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Citation for published version:

Maier, R, Pickering, M & Hartsuiker, R 2016, 'Does translation involve structural priming?' Quarterly Journal of Experimental Psychology, pp. 1-15. DOI: 10.1080/17470218.2016.1194439

Digital Object Identifier (DOI):

[10.1080/17470218.2016.1194439](https://doi.org/10.1080/17470218.2016.1194439)

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Peer reviewed version

Published In:

Quarterly Journal of Experimental Psychology

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RUNNING HEAD: TRANSLATION-PRIMING

TITLE PAGE

Does translation involve structural priming?

Submission to: *Quarterly Journal of Experimental Psychology* (full standard article)

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ACKNOWLEDGEMENTS

The research reported in this article is part of the first author's unpublished 2009 PhD thesis at the University of Edinburgh and was supported by ESRC grant PTA-040-2004-000712. A subset of the data in Experiment 2 is published and discussed with particular focus on concerns of Translation and Interpreting research in Maier (2011). Experiment 1 and discussions of results in terms of their psycholinguistic relevance have not been published before.

ABSTRACT

When asked to translate utterances, people might merely make sure that their translations have the same meaning as the source, but they might also maintain aspects of sentence form across languages. We report two experiments in which English-German and German-English bilinguals (without specialist translator training) repeated German ditransitive sentences whose meaning was compatible with more than one grammatical form or translated them into English. Participants almost invariably repeated the sentences accurately, thereby retaining the grammatical structure. Importantly, Experiment 1 found that they tended to repeat grammatical form across languages. Experiment 2 included a condition with sentences that had no grammatical equivalent form in English; here participants tended to persist in the order of thematic roles. We argue that cross-linguistic structural priming plays a major role in the act of translation.

KEYWORDS

structural priming, translation, on-line processing, cross-linguistic priming, ditransitive constructions

MAIN TEXT

Introduction

How do untrained bilinguals translate between their languages? They can do so quite successfully without special training. For example, they can perform simultaneous interpretation (Barik, 1971; Isham, 1994; Lörcher, 2005; Macizo & Bajo, 2006), in which their goal is to translate very rapidly (i.e., starting before the source utterance is complete). Moreover, Harris and Sherwood (1978) found that bilingual children appeared to translate before they were three. So why is translation so straightforward?

It would be helpful if translators could make direct use of similarities between the languages. If so, translation should be easier if representations of the bilingual's two languages are closely related. Most psychological research suggests that this is the case. For instance, words from both a bilingual's languages are activated during comprehension (e.g., Spivey & Marian, 1999) and production (e.g., Costa, Miozzo, & Caramazza, 1999). Moreover, aspects of syntactic representations are shared between languages (e.g., Hartsuiker, Pickering, & Veltkamp, 2004). But how might translators make use of these relationships?

Here we address this question by considering syntactic aspects of translation in bilingual speakers of English and German and report two experiments investigating whether they tend to repeat grammatical form as well as meaning. We focus on speeded translation by bilinguals who had not had special training. This approach provides the clearest evidence about the automatic processes underlying translation, is most closely related to traditional psycholinguistic experiments, and minimizes influences from explicit training in translation (e.g., a strategy to avoid producing translations that are overly literal).

We first discuss a simple "vertical" account of translation (originating with Seleskovitch, 1976) that does not assume any syntactic transfer, and point out that it may be insufficient to account for evidence that translators preserve syntax. We then propose an account in which sentences are regenerated after comprehension, and crucially, in which regeneration is influenced by cross-linguistic structural priming derived from the process of comprehending the source-language sentence. We discuss relevant evidence from structural priming and thereby make predictions for two experiments involving ditransitive sentences in German and English.

A psycholinguistic theory of translation

Theories of translation assume that translators comprehend the meaning of an utterance (i.e., the message) in the source (i.e., initial) language, switch between languages, and produce an utterance with corresponding meaning in the target language. However, theories differ in the extent to which they assume translation is “vertical”, whereby comprehension and production are kept separate, or “horizontal”, whereby grammatical and lexical properties of the source language affect how it is translated (see Ruiz, Paredes, Macizo, & Bajo, 2008). In psycholinguistic terms, the vertical account assumes that the translator comprehends without influence of the target language, switches language, and then produces without influence of the source language. If this is correct, grammatical and lexical properties of the source language should only influence the target language insofar as they relate to meaning. If so, translators should not repeat syntax between languages when the alternative syntactic forms have the same meaning. In contrast, the horizontal account assumes that characteristics of the source language utterance can affect the translation, either because the target language is already activated during the translator’s comprehension of the source utterance or because the source language remains active during the production of a target utterance. It therefore predicts that translators repeat syntax and other aspects of linguistic form between languages.

Although some theories of translation assume that horizontal processes involve a specialist strategy that requires extensive training (Paradis, 1994, 2004; Seleskovitch, 1962, 1976), most evidence supports some use of horizontal processes by untrained bilinguals. For example, Barik (1971, p. 209) described amateur translations as ‘typically very literal, being in many instances almost word-for-word “verbal transpositions” rather than translations, whereas those by professional [translators] are substantially more in agreement with the idiom of the target language.’ Similarly, Lörcher (2005) found that language students tended to repeat syntax more than professional translators. Finally, Van Hell and De Groot (2008) showed that translation equivalent words with form overlap (“cognates”, e.g., the word *lip* in Dutch and English) were translated more quickly than non-cognates, even when they appeared in the context of a sentence. These findings suggest that horizontal processes occur automatically, and that specialist training is needed to remove their effects when deemed inappropriate.

However, corpus analyses also suggest that translation professionals use horizontal processes. For instance, Eskola (2004) conducted a corpus study of written translations into Finnish and showed that the frequency of certain constructions that are specific to Finnish was much lower in texts translated from English or Russian

than in texts directly written in Finnish. This suggests that translation involved the use of structures that are similar between Finnish and Russian or English at the expense of Finnish-specific constructions (also see Brunner, 2008, for a corpus study of professional speech interpreting). Additionally, psycholinguistic experiments showed that when translators read a text for translation (in contrast to regular reading) they are influenced by lexical overlap and syntactic congruency between source and target language (Macizo & Bajo, 2006; also see Ruiz et al., 2008). Although our current interest is in translation by non-specialists, it is important to note that horizontal processes occur in specialists as well.

What cognitive mechanisms would underlie the horizontal route of translation? One possibility is that sentence translation is analogous to sentence recall, with the difference of course that the recalled sentence is produced in another language. Potter and Lombardi (1990) argued that people do not remember sentences by retaining a surface representation. Instead, they access the sentences' meaning and then use this meaning as the basis for regenerating the form. On its own, this account would of course imply that people might vary any aspect of a sentence that did not correspond to meaning, for example replacing words with their synonyms. But Potter and Lombardi (1990) also proposed that comprehending words primes those words so that they tend to be used during recall.

Similarly, Potter and Lombardi (1998) argued that people are primed to repeat syntax during recall. For example, if they attempt to recall the "prepositional object" (or PO) sentence *The man sold the book to the woman*, they access the meaning SELL (MAN, BOOK, WOMAN) and then regenerate syntax from that representation. They could then construct either *The man sold the book to the woman* or the "double object" (or DO) sentence *The man sold the woman the book*, as they both have (essentially) the same meaning. But as we shall see in the next section, there is a great deal of evidence for structural priming (Bock, 1986). Hence comprehending the PO sentence primes the PO syntactic structure, so that people would tend to use this structure during recall rather than the DO alternative. In one of their experiments, participants recalled prime sentences followed by target sentences; they sometimes misremembered the target sentence as having the same structure as the prime sentence. In two further experiments, participants remembered and then recalled sentences that consisted of a target clause followed by a prime clause. Participants sometimes misremembered the initial clause as having the same structure as the prime clause. Thus, priming appears to affect sentence recall.

Importantly, structural priming also takes place between languages (see Meijer & Fox Tree, 2003, for a between-language version of Potter & Lombardi's 1998 study; also see Hartsuiker et al., 2004; Loebell & Bock,

2003). Thus, if German/English bilinguals translate a DO sentence such as *The man sold the woman the book* into German, they have the choice between a (canonical) DO sentence with the same order as in English (henceforth a DO-DatAcc, as in German the first object has dative case and the second object has accusative case), a (marked) DO with the objects in reversed order (henceforth DO-AccDat, as the first object has accusative case and the second object has dative case), and for some verbs, a PO. As a result of cross-linguistic structural priming, these translators would be relatively likely to choose the DO-DatAcc order. This account therefore provides an explanation of translation in untrained translators and predicts cross-linguistic effects on syntactic form. Let us now discuss the evidence for structural priming and its implications for translation, and use it to motivate our two experiments.

Structural priming between languages and its implications for translation

There is considerable evidence for within-language structural priming. Researchers first noticed the tendency to repeat syntactic structure in naturalistic data (e.g., Schenkein, 1980; Weiner & Labov, 1983) and in an experimental study of questions and answers (Levelt & Kelter, 1982). Soon afterwards, Bock (1986) found that English-speaking participants were more likely to describe a picture using a PO after hearing and repeating another otherwise unrelated PO sentence than after a DO sentence with the same meaning; they were also more likely to use a passive after hearing another passive than after hearing an active. Importantly, such priming does not depend on lexical repetition (Bock, 1986, 1989), and appears unaffected by the repetition of closed class elements such as prepositions or verbal morphology (Bock, 1989; Bock & Loebell, 1990; Pickering & Branigan, 1998). It occurs for a range of different methods, such as spoken and written sentence completion (Branigan, Pickering, & Cleland, 2000a; Pickering & Branigan, 1998), picture description (Bock, 1986), and sentence recall (Potter & Lombardi, 1998), for constructions such as datives, transitives, verb-auxiliary order (Hartsuiker & Westenberg, 2000), and subject-locative order (Hartsuiker, Kolk, & Huiskamp, 1999), and in many different languages (see Pickering & Ferreira, 2008). Strong effects of repetition occur in studies of naturalistic corpora (Gries, 2005; Szmrecsanyi, 2006).

Several aspects of priming may be relevant to translation. First, priming occurs between comprehension and production comparable to priming within production (Bock, Dell, Chang, & Onishi, 2007). Potter and Lombardi (1998) provide an example of such priming. Moreover, Branigan, Pickering, and Cleland (2000b) found strong priming in a dialogue game in which a confederate and a participant took turns describing pictures

with ditransitive (PO or DO) sentences (and finding the relevant picture in an array). Second, priming is enhanced when the lexical heads (e.g., the main verb) of prime and target utterances are the same (the *lexical boost*; Branigan et al., 2000b; Hartsuiker, Bernolet, Schoonbaert, Speybroeck, & Vanderelst, 2008; Pickering & Branigan, 1998; Santesteban, Pickering, & McLean, 2010) or semantically related (the *semantic boost*; Cleland & Pickering, 2003). For example, Branigan et al. (2000b) found that participants repeated their partner's form more than 80% of the time when the verb was repeated. There is also some evidence that priming may be enhanced by repetition of non-head words (Cleland & Pickering, 2003; McLean, Pickering, & Branigan, 2005). Third, when words are repeated, priming is stronger when prime and target are adjacent (i.e., not separated by additional linguistic material) than when they are separated (Hartsuiker et al., 2008).

Finally, for translation to be affected by structural priming, there must of course be large, reliable effects of cross-linguistic structural priming. As mentioned above, this appears to be the case. Loebell and Bock (2003) found priming between German (L1) and English (L2) for ditransitive constructions (though not for active/passive constructions). German-English bilinguals repeated a prime sentence in one language and then described a picture in the other language. Participants were more likely to produce an English DO sentence after a German DO-DatAcc sentence and to produce a German DO-DatAcc sentence after an English DO sentence. There was a trend in the same direction for POs. Additionally, Hartsuiker et al. (2004) had Spanish-English bilinguals describe pictures to each other in a dialogue game (Branigan et al., 2000b). Participants heard a prime description in Spanish (L1) and then described the subsequent image using English (L2). They produced English passive sentences more often following a Spanish passive than following a Spanish active or an intransitive sentence.

Many studies have found cross-linguistic priming, both from L2 to L1 and from L1 to L2, between, for example, Dutch and English (Desmet & Declercq, 2006; Schoonbaert, Hartsuiker & Pickering, 2007), English and German (Loebell & Bock, 2003), German and Dutch (Bernolet, Hartsuiker & Pickering, 2007), Spanish and English (Hartsuiker et al., 2004; Vasilyeva et al., 2010, with children), Greek and English (Salamoura & Williams, 2006, 2007), Swedish and English (Kantola & Van Gompel, 2011), Korean and English (Shin & Christianson, 2009), and Mandarin and Cantonese (Cai, Pickering, Yan, & Branigan, 2011). These studies have used different constructions (e.g., transitives, datives, noun phrases) and methods (e.g., picture description, sentence completion). In some studies, the effects are similar to within-language priming (e.g., Kantola & Van

Gompel, 2011; Schoonbaert et al., 2007), though other studies have shown reduced effects from L2 to L1 (Bernolet, Hartsuiker, & Pickering, 2013; Cai et al., 2011).

Importantly, cross-linguistic priming is enhanced when the verb has the same meaning in both languages (Cai et al., 2011; Schoonbaert et al., 2007). Schoonbaert et al. (2007) found this *translation-equivalent boost* from L1 (Dutch) to L2 (English) but not from L2 (English) to L1 (Dutch). However, Cai et al. (2011) found the boost in both directions for Cantonese-Mandarin bilinguals. Because in translation the source and the target utterances have the same meaning, the translation equivalent boost might render it particularly likely that the structure of the target utterance would be parallel to that in the source language.

In summary, priming occurs from comprehension to production and under conditions of sentence recall. It occurs between languages (to a similar extent as within languages) and is strong when the target is processed soon after the prime and when there is meaning repetition between languages (the translation-equivalent boost). In the same way, translation involves comprehension followed by production and involves a form of sentence recall. It is of course cross-linguistic and involves meaning repetition between the languages, and often occurs rapidly (as in simultaneous or consecutive interpreting). All of these factors suggest that priming is likely to have strong effects during translation.

Current study

Our goal is to contrast the horizontal account of translation, in which comprehending a source language utterance affects production of its translation via cross-linguistic structural priming, with the vertical account, in which comprehension and production are kept separate during translation. To do so, we report two experiments investigating the role of structural priming in the translation of ditransitives from German into English, using native speakers of both English and German. In both cases, we asked participants either to translate or to repeat the prime sentence. Experiment 1 used DO-DatAcc (1a) and PO (1b) sentences.

(1a) Der kleine Junge schrieb dem Nachbarn den Brief

[word for word translation: The little boy wrote the neighbour the letter]

(1b) Der kleine Junge schrieb den Brief an den Nachbarn

[word for word translation: The little boy wrote the letter to the neighbour]

According to the horizontal account, participants should be more likely to produce an English DO sentence such as *The little boy wrote the neighbour the letter* as translation of (1a) than (1b), and more likely to produce an English PO sentence such as *The little boy wrote the letter to the neighbour* as translation of (1b) than (1a). According to the vertical account, the form of the translation should be unaffected by the source language utterance. Experiment 2 included source utterances without a direct translation into English (i.e., DO-AccDat sentences), and is discussed below.

Both experiments also included conditions in which participants repeated the prime sentence (cf. Christoffels & De Groot, 2004). This repetition task served as a baseline to gauge the extent to which task performance is affected by comprehension and (re)generation processes in the absence of a translation component. Given the similarity with the translation task, we felt this to be a suitable baseline task. We do however note a limitation of the repetition task: Repetition may be due to the regeneration and priming mechanisms proposed by Potter and Lombardi (1990, 1998) but perhaps also to access to a verbatim memory of the utterance (especially as there was no interfering material between prime and target, unlike Potter & Lombardi, 1990, 1998). This limitation does not apply to the translation task as the translations of our stimuli are lexically different from the original sentences and so cannot be based on verbatim memory.

Experiment 1

Method

Participants

We tested 32 participants in exchange for payment. Sixteen of them were native speakers of English (10 female and 6 male) and 16 were native speakers of German (14 female and 2 male). All were resident in Scotland and had a mean age of 24.4 years (range 18-41 years). None of the participants reported contact with a second language before 4.5 years. The English speakers had learned German for a mean of 10.2 years (range 4.5-22 years); the German speakers had learned English for a mean of 16.5 years (range 5.5-12 years). None had received professional training as translator/interpreter. All participants described their general proficiency level in the non-native (L2) language as intermediate or better. They also self-rated their L2 proficiency in reading,

listening, writing, and speaking on a 1(low)-7 (high) scale. The English participants had a mean L2 rating of 5.1 (with respective averages of 5.4, 5.5, 5.1, and 4.5); the German participants had a mean L2 rating of 5.9 (6.0, 6.1, 5.7, 5.8). Mean L2 ratings were higher for L1 German participants than for L1 English participants, ($t(30)=2.53, p<.05$). Note of course that the German speakers were immersed in an L2 environment, whereas the English speakers were not.

Materials

We constructed 64 German items, with 8 of them using each of 8 ditransitive verbs in DO-DatAcc and PO sentences (e.g., 1a-1b; see Appendix A.1 for the full list of items). Content words had a frequency of 2.1-6.2 per million according to *Datenbank Gesprochenes Deutsch* [database of spoken German] (see Fiehler & Wagener, 2005). We constructed four lists of items, so that each list contained for each verb two DO-DatAcc sentences for repetition, two DO-DatAcc sentences for translation, two PO sentences for repetition, and two PO sentences for translation, and so that in each list a version of each sentence occurred once in each condition. We created two versions of each list, one that started with the items for repetition and afterwards presented the items for translation and one with these tasks reversed. Two English and two German participants saw each version of each list. We also constructed 277 filler items, which were intransitive sentences with or without prepositional phrases, and which used the same set of nouns as the experimental items.

Procedure

Half the participants performed the repetition task first, and half performed the translation task first. Item order was individually randomized, with the constraint that at least one filler appeared between two experimental items. Instructions indicated whether participants would have to repeat or translate in the following task block.

On each trial, a fixation cross first appeared in the centre of the screen. Participants pressed the space bar to present the item. Items were presented on a single centred line (in 14pt Courier New). Trials were shown for 1400ms and were then replaced by the fixation cross. Participants responded by repeating or translating the sentence and then pressed the space bar to reveal the next item. If they did not respond, a beep sounded after 11.5s and the next item appeared 500ms afterwards (see Fig. 1). All responses were recorded and later transcribed.

INSERT FIGURE 1 AROUND HERE

Scoring

The main principle that was applied when scoring a response as a PO or a DO in the translation task was that responses needed to involve an alternating verb and be clearly identifiable. The verb had to be classified as dative according to Levin (1993). In the repetition task, responses also needed to be clearly identifiable and the verb needed to be one of the eight verbs used in the set of items (not necessarily the correct one). In both tasks, all responses that used other verbs, or had no verb, were classified as 'other'.

In the translation task, responses were categorized as DO if they involved a noun phrase (NP) that could be construed as relating to the recipient followed by another NP, and as PO if they involved an NP followed by a prepositional phrase (PP). (As there is no case marking in English double object sentences, we will not distinguish between DO-DatAcc and DO-AccDat in English and use the term DO for both.) In the repetition task, responses were categorized as DO-DatAcc if they involved a dative NP followed by an accusative NP, as a DO-AccDat if they involved an accusative NP followed by a dative NP, and a PO if they involved an accusative NP followed by a PP.

An incomplete constituent (containing at least an article for a NP or a preposition for a PP) was treated as a constituent (as it was clear that the participant had started to produce the constituent), if it was part of the first unambiguous attempt out of multiple attempts to produce that sentence. For instance, if a first attempt contained only the first object of a DO it was counted as a DO, even if the subsequent attempt provided a PO for the same stimulus (e.g., in the response "the count sends the writer a – sends a document to the writer"). To count as a PO or DO, the NPs had to refer to a plausible recipient or theme. Our goal was to identify the utterance that participants initially planned.

Utterances that failed to fulfil any of these criteria were categorized as 'other' (see Appendix B for a detailed breakdown of this category). This category included responses with a PP that involved other prepositions than English 'to' or German 'an' (e.g. 'about' or 'mit', with) (as it would then not be clear that the participant was producing a ditransitive). Furthermore, this category included cases where the syntactic structure was different from a DO or PO dative, where there was a morphological or syntactic error, or where there were issues with the chosen verb (e.g., missing or not-alternating verb).

In addition, we classified as 'other' all responses where there was clear evidence that participants had failed to retrieve a lexical item that corresponded to a Theme or Recipient. Therefore the 'other' category included responses in which an object noun phrase involved an (indefinite) pronoun (e.g., 'somebody'), or involved a filled or unfilled pause (e.g., 'to... hmmm', 'the -'), presumably as they are indicative of failed or disrupted attempts at lexical retrieval. We assume that participants did not intend to produce such utterances (as evident from subsequent attempts to produce the appropriate word or excuses for failing to do so). However, we did classify as DO or PO trials that involved substitution by unrelated nouns (e.g. 'football' instead of 'cake'), by abstract nouns (e.g. 'the person'), circumlocutions such as 'the uncle's wife' (for 'aunt'), nouns that were phonologically or orthographically related to the source or target noun (e.g. 'monster' for 'master'), and neologisms that were related to the source or target noun (e.g. 'Schreite' for 'Schreiber' ('writer')).

Analysis

We analysed our results using linear mixed effects modelling (Baayen, Davidson, & Bates, 2008). Our models assumed fixed effects from Native Language, Source Construction, and (where applicable) Task. Participants, Items, and Source Verbs were treated as Random Effects. Because the data were nominal, analyses used a logit link function (Jaeger, 2008). We used the same modelling strategy for all analyses. Specifically, we first tested whether interactions between Fixed Effects improved the model, followed by similar tests for slopes over Random Effects. Next, we tested whether inclusion of control variables improved the fit (e.g., progression of trials in each task, order in which tasks were performed, and corresponding interactions and random slopes). These steps were repeated either until none of the available control variables could contribute to the model any more, or until a step suggested significant effects from the intercept. In these cases, we considered the step immediately before insertion of the problematic factor/interaction/random slope to be the final model. Analyses were carried out using the lme4 library (Bates, Maechler, Bolker, & Walker, 2014) in R (R Development Core Team, 2014).

Results

We excluded data of the verb *liefern* ("to bring, to deliver"), which had been very frequently translated into a non-alternating target verb (i.e., in more than 50% of the structurally and morphologically acceptable responses

to this verb). Out of 1792 remaining responses, 729 (40%) were classified as Others. An analysis of Other responses (reported fully in Appendix B) showed that native speakers of German (i.e., the source language) produced fewer Others than the native speakers of English, especially in the repetition task. There was no effect of Source Construction on production of Others. Performance in the repetition task was close to ceiling: Participants hardly ever changed a DO-DatAcc to a PO or vice versa (Table 1).

INSERT TABLE 1 AROUND HERE

Our main analysis studied participants' construction choices in the translation task (Table 1). In the 408 acceptable responses in this task, 206 DO-DatAcc and 202 PO source sentences were translated from German into English as 82 DO and 326 PO sentences. The logit mixed effect model was not improved by including the Native Language x Source construction interaction [$\chi^2(1) < 1, p > 0.92$]. For random effects, the model included Participants and Source Verbs. Inclusion of Item as a random effect did not contribute to the model. The model's fit to data was improved by inclusion of a control variable for habituation, measured as (centred) trial number and interacting with Native Language ($\chi^2(2) = 15.1, p < 0.001$).

INSERT TABLE 2 AROUND HERE

Most importantly, this analysis shows a significant effect of Source construction: The participants were more likely to use a DO construction as a translation of a DO-DatAcc source construction than as a translation of a PO source construction (see Table 2). Thus, it appears that translation is influenced by structural priming. There was only a marginal effect of Native Language; native speakers of German were slightly less likely to produce English DO constructions than native speakers of English. This effect was qualified by an interaction with trial number: as the experiment progressed, the likelihood to produce a DO translation nearly halved among German speakers (22.4% in the first half vs. 12.2% in the second half), a change that was much less strong among English speakers (28.0% vs. 20.5%).

Discussion

Experiment 1 found a strong effect of Source construction in the translation task: Participants were more likely to produce a DO translation of a DO-DatAcc source sentence than of a PO source sentence. This effect did not depend on whether subjects had German as their L1 (and were thus translating into their L2 English) or vice versa. The strong tendency to repeat syntactic structure during translation is compatible with the horizontal account, which predicts syntactic influences from the source language onto the translation in the target language; but it is not compatible with the vertical account, which predicts no such influences. In sum, Experiment 1 shows that structural choices in (untrained) translation are affected by the structure of the sentences in the source language.

Experiment 1 used conditions in which available structural choices were equivalent across the two languages. For the verbs used in the experiment, both languages allow a PO structure and a DO structure in which the first object typically has the thematic role of recipient and the second object has the thematic role of theme (with the difference that in German but not English the objects are marked for dative and accusative case). The participants could therefore make extensive use of horizontal relationships. However, this is not always the case. Frequently, translation between two different languages necessitates translators to use different constructions, because the same construction does not exist in both languages. One possibility is that horizontal processes are used only when the source involves the same construction as the potential target. But a stronger version of the horizontal account assumes that translation also makes use of structural correspondences between source and target sentences that occur even when they involve different constructions. For instance, translation pairs may share the order of thematic roles even if they differ syntactically. As we shall see below, there is evidence that such correspondences lead to structural priming, and hence they may also affect translation.

Experiment 2

Experiment 2 tested whether translators use horizontal routes when source and target language sentences involve different constructions. To do so, we used the German DO-AccDat construction (consisting of NP_{THEME}-NP_{RECIPIENT}) which does not occur in English (1c).

(1c) Der kleine Junge schrieb den Brief dem Nachbarn

[word for word translation: The little boy wrote the letter the neighbour]

It is possible that translators would be unaffected by the structural properties of the source construction, as the target language simply does not have a structural equivalent that could be imitated. But it is also possible that bilinguals tend to translate the new construction into what they see as the nearest equivalent in the target language. If so, horizontal influences during translation would be strong.

But what would constitute the nearest equivalent construction? One possibility is that this solely depends on phrase structure. The DO-AccDat has two NP arguments (like the DO in English) and might therefore be mostly translated using DO sentences. However, there is good evidence that besides phrase structure, people also repeat other aspects of structure, such as the order of thematic roles. Chang, Bock, and Goldberg (2003) had participants recall sentences involving a verb that allowed two possible structures. Both involved a noun phrase and a prepositional phrase, but differed in the thematic roles associated with each phrase, with either the (inanimate) Theme of the action appearing or the (inanimate) Location of the action appearing as the direct object noun phrase, directly following the verb (e.g., *The short order cook spattered grease on his apron* vs. *The short order cook spattered his apron with grease*). Participants tended to persist in their structural choices (e.g., recalling *The short order cook spattered grease on his apron* more often after *The farmer loaded hay on the wagon* than after *The farmer loaded the wagon with hay*). As there is no evidence for priming of closed-class items (here, *on* vs. *with*; Bock, 1989), priming appears to be due to some aspect of thematic roles. Similarly, Cai, Pickering, and Branigan (2012) found that Mandarin speakers tended to repeat the order of thematic roles (Theme and Recipient) when prime and target sentences were syntactically distinct. Most relevantly, Köhne, Pickering, and Branigan (2014) had participants perform sentence-picture matching with prime sentences involving sentences similar to (1a-c) or intransitive sentences, and then produce spoken descriptions of target pictures. Participants produced more PO responses following DO-AccDat sentences (1c) than following DO-DatAcc sentences (1a). In other words they tended to repeat the order of thematic roles (and a second experiment ruled out an explanation in terms of the order of animate vs. inanimate arguments).

Such findings suggest that cross-linguistic structural priming may occur across constructions, in particular when the structure of the prime language sentence does not occur (or is strongly disfavoured) in the target language. For example, Bernolet, Hartsuiker, and Pickering (2009) found that participants tended to use English

passive sentences after encountering Dutch passives in which the prepositional phrase occurs before the verb (*De kerk wordt door de bliksem getroffen*, lit. “the church is by lightning struck”). Moreover, Fleischer, Pickering, and McLean (2012) found that Polish-English bilinguals tended to produce English passive sentences after comprehending an active Polish sentence with object-verb-subject word order (see also Heydel & Murray, 2000). Finally, Vernice, Hartsuiker, and Pickering (2012) found that Dutch participants were more likely to produce passives after active sentences in which the patient was emphasized than after active sentences in which the agent was emphasized. These results suggest that people tend to repeat order of thematic roles or which thematic roles are emphasized across languages. It is therefore possible that thematic role priming may also affect translation. To test this claim, Experiment 2 used the same paradigm as Experiment 1, but with German DO-DatAccs and DO-AccDats (and did not use POs).

Method

Participants

We tested 32 further participants in exchange for payment. Sixteen were native speakers of English (8 male and 8 female) and 16 were native speakers of German (5 male and 11 female). Their age ranged from 18–69 years (mean 33.0); none of them reported contact with a second language before the age of 4 years. The native speakers of English had learned English for a mean of 12.1 years (range 4-19 years), the native speakers of German had learned English for a mean of 11.2 years (range 9-15 years). None of the participants had received training as a translator/interpreter, and all described their proficiency level in the non-native language as intermediate or better. Their mean L2 self-ratings of proficiency were 5.0 for L1 English (reading 5.5, listening 5.3, speaking 4.6, writing 4.5), 5.9 for L1 German (6.1, 6.0, 5.8, and 5.7); as in Experiment 1, mean L2 ratings were significantly higher in the L1 German group than the L1 English group, $t(30)=2.71$, $p<.05$.

Materials

The materials were constructed in the same way as Experiment 1, except that we were not restricted to verbs that could be used in prepositional dative sentences. We therefore selected much more frequent verbs than in Experiment 1, as this might make translation more accurate and hence reduce the number of ‘other’ responses. The selected verbs had a frequency of 5.0-15.4 per million in the *Datenbank Gesprochenes Deutsch* (database of

spoken German; see Fiehler & Wagener, 2005) – about eight times those in Experiment 1). The nouns were the same as in Experiment 1.

Procedure, Scoring, and Analysis

These were the same as in Experiment 1.

Results

In contrast to Experiment 1, all verbs in Experiment 2 elicited a translation response with a lexical, alternating verb on more than 50% of the trials; thus, we now did not exclude any verb. Out of 2048 responses, 622 (30%) were classified as Other. An initial analysis tested whether the number of Others varied with condition (see Appendix B). As in Experiment 1, the native speakers of German produced fewer Others than the native speakers of English, especially in the repetition task. Further, there were more Others in response to a DO-AccDat than to a DO-DatAcc. The repetition task showed that, aside from the production of Others and the very occasional production of a PO, repetition performance was near ceiling: Participants very rarely recalled a DO-DatAcc as a DO-AccDat or vice versa (Table 3).

INSERT TABLE 3 AROUND HERE

Out of 675 acceptable (i.e., non-Other) responses in the translation task, 325 DO-DatAcc and 350 DO-AccDat sentences were translated from German into English as 235 DO and 440 PO constructions. Logit mixed effect models were fitted to these (categorical) data. The model included Native Language and Source Construction as fixed effects; for random effects, we included again participants and source verbs. Inclusion of Item as a random effect did not contribute to the model. Inclusion of an interaction between the two fixed effects improved the model fit significantly [$\chi^2(1) = 7.6, p < 0.01$]. A random slope for participants by Source Construction improved the model's fit to data further [$\chi^2(2) = 6.2, p < 0.05$].

INSERT TABLE 4 AROUND HERE

This analysis (Table 4) reveals an effect of Source construction: Participants were more likely to use a DO as the translation of a DO-DatAcc sentence than as the translation of a DO-AccDat sentence. This again confirms the predictions of a horizontal account, and more specifically, the “strong” version of that account according to which there are even horizontal influences when the source construction is not available in the target language. These horizontal influences may be due to thematic role order. As in Experiment 1, there was an effect of Native Language (fully significant this time), indicating that native speakers of German were less likely to produce English DO constructions than native English speakers.

Importantly, there was also a significant interaction between Native Language and Source Construction, indicating that the native speakers of English were more likely to be affected by the source sentence (about 56%) than the native speakers of German (about 20%). Table 3 indicates that the two groups were very similar in their tendency to use PO rather than DO translations of DO-AccDat sentences. German speakers also often produced PO rather than DO translations of DO-DatAcc sentences, but English speakers tended to use DO rather than PO translations of DO-DatAcc sentences.

Discussion

Again, the translation data showed that untrained translators were influenced by the source language construction: given a DO-DatAcc source sentence, they tended to produce DOs in English; but given a DO-AccDat, they tended to produce POs. This effect of structural priming interacted with native language: the native speakers of English showed much stronger priming than the native speakers of German. This means that participants were more likely to repeat structure when translating from their L2 to their L1 than from their L1 to their L2. This finding contrasts with Experiment 1, which found comparable repetition of POs and DOs in both translation directions. This finding also contrasts with Schoonbaert et al.’s (2007) study testing cross-linguistic structural priming of POs and DOs within and between L1 and L2. These authors found 17% priming for translation-equivalent verbs from L1 (Dutch) to L2 (English) but only 6% priming from L2 (English) to L1 (Dutch); priming with unrelated verbs was very similar in both directions.

So why was there stronger syntactic repetition from L2 into L1 than vice versa in our Experiment 2? Given the lack of such an asymmetry in Experiment 1, the explanation is likely to involve the structures tested in Experiment 2. Specifically, only Experiment 2 presented the DO_AccDat structure, which occurs in German but not in English. One possibility is that the L1 German speakers represented this structure differently from the L1

English speakers. On this account, German native speakers have a stable representation for the DO_AccDat structure, treating it syntactically as a DO. In contrast, many native speakers of English may not yet have acquired a stable representation of the German DO_AccDat structure, a structure to which they are very seldom exposed. As a result, these speakers do not yet treat the DO_AccDat as structurally similar to the DO (see Hartsuiker & Bernolet, 2016, for a sketch of L2 acquisition that assumes syntactic representations across languages are “merged” only after sufficient exposure). Rather, we hypothesize that upon presentation of a German DO_AccDat structure, such English speakers activate the PO node, as the PO is superficially similar to the DO_AccDat (except for the preposition). If this is the case, the tendency to translate DO_AccDat sentences as POs in the native English-speaking participants would be caused by two simultaneous horizontal influences: syntactic structure and thematic-role order. In contrast, the native German-speaking participants would be subject to only a single horizontal influence: thematic-role order. Of course, this account is post-hoc and awaits further testing. But whatever the precise explanation for the asymmetry in repetition effect in Experiment 2, these findings support a strong horizontal view of translation, according to which non-syntactic aspects of structure, such as the order of thematic roles, tend to persist alongside syntactic structure.

General Discussion

Two experiments found that people tend to preserve structure during translation. In Experiment 1, native English and German speaking participants tended to translate German PO sentences as English POs, and German DO-DatAcc sentences as English DOs. In Experiment 2, participants also showed a tendency to be affected by the form of the source utterance, even when the sentence form in German (a DO-AccDat) did not have an English counterpart.

Our findings support the horizontal account, in which translation is not merely affected by meaning, but by structural correspondences between the source utterance and its translation. We propose that translators comprehend the source sentence, thereby determining its conceptual representation. They then use this conceptual representation to produce the target utterance, in a process of translation-by-regeneration. This can be considered akin to Potter and Lombardi's (1998) proposal that the preservation of syntactic structure in sentence recall may be due not to verbatim memory alone, but also to regeneration. Potter and Lombardi

explained the tendency to preserve structure as being due to within-language structural priming. In the same way, we propose that the tendency to preserve structure is due to between-language structural priming.

Our experiments demonstrated two different horizontal effects, due to two forms of structural priming. The findings in Experiment 1 demonstrated that people tend to repeat syntactic structure in translation, specifically associated with the order of phrases in ditransitive constructions. The results are therefore consistent with findings of between-language ditransitive priming (e.g., Schoonbaert et al., 2007), and support the existence of a syntactic component to horizontal processes in translation. The findings in Experiment 2 demonstrated that people tended to use POs more often and DOs less often as translations of DO-AccDat, compared to DO-DatAccs. They are consistent with evidence for between-language thematic priming (e.g., Bernolet et al., 2009; Fleischer et al., 2012) and support the existence of a non-syntactic structural component to horizontal processes in translation.

Strikingly, in Experiment 2 there was a much stronger tendency to translate DO_AccDat sentences as POs in the English native speakers than in the German native speakers. This pattern of results differs from studies testing DOs and POs, including Experiment 1 and Schoonbaert et al. (2007). It is possible that this difference in results is related to differences in L2 proficiency (the L1 German speakers rated their L2 proficiency somewhat higher than the L1 English speakers). A further group difference is that the English natives were not immersed in a German-speaking context (unlike the German natives in the same experiment). Both their comparatively low proficiency and lack of immersion may have meant that the English native speakers had only minimal experience of the German DO_AccDat structure, which is of quite low frequency. As a result, these English natives may not have a stable representation of that structure. Instead, they may have merged it with the PO, which we assume they treated as its nearest neighbour. We hypothesize that this difference underlies the asymmetry that we observed: the English natives, treating the DO_AccDat as a PO, preserved both syntactic structure and thematic role order in their translations, whereas the German natives only preserved thematic role order.

Our explanation of the tendency to translate DO_AccDat as PO in Experiment 2 is that translators tend to preserve the order of thematic roles across source and target utterances (as German DO-AccDat and German and English PO sentences have theme-recipient order, whereas DO-DatAcc sentences in German and DOs in English have recipient-theme order). However, our findings may suggest an account that hinges entirely on the non-syntactic structural component, i.e. positional features, so that respondents simply preserve the order in

which lexical information is provided in the source. There are two arguments against this alternative. First, such a lexical persistence account would predict that German DO-DatAcc sources would tend to be translated as DOs, which preserves word order between source and translation. However, even in this condition, there was an overall strong bias towards POs in both groups, especially in Experiment.1. Second, there is much evidence for the persistence of thematic role order or of emphasis on thematic roles in structural priming (Bernolet et al. (2009), Cai, Pickering, & Branigan, 2012; Chang, Bock, & Goldberg (2003), Fleischer et al. (2011), Köhne et al., 2014; Vernice et al. (2012)).

Our account that translators tend to preserve thematic role order is preferable to an alternative account in which the DO-DatAcc and DO-AccDat have different syntactic structure (perhaps assuming that DO-AccDat sentences involve some form of “scrambling” or rearrangement of the noun phrases from an underlying representation), and that the locus of priming is the repetition of syntactic structure rather than thematic role order. If so, priming would be restricted to the DO-DatAcc sentences, which are the same in German and English; priming would not occur between the German DO-AccDat sentences and the English PO sentences. The proposal, however, is incompatible with the strong evidence for the priming of thematic role order.

If translation involves cross-linguistic priming of structure, then this has implications for properties of translations as well as for the on-line process of translating. First, whenever there is optionality in the target language (e.g., between a DO and a PO in English) one might expect a tendency for translations to follow the structure used in the source language (a DO, given a German DO-DatAcc) or one that is seen as closest to it (a PO, given a German DO-AccDat). A particular interesting situation arises when one language allows several syntactic options whereas other languages allow only one. Dutch, for instance, allows by-phrase final passives (like English) but also verb-final passives (like German). One might therefore predict that translations from English into Dutch differ from translations from German into Dutch with respect to the frequency of both kinds of passive structures. However, such parallelism may be limited as a structure repeated from the source language may, strictly speaking, be correct while being marked or even infelicitous in the target language. An example might be Spanish passives, which occur very rarely and are considered to be odd by native speakers in many contexts. We expect that professional translators are highly sensitive to such subtleties and so frequently reject repeated forms (either before overt production, as an immediate self-correction, or in a later stage when reviewing or proofreading their translation).

Second, priming may also influence the on-line process of translation: that is, if a construction in the source language is possible and felicitous in the target language, then it can be used right away. In contrast, if that construction is not possible or less acceptable, then a different construction needs to be formulated from scratch, thereby delaying the translation considerably. Consistent with this are the findings from an experiment reported by Vandepitte and Hartsuiker (2011). These authors used keystroke logging to measure translation times of English sentences involving metonymy, such as *Music took him around the world*. Nouns such as *music* lack many of the properties of prototypical agents (e.g., animacy and volition) and are therefore poor candidates for subjecthood; in several languages, including Dutch, such constructions are therefore unacceptable. Indeed, participants took longer to translate such sentences into Dutch than they did to translate matched control sentences (*Mother took him around the world*), suggesting that processing is slowed down when the source construction cannot be used in the translation.

It is important to note that while we view priming as an important process during translation, a complete account of translation needs to postulate other processes as well. There are several ways in which the processes involved in translation are different from the processes involved in a typical priming experiment. Translation involves a comprehension process (of a source sentence in a particular context) and a production process (the construction of a target sentence that is acceptable in the target language and that expresses the same meaning as the source sentence). But in a typical priming experiment, participants comprehend one sentence and then produce another sentence (e.g., by describing a picture). Thus, these processes differ at the most basic level in the input that drives the production process (a message obtained from understanding a sentence vs. a picture) and also in the relationship between the sentences (identical meaning vs. unrelated in meaning; with some exceptions, Cleland & Pickering, 2003, did have a condition in which prime and target were identical) and the task requirements (i.e., the need to map the sentences onto each other).

Both groups of participants showed clear priming effects in translation. One striking difference between the groups, which we observed in both experiments, was the stronger bias for German native speakers to use English PO sentences than for the English native speakers to do so. It is unclear what brought about this difference, especially given that POs in German are restricted to only some verbs; hence it is unlikely that this difference results from the L1 German speakers transferring the most common structure from their L1 into their L2. One possibility is that while the L1 German speakers have acquired both the English DO and PO, they have not yet formed stable representations of the frequency with which each of them occurs in English; as a result,

they use fewer DOs than native speakers (who of course have much more experience with these structures in English and whose usage frequency therefore approximates that of the language more generally).

In conclusion, our data support a horizontal account of translation, according to which (untrained) translators generate each target language sentence on the basis of their comprehension of the source language sentence, while being strongly affected by priming at multiple linguistic levels.

ACKNOWLEDGEMENTS

The research reported in this article is part of the first author's unpublished 2009 PhD thesis at the University of Edinburgh and was supported by the Economic and Social Research Council (ESRC) under Grant PTA-040-2004-000712. A subset of the data in Experiment 2 is published and discussed with particular focus on concerns of Translation and Interpreting research in Maier (2011). Experiment 1 and discussions of results in terms of their psycholinguistic relevance have not been published before.

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Appendix A: List of items

Experiment 1

This list shows the experimental items created for Experiment first in their rendition as DO-DatAcc sentences, then as PO sentences. Approximate translations into English are also given as PO constructions.

- 1 Das Paar liefert dem Grafen das Obst.
Das Paar liefert das Obst an den Grafen.
(The couple delivers the fruit to the earl)
- 2 Die Tante liefert dem Meister den Vogel.
Die Tante liefert den Vogel an den Meister.
(The aunt delivers the bird to the master)
- 3 Der Schreiber meldet dem Fürsten die Absicht.
Der Schreiber meldet die Absicht an den Fürsten.
(The scribe reports the intention to the prince)
- 4 Die Bekannte meldet dem Meister die Information.
Die Bekannte meldet die Information an den Meister.
(The acquaintance (f.) reports the information to the master.)
- 5 Das Opfer schickt dem Paar das Dokument.
Das Opfer schickt das Dokument an das Paar.
(The victim sends the document to the couple.)
- 6 Der Fürst schickt dem Burschen die Decke.
Der Fürst schickt die Decke an den Burschen.
(The prince sends the blanket to the boy.)
- 7 Der Autor sendet dem Präsidenten das Dokument.
Der Autor sendet das Dokument an den Präsidenten.
(The author sends the document to the president.)
- 8 Der Papst sendet dem Schreiber die Information.
Der Papst sendet die Information an den Schreiber.
(The pope sends the information to the scribe.)

- 9 Der Autor übergibt dem Helden den Bauernhof.
Der Autor übergibt den Bauernhof an den Helden.
(The author gives the farm to the hero.)
- 10 Der Feind übergibt dem Präsidenten das Gerät.
Der Feind übergibt das Gerät an den Präsidenten.
(The enemy gives the device to the president.)
- 11 Der Meister verkauft dem Helden das Glas.
Der Meister verkauft das Glas an den Helden.
(The master sells the glass to the hero.)
- 12 Die Bekannte verkauft dem Onkel das Fahrrad.
Die Bekannte verkauft das Fahrrad an den Onkel.
(The acquaintance (f.) sells the bicycle to the uncle.)
- 13 Der Bursche vermietet dem Helden das Boot.
Der Bursche vermietet das Boot an den Helden.
(The lad rents the boat to the hero.)
- 14 Der Schreiber vermietet dem Paar das Fahrrad.
Der Schreiber vermietet das Fahrrad an das Paar.
(The scribe rents the bicycle to the couple.)
- 15 Das Opfer verrät dem Meister die Wirkung.
Das Opfer verrät die Wirkung an den Meister.
(The victim betrays the effect to the master.)
- 16 Der Bub verrät dem Papst den Beweis.
Der Bub verrät den Beweis an den Papst.
(The boy betrays the proof to the pope.)
- 17 Der Schreiber liefert dem Gegner den Tee.
Der Schreiber liefert den Tee an den Gegner.
(The scribe delivers the tea to the opponent.)
- 18 Der Typ liefert dem Onkel die Kartoffel.
Der Typ liefert die Kartoffel an den Onkel.
(The guy delivers the potato to the uncle.)
- 19 Der Held meldet dem Schreiber den Beweis.
Der Held meldet den Beweis an den Schreiber.
(The hero reports the proof to the scribe.)

- 20 Der Typ meldet dem Papst den Gewinn.
Der Typ meldet den Gewinn an den Papst.
(The guy reports the profit to the pope.)
- 21 Der Meister schickt dem Gegner den Witz.
Der Meister schickt den Witz an den Gegner.
(The master sends the joke to the opponent.)
- 22 Der Schriftsteller schickt dem Präsidenten den Stock.
Der Schriftsteller schickt den Stock an den Präsidenten.
(The writer sends the stick to the president.)
- 23 Das Paar sendet dem Papst die Erzählung.
Das Paar sendet die Erzählung an den Papst.
(The couple sends the story to the pope.)
- 24 Der Feind sendet dem Helden den Beweis.
Der Feind sendet den Beweis an den Helden.
(The enemy sends the proof to the hero.)
- 25 Der Bürger übergibt dem Paar den Antrag.
Der Bürger übergibt den Antrag an das Paar.
(The citizen gives the application to the couple.)
- 26 Der Papst übergibt dem Chef das Schild.
Der Papst übergibt das Schild an den Chef.
(The pope gives the sign to the boss.)
- 27 Das Paar verkauft dem Grafen den Topf.
Das Paar verkauft den Topf an den Grafen.
(The couple sells the pot to the earl.)
- 28 Der Bürger verkauft dem Gegner die Tasche.
Der Bürger verkauft die Tasche an den Gegner.
(The citizen sells the bag to the opponent.)
- 29 Das Paar vermietet dem Gegner das Flugzeug.
Das Paar vermietet das Flugzeug an den Gegner.
(The couple rents the plane to the opponent.)
- 30 Der Fürst vermietet dem Feind die Tasche.
Der Fürst vermietet die Tasche an den Feind.
(The prince rents the bag to the enemy.)

- 31 Der Feind verrät dem Helden den Witz.
Der Feind verrät den Witz an den Helden.
(The enemy betrays the joke to the hero.)
- 32 Der Onkel verrät dem Meister die Erkenntnis.
Der Onkel verrät die Erkenntnis an den Meister.
(The uncle betrays the insight to the master.)
- 33 Der Onkel liefert dem Chef die Blume.
Der Onkel liefert die Blume an den Chef.
(The uncle delivers the flower to the boss.)
- 34 Der Schreiber liefert dem Feind die Frucht.
Der Schreiber liefert die Frucht an den Feind.
(The scribe delivers the fruit to the enemy.)
- 35 Der Bürger meldet dem Gegner den Gewinn.
Der Bürger meldet den Gewinn an den Gegner.
(The citizen reports the profit to the opponent.)
- 36 Der Schreiber meldet dem Gegner die Wirkung.
Der Schreiber meldet die Wirkung an den Gegner.
(The scribe reports the effect to the opponent.)
- 37 Der Fürst schickt dem Paar das Vermögen.
Der Fürst schickt das Vermögen an das Paar.
(The prince sends the fortune to the couple.)
- 38 Der Onkel schickt dem Gegner die Karte.
Der Onkel schickt die Karte an den Gegner.
(The uncle sends the card to the opponent.)
- 39 Der Fürst sendet dem Paar den Beweis.
Der Fürst sendet den Beweis an das Paar.
(The prince sends the proof to the couple.)
- 40 Die Angestellte sendet dem Helden die Erzählung.
Die Angestellte sendet die Erzählung an den Helden.
(The employee (f.) sends the story to the hero.)
- 41 Der Autor übergibt dem Chef das Gerät.
Der Autor übergibt das Gerät an den Chef.
(The author gives the device to the boss.)

- 42 Der Graf übergibt dem Präsidenten den Antrag.
Der Graf übergibt den Antrag an den Präsidenten.
(The earl gives the application to the president.)
- 43 Der Held verkauft dem Bürger den Zucker.
Der Held verkauft den Zucker an den Bürger.
(The hero sells sugar to the citizen.)
- 44 Die Bekannte verkauft dem Meister den Hund.
Die Bekannte verkauft den Hund an den Meister.
(The acquaintance (f.) sells the dog to the master.)
- 45 Das Paar vermietet dem Fürsten das Boot.
Das Paar vermietet das Boot an den Fürsten.
(The couple rents the boat to the prince.)
- 46 Der Schreiber vermietet dem Helden die Tasche.
Der Schreiber vermietet die Tasche an den Helden.
(The scribe rents the bag to the hero.)
- 47 Der Bub verrät dem Präsidenten den Gewinn.
Der Bub verrät den Gewinn an den Präsidenten.
(The boy reports the profit to the president.)
- 48 Der Onkel verrät dem Helden den Beweis.
Der Onkel verrät den Beweis an den Helden.
(The uncle betrays the proof to the hero.)
- 49 Der Meister liefert dem Onkel den Kaffee.
Der Meister liefert den Kaffee an den Onkel.
(The master delivers the coffee to the uncle.)
- 50 Der Typ liefert dem Präsidenten das Brot.
Der Typ liefert das Brot an den Präsidenten.
(The guy delivers the bread to the president.)
- 51 Das Opfer meldet dem Schreiber das Flugzeug.
Das Opfer meldet das Flugzeug an den Schreiber.
(The victim reports the plane to the scribe.)
- 52 Der Typ meldet dem Fürsten die Erkenntnis.
Der Typ meldet die Erkenntnis an den Fürsten.
(The guy reports the insight to the prince.)

- 53 Der Meister schickt dem Chef die Erzählung.
Der Meister schickt die Erzählung an den Chef.
(The master sends the story to the boss.)
- 54 Der Schreiber schickt dem Buben die Decke.
Der Schreiber schickt die Decke an den Buben.
(The scribe sends the blanket to the boy.)
- 55 Der Feind sendet dem Präsidenten die Karte.
Der Feind sendet die Karte an den Präsidenten.
(The enemy sends the card to the president.)
- 56 Der Graf sendet dem Schreiber das Dokument.
Der Graf sendet das Dokument an den Schreiber.
(The earl sends the document to the scribe.)
- 57 Der Fürst übergibt dem Paar den Hund.
Der Fürst übergibt den Hund an das Paar.
(The prince gives the dog to the couple.)
- 58 Der Meister übergibt dem Gegner das Schild.
Der Meister übergibt das Schild an den Gegner.
(The master gives the sign to the opponent.)
- 59 Der Graf verkauft dem Feind die Kerze.
Der Graf verkauft die Kerze an den Feind.
(The earl sells the candle to the enemy.)
- 60 Der Onkel verkauft dem Paar den Stoff.
Der Onkel verkauft den Stoff an das Paar.
(The uncle sells the cloth to the couple.)
- 61 Der Schreiber vermietet dem Burschen den Bauernhof.
Der Schreiber vermietet den Bauernhof an den Burschen.
(The scribe rents the farm to the lad.)
- 62 Der Typ vermietet dem Onkel die Decke.
Der Typ vermietet die Decke an den Onkel.
(The guy rents the blanket to the uncle.)
- 63 Das Opfer verrät dem Gegner die Information.
Das Opfer verrät die Information an den Gegner.
(The victim betrays the information to the opponent.)

- 64 Der Bürger verrät dem Schreiber die Wirkung.
Der Bürger verrät die Wirkung an den Schreiber.
(The citizen betrays the effect to the scribe.)

Experiment 2

This list shows the experimental items created for Experiment first in their rendition as DO-DatAcc sentences, then as DO-AccDat sentences. Approximate translations into English are given as PO constructions.

- 1 Der Schriftsteller bringt dem Grafen den Tee.
Der Schriftsteller bringt den Tee dem Grafen.
(The writer brings the tea to the earl.)
- 2 Das Paar bringt dem Helden die Kerze.
Das Paar bringt die Kerze dem Helden.
(The couple brings the candle to the hero.)
- 3 Der Chef erzählt dem Buben die Erkenntnis.
Der Chef erzählt die Erkenntnis dem Buben.
(The boss tells the insight to the boy.)
- 4 Das Opfer erzählt dem Onkel die Wirkung.
Das Opfer erzählt die Wirkung dem Onkel.
(The victim tells the effect to the uncle.)
- 5 Der Onkel reicht dem Feind die Blume.
Der Onkel reicht die Blume dem Feind.
(The uncle hands the flower to the enemy.)
- 6 Der Autor reicht dem Grafen den Stock.
Der Autor reicht den Stock dem Grafen.
(The author hands the stick to the earl.)
- 7 Der Bursche schenkt dem Papst die Blume.
Der Bursche schenkt die Blume dem Papst.
(The lad gives the flower to the pope (as a present).)
- 8 Der Fürst schenkt dem Schriftsteller die Karte.
Der Fürst schenkt die Karte dem Schriftsteller.
(The prince gives the card to the writer (as a present).)

- 9 Die Angestellte schickt dem Bürger die Erzählung.
Die Angestellte schickt die Erzählung dem Bürger.
(The employee (f.) sends the story to the citizen.)
- 10 Der Meister schickt dem Chef den Gewinn.
Der Meister schickt den Gewinn dem Chef.
(The master sends the profit to the boss.)
- 11 Der Onkel verkauft dem Burschen das Schwein.
Der Onkel verkauft das Schwein dem Burschen.
(The uncle sells the pig to the lad.)
- 12 Der Autor verkauft dem Fürsten das Gerät.
Der Autor verkauft das Gerät dem Fürsten.
(The author sells the device to the prince.)
- 13 Der Fürst verspricht dem Buben das Flugzeug.
Der Fürst verspricht das Flugzeug dem Buben.
(The prince promises the plane to the boy.)
- 14 Der Chef verspricht dem Bürger das Obst.
Der Chef verspricht das Obst dem Bürger.
(The boss promises the fruit to the citizens.)
- 15 Der Schreiber zeigt dem Buben das Brot.
Der Schreiber zeigt das Brot dem Buben.
(The scribe shows the bread to the boy.)
- 16 Der Schriftsteller zeigt dem Fürsten den Antrag.
Der Schriftsteller zeigt den Antrag dem Fürsten.
(The writer shows the application to the prince.)
- 17 Der Feind bringt dem Burschen den Beweis.
Der Feind bringt den Beweis dem Burschen.
(The enemy brings the proof to the lad.)
- 18 Der Autor bringt dem Meister das Fahrrad.
Der Autor bringt das Fahrrad dem Meister.
(The author brings the bike to the master.)
- 19 Der Präsident erzählt dem Burschen den Witz.
Der Präsident erzählt den Witz dem Burschen.
(The president tells the joke to the boy.)

- 20 Der Autor erzählt dem Gegner die Absicht.
Der Autor erzählt die Absicht dem Gegner.
(The author tells the intention to the opponent.)
- 21 Der Bursche reicht dem Fürsten den Kasten.
Der Bursche reicht den Kasten dem Fürsten.
(The lad hands the box to the prince.)
- 22 Der Präsident reicht dem Meister den Kuchen.
Der Präsident reicht den Kuchen dem Meister.
(The president hands the cake to the master.)
- 23 Das Paar schenkt dem Präsidenten das Vermögen.
Das Paar schenkt das Vermögen dem Präsidenten.
(The couple gives the fortune to the president (as a present).)
- 24 Der Graf schenkt dem Schreiber das Schild.
Der Graf schenkt das Schild dem Schreiber.
(The earl gives the sign to the scribe (as a present).)
- 25 Der Papst schickt dem Buben den Apfel.
Der Papst schickt den Apfel dem Buben.
(The pope sends the apple to the boy.)
- 26 Der Autor schickt dem Bürger den Topf.
Der Autor schickt den Topf dem Bürger.
(The author sends the pot to the citizen.)
- 27 Der Held verkauft dem Bürger den Vogel.
Der Held verkauft den Vogel dem Bürger.
(The hero sells the bird to the citizen.)
- 28 Der Meister verkauft dem Fürsten die Tasche.
Der Meister verkauft die Tasche dem Fürsten.
(The master sells the bag to the prince.)
- 29 Die Bekannte verspricht dem Chef die Information.
Die Bekannte verspricht die Information dem Chef.
(The acquaintance (f.) promises the information to the boss.)
- 30 Das Paar verspricht dem Fürsten das Obst.
Das Paar verspricht das Obst dem Fürsten.
(The couple promises the fruit to the prince.)

- 31 Die Angestellte zeigt dem Burschen den Stoff.
Die Angestellte zeigt den Stoff dem Burschen.
(The employee (f.) shows the cloth to the lad.)
- 32 Die Bekannte zeigt dem Präsidenten das Dokument.
Die Bekannte zeigt das Dokument dem Präsidenten.
(The acquaintance (f.) shows the document to the president.)
- 33 Der Onkel bringt dem Burschen die Information.
Der Onkel bringt die Information dem Burschen.
(The uncle brings the information to the boy.)
- 34 Der Autor bringt dem Grafen das Holz.
Der Autor bringt das Holz dem Grafen.
(The author brings the wood to the earl.)
- 35 Die Tante erzählt dem Schreiber den Witz.
Die Tante erzählt den Witz dem Schreiber.
(The aunt tells the joke to the writer.)
- 36 Der Typ erzählt dem Onkel die Wahrheit.
Der Typ erzählt die Wahrheit dem Onkel.
(The guy tells the truth to the uncle.)
- 37 Der Onkel reicht dem Buben das Brot.
Der Onkel reicht das Brot dem Buben.
(The uncle hands the bread to the boy.)
- 38 Der Bursche reicht dem Grafen den Tee.
Der Bursche reicht den Tee dem Grafen.
(The lad hands the tea to the count.)
- 39 Die Tante schenkt dem Papst die Kartoffel.
Die Tante schenkt die Kartoffel dem Papst.
(The aunt gives the potato to the pope (as a present).)
- 40 Der Feind schenkt dem Meister den Stock.
Der Feind schenkt den Stock dem Meister.
(The enemy gives the stick to the master (as a present).)
- 41 Der Präsident schickt dem Meister den Witz.
Der Präsident schickt den Witz dem Meister.
(The president sends the joke to the master.)

- 42 Die Angestellte schickt dem Grafen den Zucker.
Die Angestellte schickt den Zucker dem Grafen.
(The employee (f.) sends the sugar to the earl.)
- 43 Der Bursche verkauft dem Helden den Ring.
Der Bursche verkauft den Ring dem Helden.
(The lad sells the ring to the hero.)
- 44 Der Schreiber verkauft dem Papst das Glas.
Der Schreiber verkauft das Glas dem Papst.
(The scribe sells the glass to the pope.)
- 45 Das Paar verspricht dem Schriftsteller den Kuchen.
Das Paar verspricht den Kuchen dem Schriftsteller.
(The couple promises the cake to the writer.)
- 46 Der Chef verspricht dem Burschen das Schwein.
Der Chef verspricht das Schwein dem Burschen.
(The boss promises the pig to the lad.)
- 47 Der Bub zeigt dem Papst das Boot.
Der Bub zeigt das Boot dem Papst.
(The boy shows the boat to the pope.)
- 48 Das Opfer zeigt dem Meister das Dokument.
Das Opfer zeigt das Dokument dem Meister.
(The victim shows the document to the master.)
- 49 Die Bekannte bringt dem Meister den Kuchen.
Die Bekannte bringt den Kuchen dem Meister.
(The acquaintance (f.) brings the cake to the master.)
- 50 Der Chef bringt dem Gegner den Ring.
Der Chef bringt den Ring dem Gegner.
(The boss brings the ring to the enemy.)
- 51 Der Präsident erzählt dem Meister die Absicht.
Der Präsident erzählt die Absicht dem Meister.
(The president tells the intention to the master.)
- 52 Das Opfer erzählt dem Schriftsteller die Information.
Das Opfer erzählt die Information dem Schriftsteller.
(The victim tells the information to the writer.)

- 53 Der Papst reicht dem Onkel den Topf.
Der Papst reicht den Topf dem Onkel.
(The pope hands the pot to the uncle.)
- 54 Der Schreiber reicht dem Helden den Kaffee.
Der Schreiber reicht den Kaffee dem Helden.
(The scribe hands the coffee to the hero.)
- 55 Der Graf schenkt dem Buben den Hund.
Der Graf schenkt den Hund dem Buben.
(The earl gives the dog to the boy (as a present).)
- 56 Der Onkel schenkt dem Helden den Vogel.
Der Onkel schenkt den Vogel dem Helden.
(The uncle gives the bird to the hero (as a present).)
- 57 Der Onkel schickt dem Burschen den Apfel.
Der Onkel schickt den Apfel dem Burschen.
(The uncle sends the apple to the lad.)
- 58 Der Chef schickt dem Papst das Dokument.
Der Chef schickt das Dokument dem Papst.
(The boss sends the document to the pope.)
- 59 Der Bürger verkauft dem Fürsten die Decke.
Der Bürger verkauft die Decke dem Fürsten.
(The citizen sells the blanket to the prince.)
- 60 Der Meister verkauft dem Schriftsteller die Frucht.
Der Meister verkauft die Frucht dem Schriftsteller.
(The master sells the fruit to the writer.)
- 61 Der Fürst verspricht dem Meister das Obst.
Der Fürst verspricht das Obst dem Meister.
(The prince promises the fruit to the master.)
- 62 Der Graf verspricht dem Onkel das Vermögen.
Der Graf verspricht das Vermögen dem Onkel.
(The earl promises the fortune to the uncle.)
- 63 Der Held zeigt dem Grafen den Antrag.
Der Held zeigt den Antrag dem Grafen.
(The hero shows the application to the count.)

64 Der Bürger zeigt dem Paar den Bauernhof.

Der Bürger zeigt den Bauernhof dem Paar.

(The citizen shows the farm to the couple.)

APPENDIX B:

Appendix B: Analyses of Other responses

INSERT TABLE B1 AROUND HERE

Table B1 provides a detailed breakdown of response categories in Experiments 1 and 2. All responses are listed only once and in the first category from top to bottom that applies to them.

"*No argument order*" indicates responses in which the phrases of one or both postverbal arguments are not realized, and/or no argument order can be assigned. (e.g., "*th-the master . sells the –*" that makes an attempt to represent one argument as an NP. Irrespective of the absence of a lexical head, there is no indication of any other phrase, let alone one that might help to disambiguate the speaker's structural intentions.) Presumably, many of these responses result from the participants' failure to take in a stimulus in its entirety.

"*Unexpected argument type*" indicates responses in which one or both postverbal arguments are realized in a format that is neither NP nor (recipient) PP. (This covered many instances of non-applicable prepositions, frequently accompanied by lexical replacements of verbs – e.g. of *verraten* "to betray" in "*ehm the boy.y says something about the win – to . the . president*".) These responses often result from paraphrases in which the semantic contents of the source is not fully represented, or integrated differently into the target utterance (e.g. *meldet die Information* "tell the information" translated as "informs ... of the information").

"*Violation of clause structure*" indicates responses that violated standards of the production language with regard to morphosyntactic features. Where morphology is concerned, this covers mostly responses in German, e.g. use of cases (Genitive, Nominative) or case combinations (e.g. double accusative, "*der Onkel verrät 'n Meister 'n Kenntnis*") that are not acceptable for objects of ditransitive verbs in standard German. In English responses, use of inappropriate prepositions was often already covered in the previous category; the current category more often captures uses of pronouns that render unambiguous assignment of thematic functions impossible (e.g. "*the count sends the document – something*").

"Verb issues" is an umbrella category that covers all remaining productions where no verb has been produced (e.g., "*der Schreiber – dem Held . die Tasche*"), where the verbal voice has been changed from active to passive (e.g., "*the president is given the object by his enemy*"), where the verb is a non-alternating verb in the framework of Levin (1993), (e.g., "*the citizen – eh – explains the work to . the couple*") or a verb that does not

support recipient arguments (e.g., beneficiary argument in "*the . acquaintance buys a bike for the uncle*"), or where a phrasal verb is employed (e.g., "*the write- or the author hands . the farm over to the couple*"), and also instances where no acceptable lexical verb form is produced (e.g., "*the master shicked the opponent . joke*"). Sentences with incorrect verbs that were however form-related to the source or translations of form-related verbs (e.g., smell or riechen (smell) for German reichen (pass)) were acceptable as POs or DOs if they fulfilled all other criteria.

Under "*use of pronoun or placeholder hesitation*", 'other' status is assigned to all productions where the lexical head of one or both postverbal arguments is replaced by a hesitation (e.g., "*the . Paar rent – ööööh the plane to . hm [weiß ich nicht]*"), or one or both NPs are replaced by a pronoun (e.g. "*the boy – rents . something to someone*").

Experiment 1

An initial analysis tested whether the distribution of 'others' depended on experimental or control variables. For random effects, the model included participants and source verbs. Inclusion of the Task x Native Language interaction improved the logit mixed effect model [$\chi^2(1) = 35.6, p < .0001$]. Further improvements of the model could be achieved by inclusion of a random slope for (centered) session trial by Subject ($\chi^2(2) = 50.9, p < .0001$).

INSERT TABLE B2 AROUND HERE

The analysis (Table B2) finds a main effect of Task; participants were more likely to produce other responses in the translation task than in the repeating task. A main effect of Native Language indicates that native speakers of German (i.e., of the source language) produced fewer 'others' than native speakers of English. An interaction of Native Language with Task indicates that this advantage was larger in the repetition than the translation task.

Experiment 2

A similar analysis was conducted for Experiment 2. For random effects, the model included participants and items. One data point was excluded from this analysis because it combined a high Studentized residual ($t = -2.92$) with high Cook's distance ($D = 0.171$), suggesting an outlier with abnormally strong impact on the resulting model. Inclusion of the interactions Task x Native Language and Task x Source Construction improved

the model fit considerably in comparison to a model without any interactions [$\chi^2(2) = 32.3, p < .0001$]. In no case could the model be improved by inclusion of one or several random slopes for interactions of fixed and random effects. The control variables of Task Sequence and (centered) Session Trial, together with a random slope of Session Trial by Participant, improved the model's fit to the data further ($\chi^2(4) = 44.8, p < .0001$).

INSERT TABLE B3 AROUND HERE

The analysis of 'others' (Table B3) revealed a weak effect of Task, which indicates that participants were more likely to produce 'others' when translating than when repeating. As before, there was a main effect of Native Language: Native speakers of German (the source language) produced fewer 'others' in Experiment 2 than native speakers of English, and an interaction of Task with Native Language indicated that the difference between the groups was more prominent in the translation task than in the repeating task. Further, fewer 'others' were produced in response to DO-DatAcc than to DO-AccDat stimuli, presumably reflecting reduced availability of structural alternatives during processing. A strong interaction of Task with Source Construction seems to indicate that DO-AccDat stimuli led to more 'others' than DO_DatAcc stimuli in repetition, with a reversed pattern in translation. Different from Experiment 1, participants in Experiment 2 showed a practice effect: 'others' occurred significantly more often in earlier stages of the experimental session; they were also marginally more likely among participants who started with the translation task.

Table 1: *Response frequencies in Experiment 1 (depending on Task, Native Language, and Source Construction)*

(N=1792)

L1 speakers of...	German source construction	target constructions produced...						
		...in repeating task (German to German)				...in translation task (German to English)		
		DO-DatAcc	DO-AccDat	PO	other	DO	PO	other
English	DO-DatAcc	115	0	0	109	35	46	143
	PO	0	5	111	108	3	72	149
	TOTAL	115	5	111	217	38	118	292
German	DO-DatAcc	208	1	0	15	41	84	99
	PO	0	2	208	14	3	124	97
	TOTAL	208	3	208	29	44	208	196

Table 2: Summary of fixed effects on construction choice in a generalized mixed logit model ($N = 405$, log-likelihood = -128.8) for the translation task of Experiment 1

Predictor	Estimate	SE	z	p
(Intercept)	-0.509	0.76	-0.670	>0.50
Native Language = German	1.583	0.84	1.876	>0.06
Source Construction = PO	4.306	0.62	6.982	<0.0001
Trial-in-task (centered)	-0.020	0.02	-0.794	>0.42
Native Language x Trial	0.099	0.04	2.780	<0.01

Table 3: *Response frequencies in Experiment 2 (depending on Task, Native Command, and Source Construction)*

(N=2048)

L1 speakers of...	German source construction	target constructions produced...						
		...in repeating task (target = German)				...in translation task (target=English)		
		DO-DatAcc	DO-AccDat	PO	other	DO	PO	other
English	DO-DatAcc	146	1	0	109	100	36	120
	DO-AccDat	1	121	4	130	26	125	105
	TOTAL	147	122	4	239	126	161	225
German	DO-DatAcc	241	2	0	13	72	117	67
	DO-AccDat	3	224	0	29	37	162	57
	TOTAL	244	226	0	42	109	279	124

Table 4: Summary of fixed effects on construction choice in a generalized mixed logit model ($N = 671$, log-likelihood = -303.6) for the translation task of Experiment 2

Predictor	Estimate	SE	z	p
(Intercept)	-1.126	0.53	-2.105	<0.05
Native Language = German	1.796	0.67	2.667	<0.01
Source Construction = DO-AccDat	3.185	0.48	6.705	<0.0001
Native Language x Source Construction	-1.820	0.62	-2.933	<0.01

Table B1: Detailed breakdown of responses in Experiments 1 and 2*

N	Experiment 1			Experiment 2		
	TOTAL	L1 E	L1 G	TOTAL	L1 E	L1 G
	2048/ 1792	1024/ 896	1024/ 896	2048	1024	1024
total Others	848/ 729	581/ 508	267/ 221	622	460	162
no argument order	162/ 149	114/ 106	48/ 43	131	85	46
unexpected argument type	249/ 232	184/ 167	65/ 65	167	136	31
violation of clause structure	115/ 104	108/ 98	7/ 6	144	124	20
verb issues	151/ 87	73/ 46	78/ 41	50	34	16
--- no verb produced	6/6	5/5	1/1	3	2	1
passive voice	1/1	1/1	0/0	0	0	0
not an alternating verb	97/ 36	47/ 23	50/ 13	28	24	4
not a ditransitive verb	9/9	8/8	1/1	5	5	0
inacceptable phrasal verb (non-existent, non-alternating)	34/ 31	11/8	23/ 23	8	1	7
pseudo verb	4/4	1/1	3/3	6	2	4
use of pronoun or placeholder hesitation	172/ 157	103/ 91	69/ 66	130	81	49

* Only bold numbers are considered in the analyses of Tables 6 and 7. For Experiment 1, non-bold numbers before the slash indicate raw numbers prior to exclusion of items involving source verb *liefern* (see section 2.2).

Table B2: Summary of fixed effects on production success in a generalized mixed logit model ($N = 1788$, log-likelihood = -862.0) for Experiment 1

Predictor	Estimate	SE	z	p
(Intercept)	0.311	0.40	0.781	>0.43
Task = translation	-1.204	0.26	-4.596	<0.0001
Source Construction = prepositional	-0.074	0.12	-0.604	>0.54
Native Language = German	3.629	0.49	7.357	<0.0001
Task x Native Language	-2.511	0.46	-5.487	<0.0001

Table B3: Summary of fixed effects on production success in a generalized mixed logit model ($N = 2041$, log-likelihood = -933) for Experiment 2

Predictor	Estimate	SE	z	p
(Intercept)	0.281	0.42	0.664	>0.50
Task = translation	-0.534	0.24	-2.193	<0.05
Source Construction = DO-AccDat	-0.626	0.18	-3.458	<0.001
Native Language = German	2.530	0.53	4.773	<0.0001
task sequence = trl-rep	0.995	0.51	1.952	>0.05
Session Trial (centered)	0.019	0.01	3.511	<0.001
Task x Source Construction	0.986	0.24	4.097	<0.0001
Task x Native Language	-1.392	0.34	-4.146	<0.0001

Figure 1: Experiment event sequence (schematic representation)

