's Modified Ockham Razor (in as much as the lexical meaning of the quantifier does not correspond to the logical entailment from *all* to *some*) or as a matter of typicality (see van Tiel 2014), though this would raise the further question of why English would pattern differently from other European languages, including German. But the main question we want to raise here is whether this difference between English *some* and its counterparts impacts the derivation of scalar implicatures. We choose to test this question by comparing English *some* and French *quelques* in a simple picture choice test.

4.2. Experimental design

We choose a picture choice test paradigm in preference to the more frequently used sentence evaluation task paradigm (see, e.g., Noveck 2001, Bott and Noveck 2004) for a number of reasons. Notably, in a sentence evaluation task, the relevant condition is the one where *some* is under-informative, as it is the only one that allows one to differentiate between the pragmatic and the semantic interpretations. However, there are quite a few problems with that task, the first being that the rate of pragmatic answers (which ranges between 40% and 60%) is not clearly different from chance, given that participants have to choose between two answers (putting chance at 50%). This suggests that the infelicity of the experimental condition leads participants to random answers. Another problem is that it is not clear that the task allows a reliable distinction between pragmatic answers (negative) and semantic answers (positive) (see Guasti et al. 2005, Reboul et al. in preparation). Thus, a picture choice task, which offers a reliable distinction between the pragmatic and the semantic answers and avoids the difficulty linked to infelicity seemed by far a better choice. In essence, participants are presented with a sentence with a quantified NP (in the object position) and are asked to choose which among two pictures best corresponds to the sentence. In the *some* condition, one picture illustrates the pragmatic interpretation and the other illustrates the semantic interpretation. We tested French and English native speakers, as we will now describe. To avoid the confound raised by the entailment from *all* to *some*, participants were allowed a single answer. In addition to the *some* experimental condition, we also had an *only some* experimental condition. As Marty and Chemla (2013) have noted, the pragmatic interpretation of *some* has the same content as *only some*, the difference between the two being only the fact that the pragmatic interpretation is implicit. They used thus a comparison between *some* and *only some* and we followed their example.

4.3. Experimental material

The experiment was composed of three main conditions, exemplified in Figures 8-10 in Appendix B:

- one control condition, using *all* (4 items);
- two test conditions:
    - *only some* (8 items);
    - *some* (8 items);
- 4 filler conditions with 4 items each:
    - *half*;
    - *exactly one*;
    - *exactly two*;
    - *exactly three*.

In the *some* condition, one image corresponds to the pragmatic interpretation and the other to the semantic interpretation, as Figure 8 exemplifies. In all other conditions, including fillers, one image verified the sentence, while the other falsified it. Figure 9 exemplifies an example of the other experimental condition, *only some*. As for the control condition, the evaluated sentences contained *all*, as illustrated in Figure 10. The "correct" choice was presented either on the left or on the right in a counterbalanced way.

4.4. Participants

29 French participants were students from the University of Lyon, aged between 18 and 30 (mean age = 21.9; 17 females). They were all native speakers of French. In addition, 34 English participants were recruited through the Prolific platform. They were all students, aged between 18 and 30 (mean age = 23.1; 18 females).

4.5. Procedure

The experiment was presented online on the Qualtrics platform. It began with a short introduction, where participants indicated sex, age, student status and confirmed that they were native speakers of French or, respectively, English. They were given instructions as well as an example of the task. They then proceeded to the experiment itself. The whole process lasted ten to fifteen minutes at the most.

4.6. Results and discussion

4.6.1. Data treatment and exclusion

Exclusion was based on more than 5 items failed in either the control or the filler conditions. No participants were excluded.

3.6.2. Response analysis

The rates of response in choosing a pragmatic answer are summarized in Figure 11.Comparing the response rates of choosing a pragmatic interpretation in English and French, we find that French and English participants behave similarly in the *all* control condition choosing pragmatic answers in virtually all cases (French: 99,13%, English: 100%; chi-square test: $\chi^2(1) = 0.002$, $p = 0.96$, no significant difference at the 0.05 level) and in the *only some* test condition (French: 94,39%, English: 92,64%; $\chi^2(1) = 0.021$, $p = 0.88$). However, they behaved very differently in the *some* test condition, whereby French participants chose the pragmatic interpretation at a higher rate than did the English participants (French: 92,24%, English: 57,30%; $\chi^2(1) = 11.901$, $p = 0.0005$) and at a rate similar to that of their interpretation of *only some*. Correspondingly, French participants did not differ in their response rate on *some* and *only some* conditions ($\chi^2(1) = 0{,}029$ $p = 0.86$), while English participants showed a significantly greater preference for the targeted answer on the *only some* condition compared to the *some* condition ($\chi^2(1) = 13.9040$, $p = 0.0003$).

4.6.3. Discussion

We tested French and English participants in the simple image-choice task for three main conditions: an *all* control condition, a target *only some* condition, and a target *some* condition. This last condition was intended to establish whether French and English participants draw the scalar implicature at the same rate despite the difference in the interval inside which, respectively, *quelques* and *some* are best used in the two languages. It appears that they do not.

5. General discussion

There are two general patterns that emerge from the cross-linguistic studies we report. The first one is that French, Slovenian and German counterparts of *few, half, most* and *almost* are assigned very similar numerical bounds. The second one is that *some* and its variants like *quelques* are different in more than one way, namely: i) with respect to numerical bounds, and ii) with respect to their potential to trigger a scalar implicature.

In what follows we attempt to account for these facts by arguing that the set of quantifiers viewed as a natural class by the standard semantic-pragmatic theory is, in fact, diverse and the set-theoretic semantics is not appropriate for all of its members. As a consequence, the mechanism of pragmatic enrichment that these items trigger is of a different nature. Finally, we will argue that it is possible that languages do not assign the same kind of semantic definition to determiners that might, from a cross-linguistic perspective, look like translational equivalents.

We start with the point that not all quantifiers quantify over sets of individuals. There have been numerous proposals in the semantic literature that argue against the standard set-theoretic analysis and in favor of a degree-based analysis for some items. Classical cases involve *most, many, much, few, half* (cf. Hackl 2009, Rett 2008/2015, Solt 2009/2015, etc.). However, if we assume that these particular quantifiers have a different semantic nature, we might face a challenge in restricting the application of those pragmatic principles which rely on the availability of semantic alternatives that constitute a natural class. Crucially, this affects the derivation of quantity-based implicatures. Of course, all determiners that we have considered so far, including the ones we did not test like *every, all, no*, etc. have the same brevity and thus satisfy the basic criterion for serving as a source of a scale of alternatives (cf. Levinson 1983, 2000). However, a stricter requirement on their semantic make-up can leave some of these determiners outside of the set of possible alternatives to *all/every*, for example. But even if this is so, the results from our experiment 1, as well as the results from the other psychometric and typicality-based studies indicate that the meanings of degree-based determiners are pragmatically enriched because they differ from the respective truth-conditional meanings. So if quantity implicatures are not always available for pragmatic enrichment in the domain of quantifiers, how can one account for pragmatic strengthening in all degree-based quantifiers?

A possible answer comes from a proposal in Stateva and Stepanov (2017). That proposal extends Krifka's (2007a) analysis of negated antonyms (like *happy, not happy, unhappy, not unhappy*) to the domain of the Slovenian degree quantifiers *precej* and *veliko*, both of which are counterparts of the English *many*. The gist of the proposal is that *precej* and *veliko* are semantically equivalent but their meanings are differentiated as a result of pragmatic enrichment through an M-implicature and an R/I-implicature, respectively. R/I-implicatures are associated with a stereotypical interpretation while M-implicatures are related to non-stereotypical interpretations (Horn 1984, Levinson 2000). A prerequisite for the Krifka-type analysis is a state of affairs in which there is at least one pair of antonyms so that together they exhaust a relevant degree scale as contradictories. Since degree predicates are vague, the cut-off point is related to epistemic uncertainty for the speaker (Williamson 1994). In the availability of synonyms in the positive or the negative extension of the scale, as is the case with the two Slovenian positive amount words *precej* and *veliko* that are antonyms to the negative *malo* 'few', a stereotypical interpretation, i.e. an interpretation which is related to a segment of the positive scale which is at a safe distance from the potential cut-off point is assigned to one of the synonyms as an R/I-implicature. The stereotypical interpretation is then always closer to the endpoint of the scale than the non-stereotypical interpretation which results from the application of an M-implicature. If we generalize on the basis of the Slovenian case involving the two quantifiers *precej* and *veliko*, we will have a potential mechanism of pragmatic enrichment of other degree quantifiers which are part of a paradigm that contains at least one antonym and at least one synonym to them.

Very importantly, the above suggestion does not exclude quantity implicatures in the degree domain in general. Under a strict version of restricting scalar alternatives, we expect that, for example, *most* and *all* should not be members of a Horn-set given that one involves quantification over degrees and the other, quantification over individuals but the two degree-based quantifiers *most* and *almost all* would. This would explain why the upper part of the degree scale is not accessible for *most* (although the truth-conditional meaning of *most* is compatible with it). Arguably, *most* triggers a scalar implicature that negates the *almost-all* alternative.

We now have the ingredients for a proposal that explains the facts from the reported experiments. We would like to suggest that the existential quantifiers that we tested are of different semantic nature and because of that they are subject to different processes of pragmatic strengthening. To English *some* we attribute the standard semantic meaning as relating two sets of individuals. The results from both Experiment 1 and Experiment 2 suggest that *some* is pragmatically enriched with a scalar implicature. This hypothesis is confirmed i) by the larger acceptability interval on the proportion scale for *some* in comparison to the rest of the tested existential quantifiers where *some* covers also very high ratios, as predicted, and ii) by the lower rate of scalar implicature derivation associated with *some* in comparison to *quelques* which is also expected given the optional character of scalar implicatures. As for the counterparts of *some* in French, Slovenian and German, we would like to suggest that they are degree-based quantifiers, lexically synonymous to the lexical items corresponding to *few* in each of the languages and antonyms of the lexical items corresponding to *many*. In this analysis, the French *quelques*, Slovenian *nekaj* and German *einige* are associated with the lower part of the degree scale while the respective counterparts of *many* in each language are associated with intervals above the cut-off point. All three languages have a lexical version of *few* which competes with *quelques*, *einige* or *nekaj* for the stereotypical or non-stereotypical interpretation. Our results from Experiment 1 suggest that *quelques*, *einige* and *nekaj* are pragmatically enriched with the non-stereotypical implicature and are thus at a greater distance from the scale and-point in comparison to the stereotypically interpreted counterpart of *few*. Some overlap within synonym pairs in each of the languages is always expected due to epistemic uncertainly because of the vague character of quantifiers that do not denote end points. In much the same vein in which speakers are uncertain about the cut-off point on a relevant scale between two antonyms and simultaneously have a whole set of potential cut-off points under consideration speakers entertain a set of cut-off points within the scale part associated with the pair of synonyms. As a result of epistemic uncertainty, there are overlaps in all zones coinciding with potential points of delineation.

This explanation gets further support from the results of Experiment 2. Recall that in the Picture-Choice task, French speakers were at ceiling with the choice of the pragmatic meaning while English speakers had a significantly lower rate of choosing the pragmatic answer in comparison to the French speakers. These facts are consistent with the hypothesis that the pragmatically enriched English target sentence results from a scalar implicature negating the *all*-alternative which is only optional (Chierchia 2013). When the implicature is forced by the explicit use of *only*, speakers responded in accord with expectations and performed at ceiling, too. The relevant pragmatic alternative for the French speakers in the target condition is, in fact, not based on *all* but rather on *few* and so the non-targeted answer did not interfere in this case.

The proposal makes a prediction for the relation between *many* and *some* and their respective counterparts. These items are a pair of antonyms in French/Slovenian/German-type languages.

This entails some overlap region on the degree scale corresponding to the zone where different cut-off points are under consideration because of epistemic uncertainty but the overlap cannot be too large. As for English, *some* and *many* can partially overlap to a greater extent. We have indirect confirmation of this prediction from Experiment 1: as we saw previously, unlike its counterparts, English *some* is acceptable in contexts with very high proportions bordering the region reserved for the upper part of *most* and *almost all*. This interval can be reasonably expected to contain the interval allotted to *many*.

This is the stronger version of the proposal we want to push forward. A weaker version of it would not exclude scalar implicatures based on entailment relations even among the members of the class of quantifiers that are triggers of R/I-implicatures or M-implicatures in French/Slovenian/German i.e. among the counterparts of *some*, *few* and *many*. To give substance to this possibility we can refer to Chemla (2007) and Buccola et al (2018) which suggest that scales of alternatives are based on concepts rather than lexical elements. If this is so, a Horn-set of alternatives can well be formed by quantifiers that do not denote functions of the same semantic type. Under this weaker proposal, however, the availability of M-implicature for the French, Slovenian and German counterparts of *some* in contrast to the R/I-implicature triggered by the counterparts of *few* would trivialize the effect of quantity induced implicatures which, in this case, would not be necessary to explain the facts about the existential quantifier cross-linguistic differences we observe in Experiments 1 and 2.

Before we conclude this discussion, we would like to mention two facts that could serve as independent evidence for our proposal. The first one is based on an observation about the morphological makeup of the plural morphology paradigm in Bulgarian. Bulgarian features two plural nominal agreement patterns in the masculine paradigm. The default case is a plural ending that agrees with the plural morpheme of any adjectival modifier within the nominal phrase. The second one, known as the 'count form', is non-agreeing, and is selected if the noun is preceded by a numeral (cf. Stoyanov 1980, Stateva and Stepanov 2016, etc.). Both plural patterns are exemplified in (2a) in (2b), respectively:

(2) a. Červen-**i** (dârven-**i)** prozorc-**i**
red- pl wooden-pl window-pl
"red (wooden) windows"

b. Pet (dârven-**i)** prozorec-**a**
five wooden-pl window-count
"five (wooden) windows"

Interestingly, the count form is also used when the noun contains the existential quantifier *njakolko* 'some' but not when it contains the universal one *vsichki* 'all', as shown in (3):

(3) a. Njakolko (dârven-**i)** prozorec-**a/** *prozorc-**i**
some wooden-pl window-count/window-pl
"some wooden windows"

b. Vsichki (dârven-**i)** prozorc-**i**/*prozorec-**a**
all wooden-pl window-pl. /window-count
"all wooden windows"

The parallel between numerals and *njakolko* indicates that they belong to the same natural class to the exclusion of *vsichki*. The possibility of having a numeral-like existential quantifier in one language suggests a similar possibility for other languages even in the absence of morphological makeup indicative of the specific semantic nature of the quantifier.

Second, our proposal can account for the observation that numerical bounds of vague quantifiers depend on the cardinality of the total set. If pragmatic enrichment of degree-based quantifiers that come in pairs of antonyms and synonyms depends on delineation between lower and upper scale parts, as well as on interval assignment to stereotypical and non-stereotypical, we can expect that partitioning in a closed scale of this kind will involve a lot of overlaps. This is so because each interval to which a quantifier is related in this case ends up being too small to be distinguished from the neighboring ones, especially in view of epistemic uncertainty. It follows then that different numerical bounds are associated with the same quantifier in small and larger sets where competing alternative quantifiers are assigned to greater scale intervals.

6. Conclusion

We conclude by going back to the questions we posed in Section 3. We started with the question of whether it is possible to identify the different quantifiers' numerical bounds and whether these are encoded in quantifier meanings or are epiphenomenal. The answer that follows from our discussion is that numerical ranges are epiphenomenal: they result from pragmatic strengthening and no additional meaning component needs to be postulated in order to account for the difference between lexical meanings and actual judgments in tasks.

We believe that the cross-linguistic perspective that we added to this study sheds light on the question of whether quantifier meanings can be given the status of a semantic universal (Determiner Universal, Barwise and Cooper 1981). If our interpretation is correct, the existential quantifier is a source of considerable cross-linguistic variation.

We identified two types of pragmatic enrichment processes that are operative in the domain of quantifiers: quantity based enrichment through scalar implicatures, and stereotypical and non-stereotypical meaning enrichment through R/I-implicatures and M-implicatures. Under a stricter version of the proposal these are in complementary distribution within the quantifier paradigm. Under a weaker version, both processes are operative but in some cases the effect of quantity induced implicatures is trivialized.

Finally, we come to the question of overlapping meanings. We argued that meaning overlap is language dependent and is less likely to be expected in cases that involve pragmatic strengthening through R/I- and M-implicatures.

References:

Barwise, J. and Cooper, R. (1981). Generalized quantifiers in natural language. Linguistics and Philosophy 4, 159-219.

Bott, L. & Noveck, I.A. (2004). Some utterances are underinformative: The onset and time course of scalar inferences. *Journal of memory and Language.* 51, 437-457.

764 Buccola, B., Križ, and Chemla, E. (2018). Conceptual alternatives: competition in Language
765 and beyond. Ms. url: *https://ling.auf.net/lingbuzz/003208/current.pdf*
766 Chemla, E. (2007). French both: A Gap in the Theory of Antipresupposition. *Snippets* 15, 4-5.
767 url: http://www.ledonline.it/snippets/allegati/snippets15001.pdf.
768 Chierchia, G., Fox, D., and Spector, B. (2012). "Scalar implicature as a grammatical
769 phenomenon," in *An international handbook of natural language meaning semantics*,
770 eds. P. Portner, C. Maienborn, and K. von Heusinger, Berlin: Mouton de Gruyter,
771 2297-2331.
772 Chierchia, G. (2013). *Logic in Grammar: Polarity, Free Choice, and Intervention.* Oxford.
773 Oxford University Press.
774 Cummins, C. (2014). Typicality made familiar, *Semantics and Pragmatics*, 7:8, 1-15.
775 Daamen, D. D. L. and de Bie, S. E. (1991). "Serial context e.ects in survey interviews", In
776 *Context effects in social and psychological research*, eds. N. Schwarz and S. Sudman,
777 New York: Springer-Verlag.
778 de Carvalho, A., Reboul, A., Van der Henst, J.-B., Cheylus, A., and Nazir, T., (2016). Scalar
779 implicatures: The psychological reality of scales. *Frontiers in Psychology*, 7:1500,
780 doi: 10.3389/fpsyg.2016.01500
781 Foppolo, F., and Guasti, M.T. and Chierchia, G. (2012). Scalar implicatures in child
782 language: give children a chance. *Language Learning and Development* 8, 365-394.
783 Fuhrmann, G. (1991). Note on the integration of prototype theory and fuzzy-set theory.
784 *Synthese*, 86, 1-27.
785 Gergel, R., and Stateva, P. (2014). A decompositional analysis of *almost* : diachronic and
786 experimental comparative evidence. In *pre-proceedings of the International*
787 *Conference Linguistic Evidence 2014, Tübingen*, Tübingen: Eberhard Karls
788 Universität, 2014, 150-156.
789 Grice, P. (1989). *Studies in the Way of Words*. Cambridge, MA: Harvard University Press.
790 Guasti, M. T., G. Chierchia, S. Crain, F. Foppolo, A. Gualmini and Meroni, L. (2005) Why
791 children sometimes but not always compute scalar implicatures. *Language and*
792 *Cognitive processes*. 20, 667-676.
793 Hackl, Martin. 2009. On the grammar and processing of proportional quantifiers: most versus
794 more than half. Natural Language Semantics 17:63–98.
795 Horn, L. (1984). "Toward a new taxonomy for pragmatic inference: Q-based and R-based
796 implicature," in *Meaning, form, and use in context: Linguistic applications*, ed. D.
797 Schiffrin, Washington DC: Georgetown University Press, 11-89. Horn, L.R. (2004).
798 Implicature. In L.R. Horn, & G. Ward (eds.), *The Handbook of Pragmatics* (3-28).
799 Oxford: Blackwell Publishing.
800 Levinson, S. (1983). *Pragmatics*. Cambridge: Cambridge University Press.
801 Levinson, S. (2000). *Presumptive Meanings: The Theory of Generalized Conversational*
802 *Implicature. Language, Speech, and Communication*. Cambridge, MA: The MIT Press.
803 Krifka, M. (2007a). "Negated antonyms: Creating and filling the gap," in *Presupposition and*
804 *implicature in compositional semantics*, eds. U. Sauerland and P. Stateva, Palgrave,
805 163-177.
806 Krifka, M. (2007b). "Approximate interpretations of number words: A case for strategic
807 communication.", in *Cognitive foundations of interpretation*, ed. G. Bouma, I. Krämer
808 and J. Zwarts, Amsterdam, Royal Netherlands Academy of Arts and Sciences, 111-
809 126.
810 Marty, P. P. and Chemla, E. (2013). Scalar implicatures: Working memory and a comparison
811 with *only*, Frontiers in Psychology, 4:403. doi: 10.3389/fpsyg.2013.00403Moxey, L.
812 and Sanford, A.J. (1993) Prior expectation and the interpretation of natural language
813 quantifiers, European Journal of Cognitive Psychology, 5:1, 73-91.

Moxey, L. and Sanford, A.J. (2000). Communicating Quantities: A Review of Psycholinguistic Evidence of How Expressions Determine Perspectives. *Applied cognitive psychology* 14: 237-255.

Newstead, S.E., Pollard, P. and Riezebos, D. (1987). The effect of set size on the interpretation of quantifiers used in rating scales. Applied ergonomics, 18,178-182.

Noveck, I.A. (2001). When children are more logical than adults: Experimental investigations of scalar implicatures. *Cognition* 78, 165-188.

Penka, D. (2006). Almost there: The meaning of *almost*. In Proceedings of *Sinn und Bedeutung 10*, 275-286.

Reboul, A. et al (in preparation). The cost of scalar implicate: inference or infelicity?

Rett, J. (2008). *Degree modification in natural language*, Rutgers University, PhD dissertation.

Rett, J. (2015). *The semantics of evaluativity*. Oxford University Press.

Rosch, E. (1975) Cognitive representations of semantic categories. *Journal of experimental psychology*, 104:3, 192-233.Solt, S. (2009). *The semantics of adjectives of quantity*, City University of New York, PhD dissertation.

Solt, S. (2015). Q-adjectives and the semantics of quantity. *Journal of Semantics* 32:2, 221-274.

Sperber, D., and Wilson, D. (1995). *Relevance: Communication and Cognition*. Oxford: Basil Blackwell.

Stateva, P. and Stepanov, A. (2016). Agreement errors and structural distance: A corpus study of Bulgarian. Zeitschrift für Slawistik 61:3, 448–462.

Stateva, P. and Stepanov, A. (2017). Two "many"-words in Slovenian : experimental evidence for pragmatic strengthening. Acta linguistica academica : an international journal of linguistics, 64:3, 435-473.

Stoyanov, S. (1980) *Gramatika na balgarskiya knizhoven ezik. Fonetika i morfologiya* [Grammar of the Bulgarian Literary Language. Phonetics and Morphology]. Sofia: Nauka i izkustvo.

Van Tiel, B. (2014). Embedded scalars and typicality. *Journal of Semntics*, 31, 147-177.

Van Tiel, B. & B. Geurts. (2014). Truth and typicality in the interpretation of quantifiers. In Urtzi Etxeberria et al. (eds.), *Proceedings of Sinn und Bedeutung 18*, 433-450.

Wallsten, T.S., Budescu, D.V., Rapoport, A., Zwick, R., and Forsyth, B. (1986). Measuring the vague meanings of probability terms. Journal of Experimental Psychology: General, 115,348-365.

Wallsten, T. S., Budescu, D. V. and Zwick, R. (1993a). Comparing the calibration and coherence of numerical and verbal probability judgements. Management Science, 39, 176-190.

Williamson, T. (1994). *Vagueness*. London: Routledge.

Yildirim, I., J. Degen, M. K. Tanenhaus, and T. F. Jaeger (2013). Linguistic variability and adaptation in quantifier meanings. In M. Knauff, M. Pauen, N. Sebanz, and I. Wachsmuth (Eds.), *Proceedings of the 35th Annual Conference of the Cognitive Science Society*, 3835–3840.

APPENDIX A

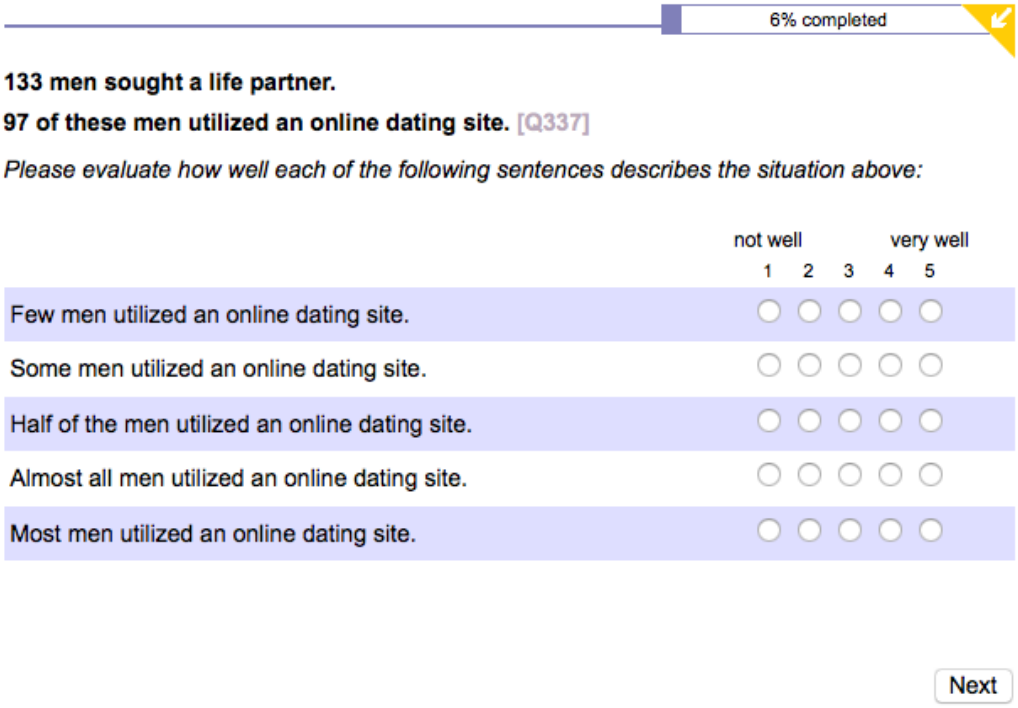


Figure 1. An example of the stimulus screen, Experiment 1.

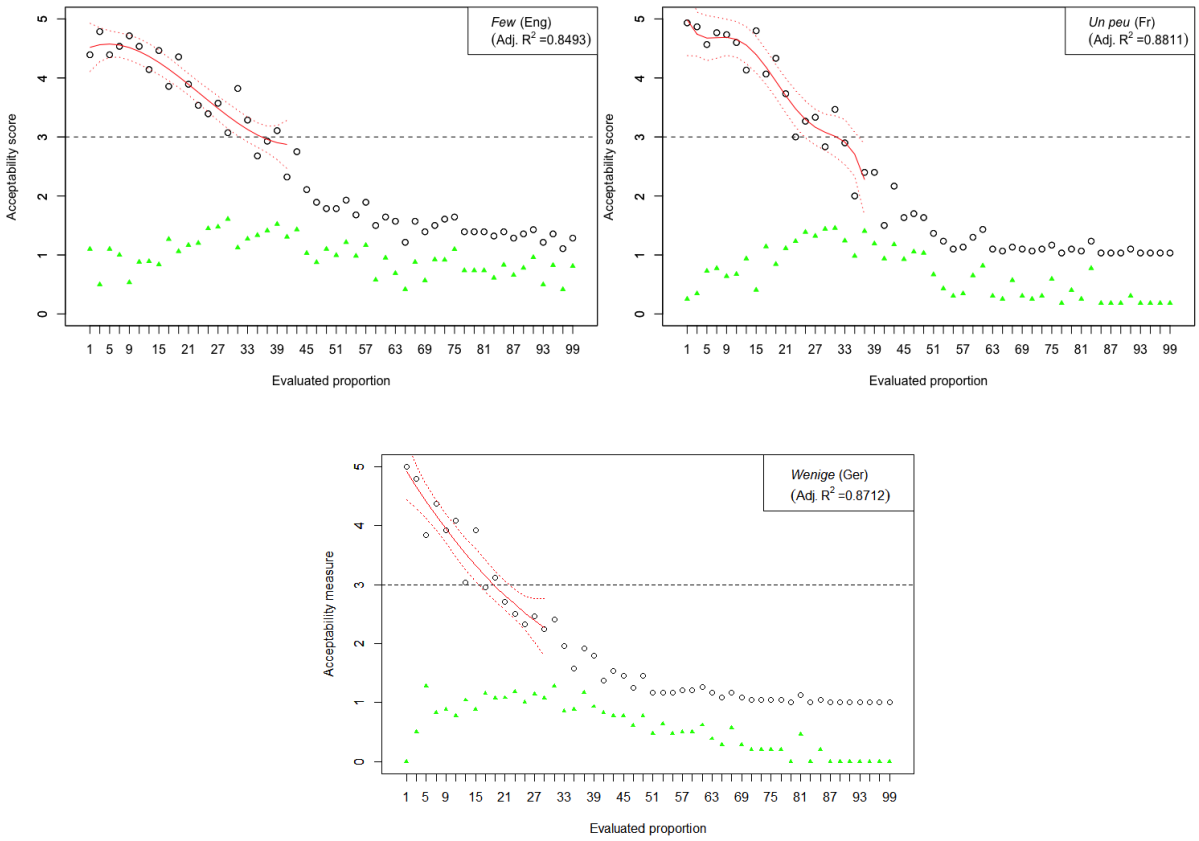


Figure 2. Experiment 1: mean acceptability scores on ***few*** and its cross-linguistic variants in the three tested languages (absolute values of standard deviation for respective means are shown in green), together with respective polynomial fit curves and confidence intervals (in red) predicting acceptability in the upper half of the Likert scale.

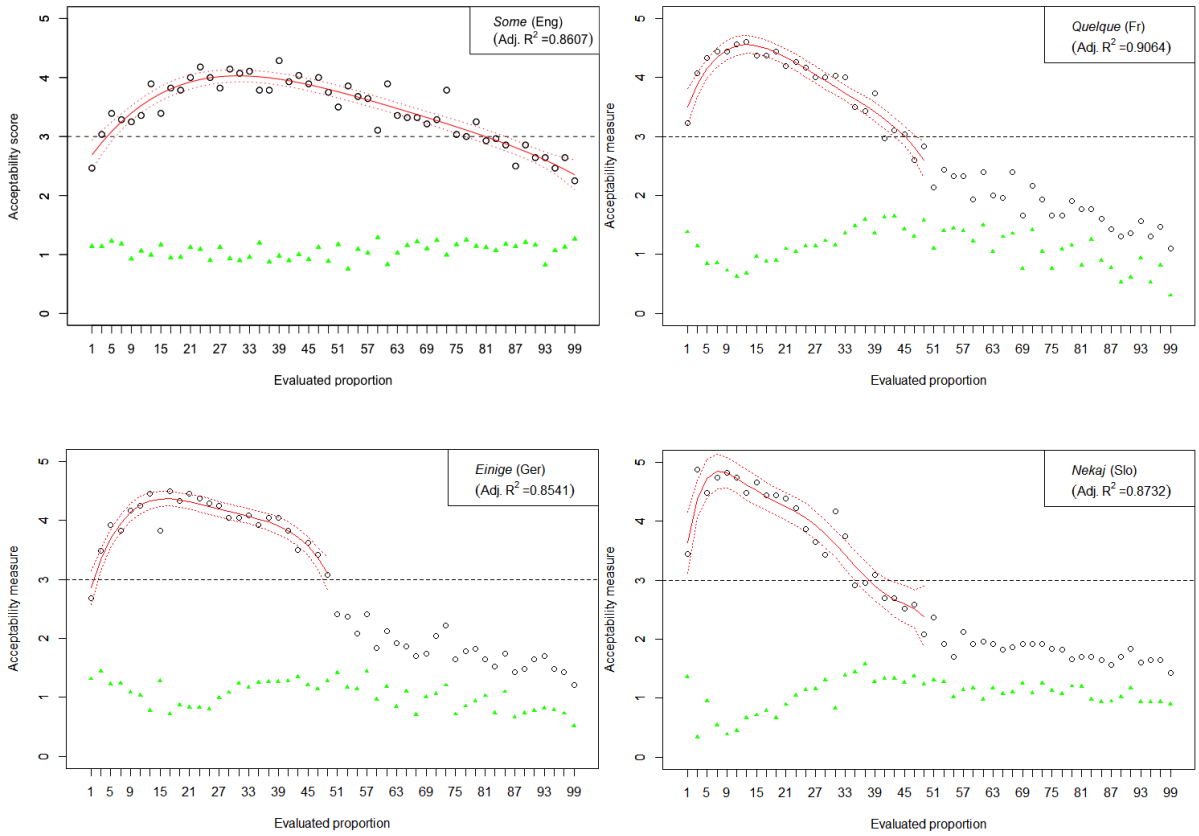


Figure 3. Experiment 1: mean acceptability scores on ***some*** and its cross-linguistic variants in the four tested languages (absolute values of standard deviation for respective means are shown in green), together with respective polynomial fit curves and confidence intervals predicting acceptability in the upper half of the Likert scale.

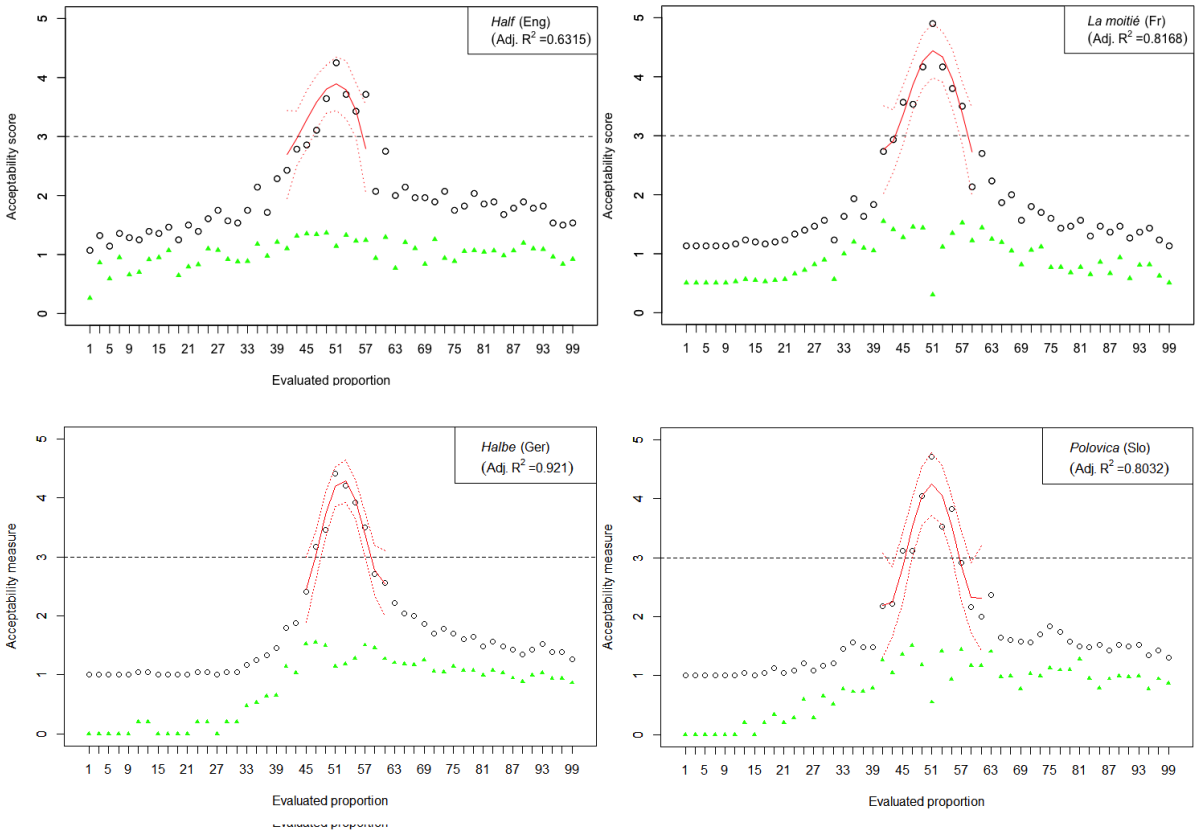


Figure 4. Experiment 1: mean acceptability scores on ***half*** and its cross-linguistic variants in the four tested languages (absolute values of standard deviation for respective means are shown in green), together with respective polynomial fit curves and confidence intervals predicting acceptability in the upper half of the Likert scale.

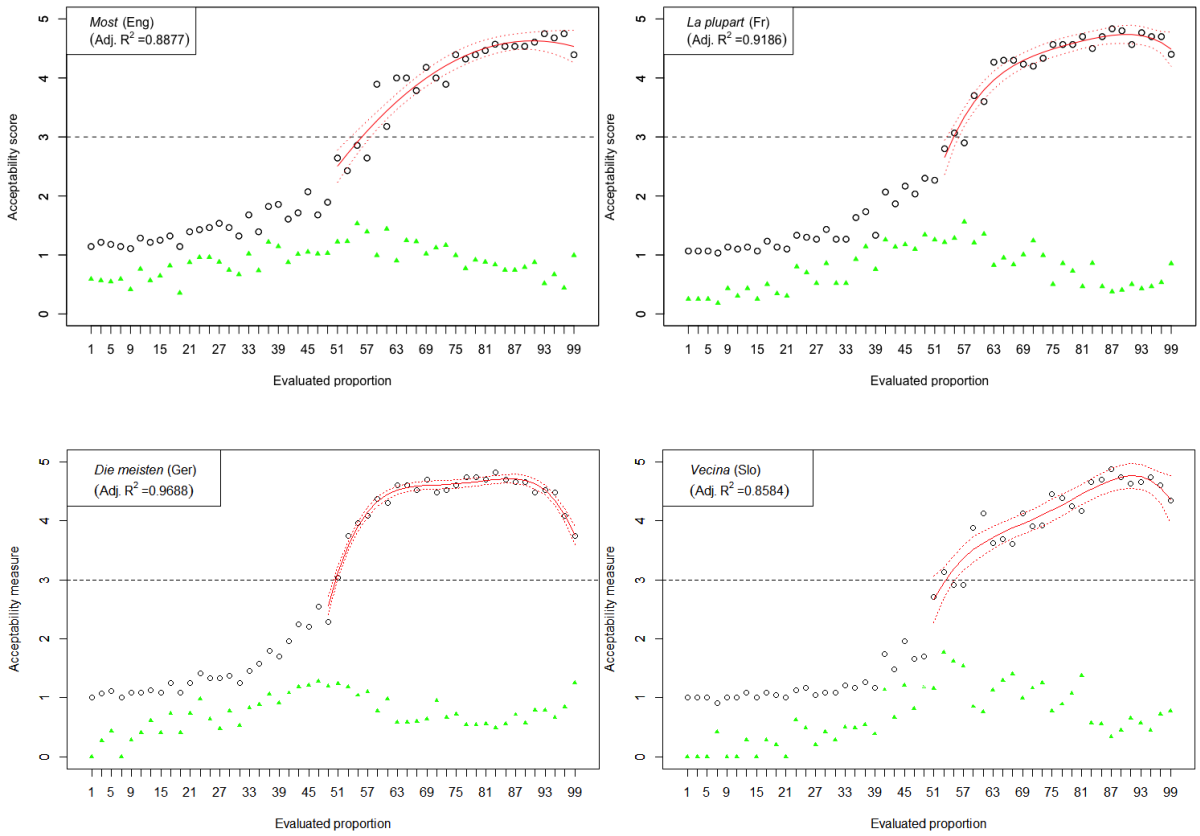


Figure 5. Experiment 1: mean acceptability scores on ***most*** and its cross-linguistic variants in the four tested languages (absolute values of standard deviation for respective means are shown in green), together with respective polynomial fit curves and confidence intervals predicting acceptability in the upper half of the Likert scale.

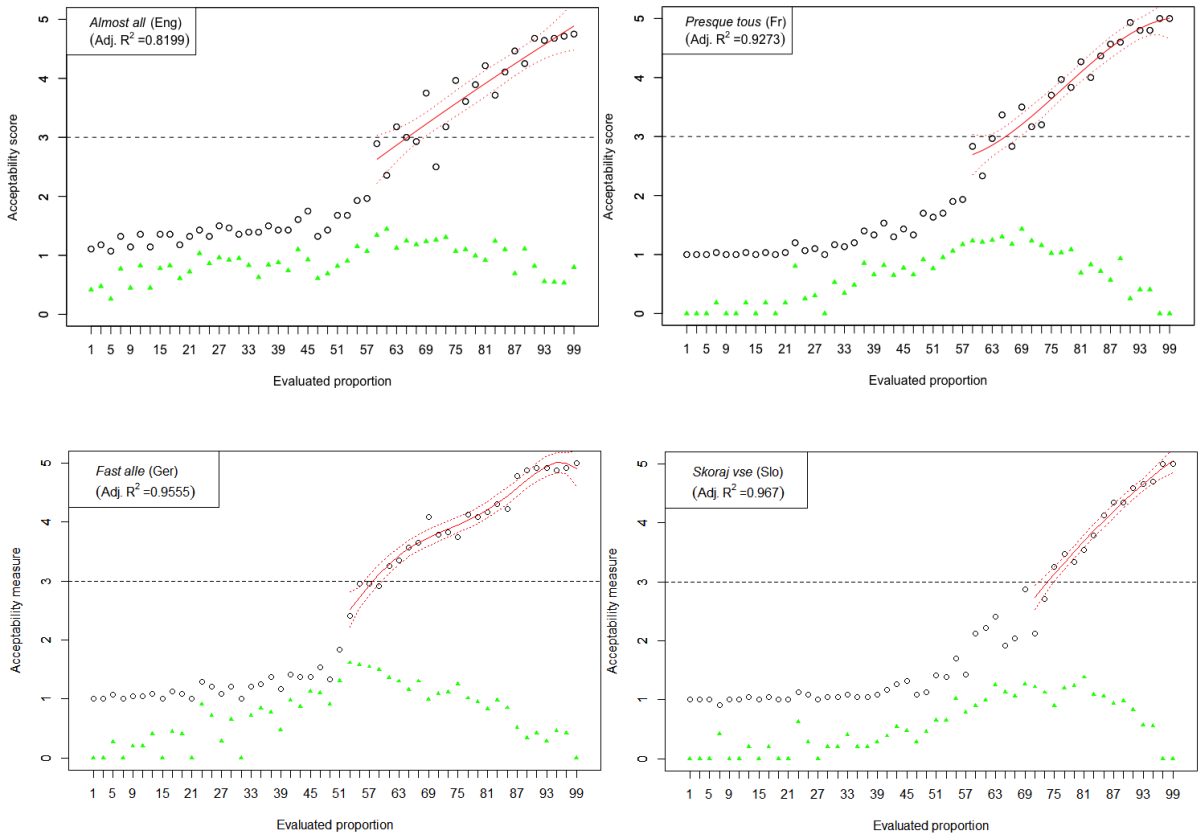


Figure 6. Experiment 1: mean acceptability scores on ***almost all*** and its cross-linguistic variants in the four tested languages (absolute values of standard deviation for respective means are shown in green), together with respective polynomial fit curves and confidence intervals predicting acceptability in the upper half of the Likert scale.

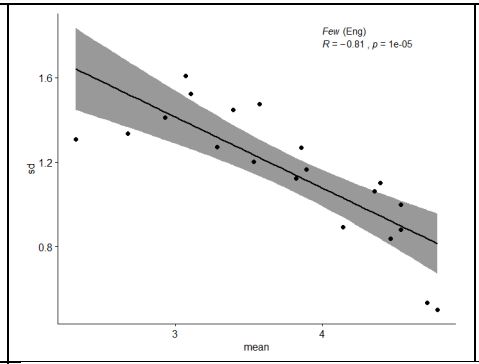
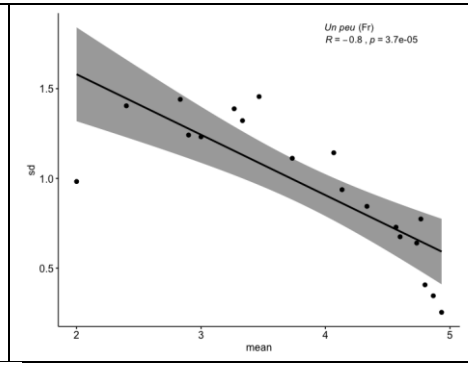
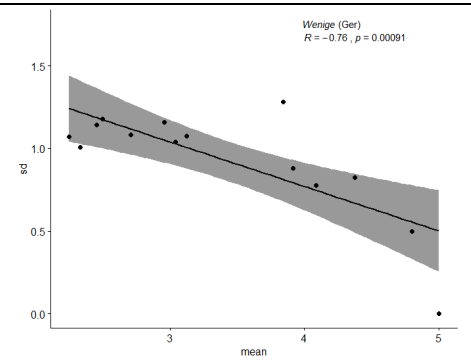
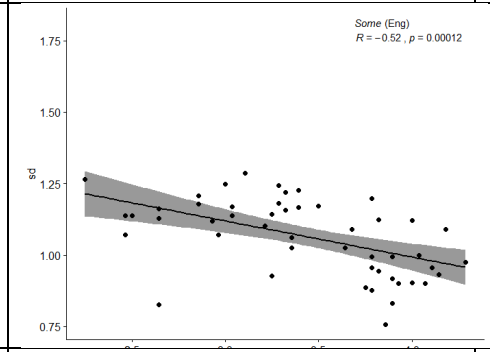
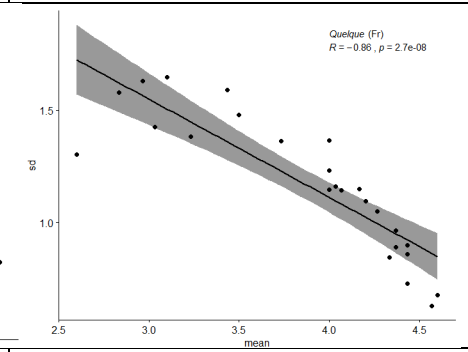
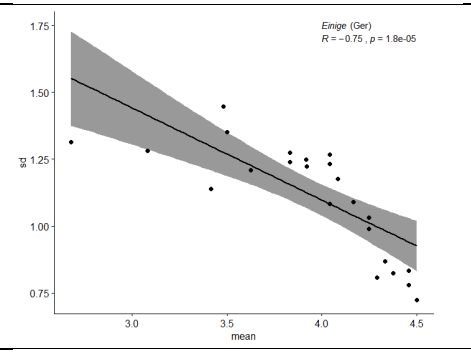
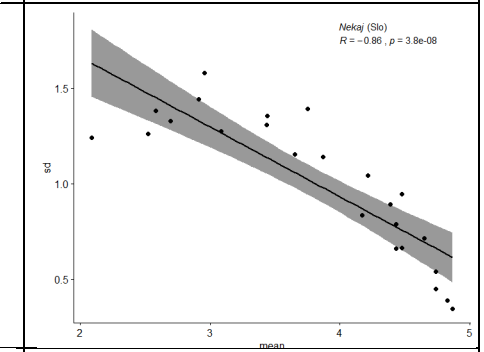
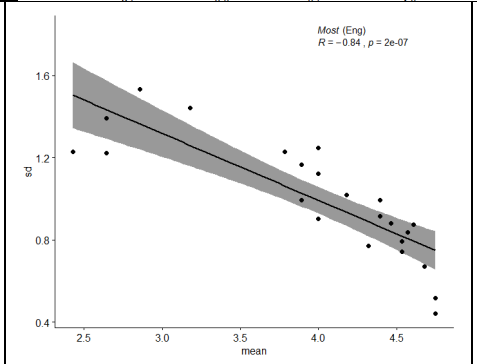
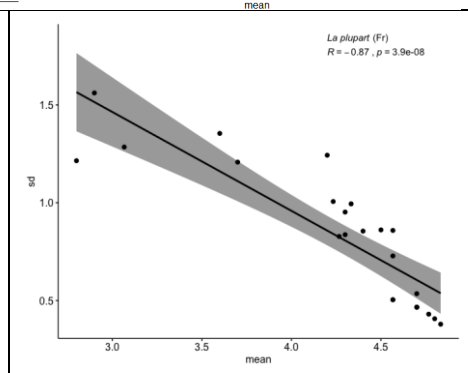
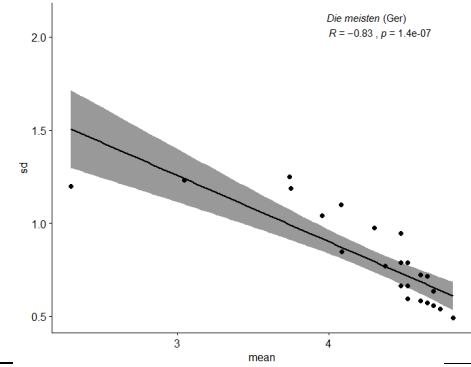
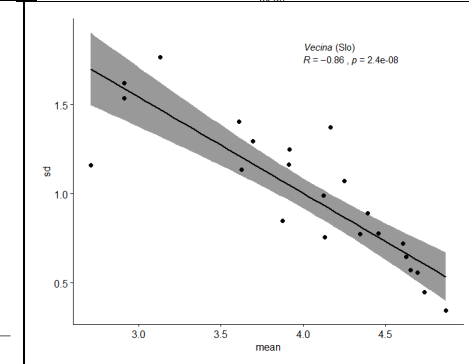
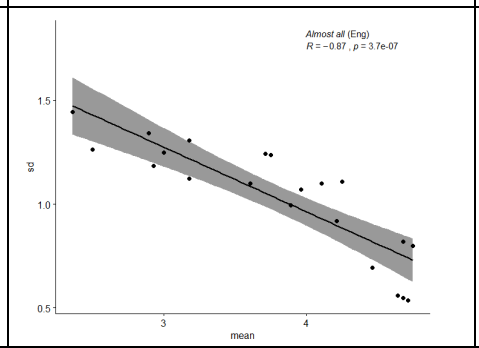
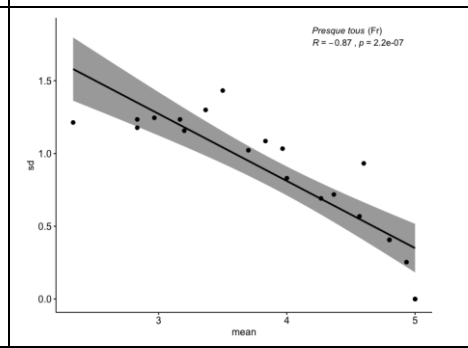
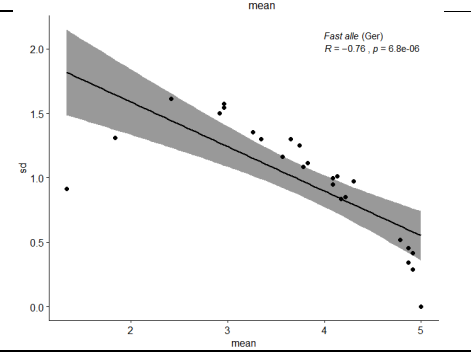
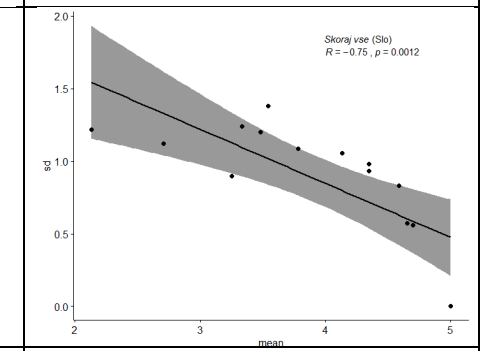
few				
some				
most				
almost all				
	ENGLISH	FRENCH	GERMAN	SLOVENIAN

Figure 7. Standard deviation in the collected score data vs. mean score (both in units on a Likert scale). Each graph represents the results on a particular quantifier in a particular language. Also shown are best fit lines, confidence interval, correlation coefficient value R and the respective *p* value for each quantifier.

APPENDIX B

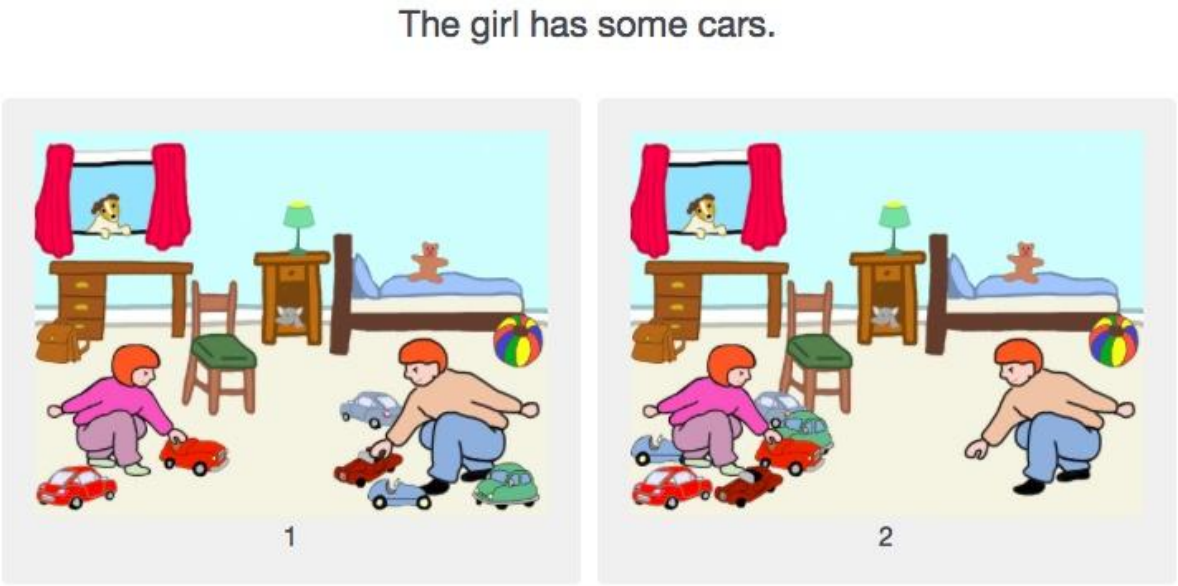


Figure 8. The *some* condition (pragmatic answer on the left, semantic answer on the right), Experiment 2.

Figure 9. The *only some* condition (the image verifying the sentence is on the left, the image falsifying it on the right), Experiment 2

Figure 10. The *all* condition (the image verifying the sentence is on the left, the image falsifying the sentence in on the left), Experiment 2

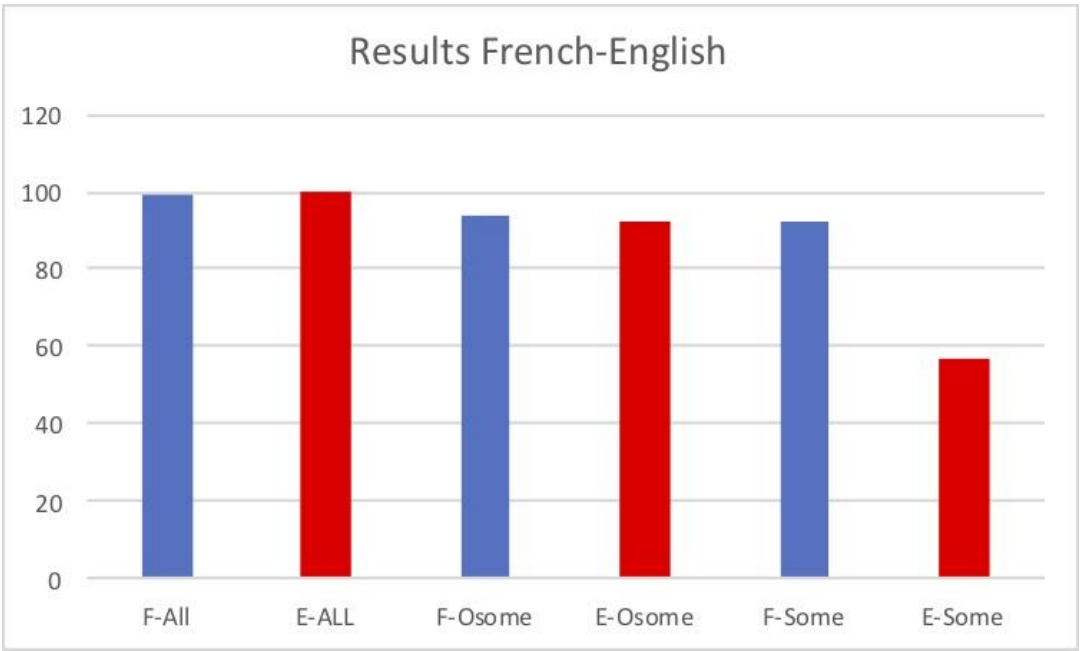


Figure 11. Response rates when choosing a pragmatic answer by French (blue) and English (red) participants (E=English; F=French; All = the *all* condition; Osome=the *only some* condition; *Some*=the *some* condition)