Structural difference and difficulty in translation and interpretation

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Contents

Abstract

Is structural difference in a language pair associated with difficulty in translating or interpreting complex sentences in that pair? This study aims to shed light on that question. Specifically, it seeks associations between typological differences in the branching direction of subordinate clauses and rates for three identified indicators of production difficulty in translation and interpretation. The unit of analysis used to measure rates for those indicators is the semantic proposition. The analysis involves translation and interpretation from English into five languages from different families: Russian, Hungarian, Turkish, Mandarin and Japanese. Three modes of language transfer are considered: legal translation, subtitle translation and simultaneous interpretation. The findings provide initial confirmation that greater structural difference in a language pair is associated with higher rates for indicators of difficulty in translating or interpreting complex sentences in that pair, with some major differences between the three modes considered.

Foreword

I've worked for more than 30 years as a translator, interpreter and language trainer. During that time, I've worked professionally with European languages including French, Spanish, German, Polish and Greek. All those languages are similar in the way clauses are arranged in a complex sentence: a complement clause comes after the verb it complements ("I know *you're hiding something*"), a relative clause comes after the noun it modifies ("all the places *I've been*"), etc. The same is largely true of Hungarian and Finnish, which I've studied and worked with as well. I've also worked with languages which are very different from European languages in complex sentence structure, including Turkish and Mandarin, and I've studied Japanese. Time and again I've seen myself and other experienced colleagues struggle to transfer the structure of complex sentences between such languages and European ones.

I've seen translators of such languages struggle to manage trade-offs between structural accuracy and readability. I've seen translations into such languages contain sentences with so many nested structures that they're very hard to understand. I've seen European language translators start working well from a new European language after studying it for a year or two, while finding it hard to work from a structurally very different language even after many years of study.

I've seen this difficulty even more in simultaneous interpretation. I learned Hungarian – a hard language, but one with sentence structure heavily influenced by that of other European languages – after the age of 40, and interpreted decently from it for years. I have a much harder time interpreting from Turkish – a language with very different complex sentence structure from that of European languages – although I've spoken it fluently for decades. I perceive that difficulty as being due to complex sentences with so many parts that need to be scrambled and repackaged that they can seem impossible to reproduce in real time. Colleagues describe similar experiences.

In simultaneous interpretation between structurally very different languages, the result can all too often be omissions, generalizations or distortions. But structural mistakes can be surprisingly common in written translation between such languages as well. Translators who are skilled at conveying meaning and feeling accurately, appropriately and naturally between European languages can stumble when translating complex sentences in a structurally very different pair. I spent years revising translations into English, and constantly saw the same types of structural problem when those translations were from Turkish, Mandarin or sometimes Hungarian. In my experience, translations without parsing problems between

structurally very different languages, even when done by experienced professionals, seem to be the exception rather than the rule.

That experience is my motivation for this study, which examines translation and interpretation between English and languages from five other families. The main question the study seeks to answer is whether structural difference in a language pair is associated with rates for indicators of difficulty in translating or interpreting complex sentences in that pair. If so, a related question is whether there are differences in those associations between the three modes of language transfer considered – legal translation, subtitle translation and simultaneous interpretation.

This study hopes to be of interest to anyone involved in translation or interpretation practice or research.

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1. Introduction

Is structural difference in a language pair associated with difficulty in translating or interpreting complex sentences in that pair? If so, are there differences in that association between the three modes of language transfer considered – legal translation, subtitle translation and simultaneous interpretation? Those are the questions this study aims to help answer. To do so, it first proposes a method for analyzing the semantic structure of a sentence and measuring changes in that structure in translation or interpretation. Then, based on research establishing such changes as indicators of cognitive difficulty, the study seeks associations between their frequency and structural difference in the language pair of translation or interpretation.

Many factors can contribute to the difficulty of a translation or interpretation task. Some of those factors can have to do with the text or speech – like subject, terms, idioms, register, style or (for interpretation) speed. Others can have to do with the translator or interpreter – like experience, background knowledge, personal beliefs, or physical or emotional state. The task can be made more difficult by cultural differences – like history, politics, popular references or norms of politeness. The same is true of linguistic features – like writing systems, morphology, irregularity, grammatical ambiguity or homophony.

But there's another major factor of difficulty which can often be underestimated: **structural difference** in the language pair of translation or interpretation – especially large-scale typological difference in the branching direction of subordinate clauses. This study seeks associations between that typological difference and three identified indicators of production difficulty in translation and interpretation. It counts the average rate for each indicator in a corpus of more than 1000 English sentences, each translated or interpreted into five languages from different families: **Russian, Hungarian, Turkish, Mandarin** and **Japanese**. It then seeks associations between those rates and the structural difference of each language pair.

Each indicator of difficulty involves relations between **propositions**. A proposition is the semantic relation underlying a syntactic clause. The proposition is a good unit for cross-linguistic comparison, because an event or situation can be described in different syntactic forms in different languages. This study uses the proposition as a unit of analysis to count rates for three features of translation or interpretation identified as indicators of difficulty: **reordering, nesting changes** and **changes in semantic relations**.

The study doesn't claim to directly measure the level of difficulty in a given translation or interpretation task. It doesn't compare the levels of difficulty reflected, say, in creating or eliminating two different nested structures. Nor does it compare the levels of difficulty reflected, say, in a nesting change and a change in semantic relations. But it does assume that, if reordering, nesting changes and changes in semantic relations are accepted as indicators of some degree of production difficulty, then, in a given sentence, a higher count for any of those indicators in one language pair suggests a greater degree of difficulty than a lower count for the same indicator in another language pair: two place shifts, two nesting changes or two changes in semantic relations reflect a higher degree of difficulty than one.

The sentences examined are from three modes of language transfer: **legal translation, subtitle translation** and **simultaneous interpretation**. For legal translation, I analyze translations of the Universal Declaration of Human Rights, the Paris Agreement on climate change and the US Foreign Corrupt Practices Act. For subtitle translation, I analyze translated subtitles for the five most popular TED talks to date at the time of writing. For simultaneous interpretation, I analyze recorded interpretation of President Obama's 2015 speech to the UN General Assembly.

The statistical analysis uses generalized linear mixed models, applied by an expert from the statistical service of the University of Louvain. The analysis seeks associations between three independent variables – structural difference, mode of transfer and sentence complexity – and three dependent variables – the indicators of difficulty mentioned above. Strong associations between those variables are revealed by statistical analysis of the corpus data.

The study is in a website format, to make it reader-friendly and easy to browse. It consists of a **Foreword** and five chapters. **Chapter 1 – Introduction** outlines the topic and content. **Chapter 2 – Literature review** gives an overview of relevant research. **Chapter 3 – Method and data** summarizes the method used to assess the preservation of semantic relations between the original version of a sentence and the same sentence in translation or interpretation. It then presents the chosen corpus of sentences and discusses the variables counted. **Chapter 4 – Analysis and results** explains how the data was collected and analyzed, describes associations and tendencies found, and presents the results of a reliability check. **Chapter 5 – Discussion** summarizes the findings, discusses strategies for interpretation and draws conclusions on implications for the profession. There's also an **Epilogue** on **Other structural challenges** not included in the statistical analysis. **Annex I** details the **Semantic parsing method** used. **Annex II** contains all **Data** from the sentences analyzed and data for the reliability check. A short version of the thesis is also available at: https://structural-difficulty-in-translation-and-interpretation.com/short-version.

Taken together, the findings of the study suggest that, the more a language pair differs in structure, the more difficult it may be to translate or interpret a complex sentence in that pair, and the more the meaning may be changed – with some major differences between the three modes of transfer considered.

2. Literature review

Professional translators and interpreters working in certain language pairs describe production difficulty they perceive as stemming from structural difference in those pairs. A major typological difference between languages which appears to be relevant to that perceived difficulty is difference in the typical branching direction of subordinate clauses. Certain features of a message which can change in translation or interpretation, such as reordered or nested elements, have also been associated with cognitive difficulty.

This study seeks to establish associations between structural difference in a language pair and identified indicators of production difficulty as applied to translation and interpretation. With that aim, it proposes a method for assessing whether the linear order and hierarchical relations between propositions as established in the original version of a sentence are preserved in translation or interpretation. The study identifies three ways in which those features can change in translation or interpretation. Two of those ways involve linear order: reordering and changes in nested structures. The other way involves hierarchical changes in the place and type of attachment between propositions. Taking each type of change as an indicator of difficulty as established in other research, the study seeks associations between measured rates for those three dependent variables and three independent variables: structural difference in a language pair, mode of language transfer and sentence complexity.

The first section of this review considers research into structural difference in a language pair as it relates to difficulty in translation or interpretation in that pair. The second section considers research into the three identified indicators of difficulty and the difficulty associated with each one.

2.1 Structural difference and difficulty

2.1.1 The branching direction of subordinate clauses

Two attached clauses can be in a relation of syntactic coordination or subordination. There are three broad categories of subordinate clause generally investigated cross-linguistically: relative, complement and adverbial clauses (Gast and Diessel 2012: 1). In addition to coordination and subordination, Spronck and Nikitina (2019) argue for a third type of clause attachment – reported speech or thought – based on a number of cross-linguistic features.

A typology of languages in terms of the typical branching direction of relative clauses is given by Dryer (2013a) in the World Atlas of Language Structures. Dryer (2007) also provides a typology of languages in terms of the typical branching direction of relative and adverbial clauses. Schmidtke-Bode and Diessel (2017) classify languages in terms of the typical branching direction of complement clauses. Diessel (2001) does the same for the typical branching direction of adverbial clauses.

According to the above classifications, Indo-European and Semitic languages are in one group, with typically right-branching relative and complement clauses, and adverbial clauses which typically branch either way. Finno-Ugric languages are in a second group, with typically right-branching complement clauses and relative and adverbial clauses which typically branch either way. Sino-Tibetan languages are in a third group, with typically right-branching complement clauses and typically left-branching relative and adverbial clauses. Other languages, like Japanese, Korean and Turkish, are in a fourth group, with typically left-branching structures for all three major types of subordinate clause.

2.1.2 SVO-SOV

A smaller-scale typological distinction is Greenberg's (1963) widely used six-way classification of typical word order in languages as "SVO" (Subject – Verb – Object), "SOV" (Subject – Object – Verb), VSO, etc. That distinction involves the typical order of the major elements of a clause, with most languages classified as SVO or SOV. Dryer (1997) argues for a typology based on two binary parameters: OV vs VO and SV vs VS. Those typological distinctions operate on a more local scale than the branching direction distinction in this study. Distinctions like SVO-SOV or OV-VO involve internal clause structure, whereas the branching distinction used here involves the typical linear placement of a subordinate clause in relation to its parent.

In terms of internal clause structure, many German and Dutch subordinate clauses are typically verb-final (SOV or OV). After describing SVO and SOV languages, Dryer (2013b) explains: “A third subtype of language lacking a dominant order consists of languages in which different word orders occur but the choice is syntactically determined. For example, in German and Dutch, the dominant order is SVO in main clauses lacking an auxiliary and SOV in subordinate clauses and clauses containing an auxiliary…. Because this results in both orders being common, neither order is considered dominant here.”

There are some Indo-European languages, like Indo-Iranian languages and Armenian, where the same can also be true of main clauses. Such head-final clauses are an exception to the head-initial structure characteristic of other large phrase types in Indo-European languages. One explanation for that exception is that verbs “face an additional challenger for initial position, because they alone of the lexical categories take specifiers” (subjects), which also claim first place in a clause (Baker 2003: 61). Rather than relegating a verb to second position after its subject – so the argument goes – languages like German (in subordinate clauses) or Hindi (in all clauses at formal register) prefer to keep a phrase head in extreme position and so send a verb to the end of its clause. In any case, the verb-final rules in such languages apply only at the level of an individual clause, not of an entire complex sentence. In contrast, left-branching languages like Japanese, Korean and Turkish not only have the main verb (along with indicators of tense, modality and negation) at the end of the main clause. They also place that main clause at the end of a complex sentence, after any subordinate clauses, in inverse order to that of Indo-European languages.

Despite this major typological difference, both Hindi and Japanese (and sometimes Hungarian or even German) are sometimes referred to as “SOV” or “OV” languages, because of the typical position of a verb in its clause. But in terms of the branching direction of relative and complement clauses, Indo-European languages (including German) are all typically right-branching; Japanese, Korean and Turkish are left-branching; and the branching direction of Sinitic languages like Mandarin is mixed. This typological distinction lies at the heart of the difficulty in translation or interpretation associated with the structural difference of a language pair, as highlighted in this study.

2.1.3 Structural difference and difficulty in translation

Translators who work between languages with very different structure can perceive that difference as a major source of production difficulty, independently of the processing

difficulty associated with a given text. That perception is supported by a growing body of research.

Some of that research involves translation between different European languages. Referring to English-German translation, Nord (2005) analyzes various types of translation problem, including "linguistic translation problems," which result from structural differences in the language pair of translation rather than from the content of any specific text. Experiments reported by Vanroy (2021) associate linear and hierarchical differences in corresponding word groups with difficulty in English-to-Dutch translation, as measured by eye-tracking and key-logging data. The author concludes that "diverging syntactic properties between a source and target unit cause increased translation difficulty" (p. 155). In studies of translation from English into Danish, German and Spanish, Bangalore et al. (2015; 2016) find that differently ordered syntax is associated with higher cognitive load, as reflected in reading time per source word, response time and total translation time.

In a study of Arabic-English translation, AlBzour and AlBzour (2015: 24) describe translation problems caused by "differences between the source language and the target language in terms of syntactic structures and semantic relations," resulting in translation solutions that are "fully ungrammatical, odd and even absurd … where there is an abyss of syntactic and semantic differences between these two systems."

Other analyses of translation difficulty involve translation between European and Asian languages. Carl and Schaeffer (2017: 55) find much higher degrees of syntactic variation between English and Japanese or Hindi than between English and Danish, Spanish or German, which they say makes the translation process much "more difficult and time-consuming." Zou (2016: 190) finds that the most difficult aspect of English-Mandarin translation is the translation of long, complex sentences, due to "difference in phrases and sentence structures." In a study involving Mandarin and seven European langugages, Wong (2006: 124) concludes that "translating between the European languages is much easier than translating between Chinese and any one of the European languages," with structural difference being a greater factor of difficulty than differences in vocabulary or culture. In his view, "this is because the translator is, during the translation process, constantly dealing with syntax in two directions: the syntax of the source language on the one hand and the syntax of the target language on the other." Philippi (1989: 682) colorfully describes Japanese-English translation as "a process of radical demolition, in which a confused-looking mass of raw materials is dynamited and then reassigned, after considerable shifting of positions … to neat, new sentences."

Some researchers propose special strategies to avoid distortion of meaning due to structural difference. Such strategies are examined by Chesterman (2000) in a general analysis of translation between structurally different languages. Muñoz Martín (2012) discusses mental load and coping strategies in translation. Lian (2006) describes such strategies in English-to-Mandarin translation. Others confirm such techniques as applied to a specific translation task: Yang (2010) for a work translated from Finnish into Mandarin, and Ikbal et al. (2016) for a translation from English into Arabic. These strategies generally involve changing the hierarchical structure of sentences to ensure smoother reading and better rhetorical effect. That suggests there may be a trade-off between structural accuracy and readability.

2.1.4 Structural difference and difficulty in interpretation

Several authors have proposed models for how interpreters manage the difficulty associated with simultaneous interpretation. Both Kirchhoff's (2002/1976) "multi-phase model" and Gile's (2009) "effort models" assume that different parts of the interpretation task involve varying degrees of cognitive load, which need to be managed within the limits of overall processing capacity. Kirchhoff analyzes linguistic errors as well as distortion and omission of content as indications of cognitive overload, concluding that "multiple-task performance becomes a problem if task completion requires cognitive decisions which, in sum, reach or even exceed the individual's processing capacity limit" (p. 118). She discusses "changing the order of phrases" as a strategy for reducing cognitive load in interpretation.

Gile (2009: 182) supplements his "effort models" with the "tightrope hypothesis," according to which "most of the time, interpreters work close to saturation, be it in terms of total processing capacity requirements or as regards individual Efforts." That hypothesis is supported by findings of errors and omissions in a study by Gile (2001) comparing simultaneous interpretation to consecutive interpretation of a speech.

Departures from original sentence content, such as errors or omissions, have been proposed as indicators of difficulty in simultaneous interpretation. Barik (1975) analyzes various types of error, omission and substitution in interpretation, which can be seen as indicators of difficulty. Gile (2009) takes errors and omissions as an indication of increased cognitive load in interpretation. Pym (2009) analyzes interpreter omissions from an experiment by Gile as an indication of risk transfer from one type of effort to another. Cai et al. (2018) use omissions as a measure of difficulty in interpretation.

In a study of strategies used by professional French-Dutch interpreters to cope with syntactically complex sentences and high-speed delivery, Meuleman and Van Besien (2009) find that most of their subjects produce an acceptable rendition of complex sentences by segmenting them into shorter, simple sentences, while a few do so by trying to reproduce the original complexity.

Difficulty associated with structural difference between languages has been an increasing topic of research into simultaneous interpretation, because of the added burden which some authors see structural difference as placing on an interpreter's working memory.

Nowhere is that difficulty more strongly questioned than in Seleskovitch and Lederer's (1989) influential *théorie du sens* or interpretive theory. Central to that theory is the notion of "deverbalizing" – processing a message through a language-free stage between understanding and reformulation. The interpretive theory maintains that simultaneous interpretation "hardly differs from one language pair to the next" (p. 137). This view is supported by pointing to interpretation between German and other European languages: "The success of simultaneous interpretation [from German into French] shows the validity of the interpretive method applied to a syntactically very different language pair" (p. 149).

The interpretive theory maintains that observations of interpretation between languages like English, French and German can be extrapolated to interpretation in any language pair. But other researchers disagree. They argue that major differences in the linear order of clauses may make complex sentences in some language pairs resistant to structurally accurate and coherent translation or interpretation. It's this aspect of discourse, the "constraint of linearity," which, in their view, the interpretive theory disregards (Gumul and Łyda 2007; Shlesinger 2014).

In that view, non-linguistic processing, though useful as a conceptual tip for interpreters, may not be able to obviate major differences in the order in which information is presented in a sentence, especially if the sentence has many subordinate clauses. Chomsky (2000) sees the clause as constituting a unit of logical processing, or "phase." In a study of interpreters' ability to recall the form of a sentence they've just interpreted, Isham (1994: 195) finds that interpreters have a greater tendency to process sentence information clause by clause than sentence by sentence, suggesting that "interpreters use the clause as their default unit of processing." This supports findings by Goldman-Eisler (1972) in a study of input segmentation in interpretation, and by Davidson (1992) in a study of Japanese-English interpretation.

Setton (1993: 238) is critical of the interpretive theory, which he says has come in for increasing criticism, "especially from the Japanese sphere…. Apart from … the perceived 'naively empirical' nature of the theory, … cultural and linguistic factors are … swept aside by (largely … uninformed) dogma in support of the theory's universality." He also finds that structural factors "amplify certain difficulties beyond the point where they can be satisfactorily solved by strategies proposed hitherto" (p. 252). Setton (1999: 54) says: "Outside the [interpretive theory], almost all writers … with the relevant experience consider [interpretation from a left-branching language into a right-branching one] to present particular problems." Setton and Motta (2007: 205) consider that "the famous notion of 'deverbalization' … has never been formulated with enough precision to satisfy everybody, or perhaps to be properly tested." According to Gile (2009: 198): "While the relevance of language-specificity in interpreting has not been demonstrated empirically, arguments in favour of the hypothesis are strong, especially with respect to the implications of syntactic differences between the source language and the target language in simultaneous interpreting."

As explained above, German is typologically similar to other Indo-European languages in terms of the typical branching direction of subordinate clauses. Despite that large-scale structural similarity, many studies explore specific difficulties associated with interpretation between German and other European languages.

In an overview of German-English simultaneous interpretation, Wilss (1978: 343) suggests that "languages with predominantly parallel syntactic patterning, e.g. English and French, demand less syntactic restructuring than do languages which differ considerably in structure, e.g. German and English," concluding that "transfer on the basis of parallel syntactic structures can … be regarded as easier to accomplish."

Jörg (1997: 218-219) analyzes the strategy of anticipation in German-English interpretation, where he summarizes the specific challenge of that language pair as follows: "The underlying problem in German-English [interpretation], which often compels interpreters to resort to verb anticipation, is syntactic divergences between the two languages…. In German, the semantically relevant element of the verb phrase is often in end position … [so] waiting for the main verb may overtax the interpreter's short-term memory and result in a loss of information…. One way out of this dilemma is the anticipation of the verbal component at the end of the sentence."

In an overview of simultaneous interpretation strategies, including ones specific to certain language pairs, Riccardi (1999: 173) finds that "a synthetic language like German will involve

greater difficulties in transfer to an analytic language like Italian, as more syntactic reformulation is required…. Syntactic restructuring is generally accompanied by greater cognitive load, unless automatic strategies for reformulating particular source language structures are acquired" [my translation].

In an analysis of data from German-French simultaneous interpretation published by Lederer, Van Besien (1999) finds anticipation to be a frequently used strategy. He summarizes his findings by saying (p. 251): "The fact that so many verbs were anticipated suggests that anticipation is a language-specific phenomenon. The material also contains cases of structural anticipation, a strategy which enables the interpreter to postpone the moment at which s/he has to produce a verb."

In a study comparing strategies used by students of English-Italian and German-Italian interpretation, Donato (2003: 128-130) finds that "fewer restructuring operations are required in [interpretation] from English to Italian than in [interpretation] from German to Italian, where structural dissimilarities are deeper," and that "the subjects' ability to follow the [source language] structure … is indeed facilitated by closer morphosyntactic similarities between [source language] and [target language]." She describes various interpretation strategies such as "morphosyntactic transformation," which she finds her subjects to use almost twice as often in interpreting from German to Italian as in interpreting from English to Italian.

In a study of German-to-English interpretation, Seeber and Kerzel (2012: 238) find that "cognitive load during simultaneous interpreting of syntactically asymmetrical structures increased. These results are at odds with a universalist view of interpreting, according to which structural differences of the languages involved are irrelevant to the process."

Another language sometimes considered to pose language-specific difficulties for interpretation from or into European languages is Arabic. Arabic and other Semitic languages are in the same typological group as Indo-European languages in terms of the branching direction of subordinate clauses (with typically right-branching relative and complement clauses and adverbial clauses which typically branch either way). One structural challenge of Arabic is the tendency for a verb to be placed before its subject in some types of clause. Like verb-final clauses in German, this feature operates on a local scale, involving the order of elements within a clause, rather than the order of clauses in a complex sentence.

In a study of simultaneous interpretation between English and Arabic, Al-Rubai'i (2004: 262) concludes that non-parallel syntax between English and Arabic can "have an adverse effect

on the quality of simultaneous interpreters' performance." In another study of English-to-Arabic interpretation, El-Zawawy (2022: 30) finds that "simultaneous interpreters operating from English into Arabic deal with complex structures in different ways by adopting and adjusting their strategies. The dominant strategy is linearization, which is triggered by the need to translate under time pressure. This strategy also unloads the simultaneous interpreter's cognitive burden."

The works cited above suggest that simultaneous interpretation of comparable speeches may be more difficult in language pairs like English-German, Italian-German or English-Arabic than in language pairs like English-Italian or English-French, for reasons specific to the structural difference of those language pairs. But that structural difference mostly involves the order of elements within a clause. So it operates on a more local scale than the major differences which divide languages like Indo-European and Semitic ones from languages in several other families in terms of the typical branching direction of subordinate clauses. If local differences in the internal structure of a clause may be associated with increased production difficulty in translation or interpretation, as suggested in the above studies, it seems reasonable to suspect that larger-scale typological differences may be associated with greater degrees of production difficulty.

To date, little empirical research has been done on difficulty associated with structural difference in simultaneous interpretation between languages with major differences in complex sentence structure.

Gile (2011: 34) reports on a comparative study analyzing interpretation of an English speech into French, German and Japanese. He finds that "there were more errors and omissions in the Japanese renderings than in either the German or French renderings," concluding that this is "consistent with the tightrope hypothesis, according to which interpreters tend to work close to cognitive saturation, which also makes language-specific and language-pair-specific idiosyncrasies relevant parameters in the interpreting process."

Ahn (2005) finds that complex sentences can't be interpreted with sustained accuracy and coherence from Korean into English, analyzing two types of syntactic management strategy which distort "perspective coherence."

In a study of English-Mandarin interpretation, Wang and Gu (2016) find a high frequency of unnatural pauses, errors and inaccuracies, which they see as indicators of difficulty associated with "structural asymmetry" in that language pair. They conclude: "While waiting helps to earn more time for the interpreters to process and restructure the right-branching sentences,

it is employed with a high risk of cognitive saturation which more often than not causes such problems as information loss or errors in their interpretations" (p. 13).

Yang (2002, as cited in Chen, Song and Wu, 2015) proposes the principle of "syntactic linearity" as a specific interpretation strategy for dealing with the structural difference between English and Mandarin. That strategy consists in interpreting the elements of a complex sentence in more or less parallel order to the order in which they appear in the source language for as long as possible, then breaking to start a new sentence in interpretation. This echoes the technique of "translating with the flow," proposed by the "Beijing school" for interpreting from Mandarin into English. Zhuang (1991), as cited in Setton (1999: 51), describes that technique as "flexibly selecting English words and phrases to follow closely the order of the Mandarin original; this sometimes sounds awkward, but it is still tolerable."

2.1.5 Managing separate syntactic representations

Outside of translation and interpretation, evidence for cognitive difficulty associated with structural difference between languages is provided by studies suggesting that bilinguals process syntactic structures in their two languages more easily when those structures are similarly ordered in both languages.

Jacob et al. (2016) find that German speakers of English as a second language have easier mental access to English structures with the same constituent order and embedding level as in German than they do to structures where constituents are ordered differently or embedded at different levels in each language. A study of English-Spanish bilinguals by Hartsuiker et al. (2004: 204) suggests that, in the language mechanism of a bilingual person, "rules that are the same in the two languages are represented once." A study of Dutch-English, Dutch-French and Dutch-German bilinguals by Hartsuiker et al. (2016) provides further evidence that bilinguals have "shared syntactic representations" of similarly ordered structures and different syntactic representations of differently ordered ones.

It seems reasonable to extend these findings to bilinguals whose languages are more structurally different than any two Indo-European languages. This suggests that a translator or interpreter working between two languages with similarly ordered structures is likely to use a shared syntactic representation in transferring content between those structures. In contrast, a translator or interpreter working between languages with opposite branching order may be faced not only with problems of working memory, but also with the need to

manage two different syntactic representations in reproducing the relations between differently ordered propositions.

In a sense, saying that a speaker of two languages with similarly ordered structures has a shared syntactic representation of those structures is stating the obvious. It's like saying that a speaker of two languages with versions of the same alphabet has a shared representation of the writing system of both languages. Finnish is in a different language family from most other European languages. But a speaker of a European language learning Finnish is likely to learn easily that "että" is the Finnish word for "that" (as in "I know that he's here"). That's because they already have a mental representation of a parallel structure with an initial lexical complementizer (like English "that," French "que," German "dass," etc.). In contrast, a speaker of a European language learning Turkish is likely to have a much harder time learning the corresponding Turkish structure. That's because complementizing morphology in Turkish is neither initial nor lexical, instead involving nominalization, formation of the genitive, various possessive forms, plus other case endings depending on the type of complement taken by the verb in the main clause, which follows the complement clause.

Such differences in difficulty because of the existence or lack of shared syntactic representations suggest that a translator or interpreter working between languages with major differences in structure isn't just dealing with the task of reordering, changing nested structures or preserving the relations between propositions. At the same time, they're also likely to be managing two different syntactic representations of each differently ordered structure.

This section has reviewed research and discussions on translation and interpretation challenges associated with the main independent variable in this study: structural difference between languages. The next section looks at research on our three dependent variables: the three features identified as indicators of difficulty in translation or interpretation.

2.2 Indicators of difficulty in translation or interpretation

This study identifies three features as indicators of difficulty in translation or interpretation – reordering, nesting changes and changes in semantic relations. Each of those features involves the linear or hierarchical relations between propositions. So we'll start with a brief look at why the proposition was chosen as the unit of analysis for this study and at relevant research into propositions, before considering literature on each of the identified indicators of difficulty.

2.2.1 Choosing a unit of analysis

There are many linguistic approaches to segmenting discourse, with various units of analysis depending on their intended use. This study measures rates for indicators of difficulty in translating or interpreting complex sentences. So there were two main criteria in looking for an appropriate unit of analysis. One was whether the unit chosen could be the basis for a method of displaying and measuring such indicators in any language. The second was whether it would lend itself to cross-linguistic comparison – specifically, whether it would reflect the similarity in function between different grammatical structures which languages can use to describe a given event or situation.

Syntactic analysis in the tradition of generative grammar considers relations between morphemes and other grammatical constituents. But those constituents are often too small to be suitable for analyzing complex sentence structure. Plus they don't meet the criterion of cross-linguistic comparability, because they highlight grammatical differences rather than functional similarities. Several methods of discourse segmentation, including the linguistic discourse model (Polanyi 1988) and centering theory (Grosz et al. 1995; Taboada and Hadic Zabala 2008), focus on the finite clause. But that doesn't meet the criterion of cross-linguistic comparability either, because an event or situation can be expressed in a finite clause in one language and in a non-finite clause or a clause-like nominal structure in another language. Tanguy et al. (2012) use the finite clause, together with the prosodic unit or punctuation, to define minimal discourse units. But prosody and punctuation were considered too language-specific and hard to compare for the purposes of this study.

Other methods analyze dialogue using main clauses with subordinate clauses, known as "T-units" (Hunt 1965), or main clauses with modifiers, known as "C-units" (Hughes et al. 1997), or utterances (Passonneau and Litman 1996). But dialogue isn't typical of language that's generally translated or interpreted. Also, dialogue doesn't usually involve sentences with the

degree of complexity associated with the type of difficulty under consideration. Some approaches to segmentation use dependency units, based on Tesnière's dependency grammar (Kintsch 2013; Mel'čuk 1988). But those approaches focus mostly on constituents of clauses, rather than relations between clauses or clause-like structures. The method proposed by Poesio (2000) treats both finite and non-finite clauses as discourse units. But an event or situation described in a finite or non-finite clause in one language can also be described in a nominal structure in another language. What this study needed was a method which treats clause-like nominal structures in the same way as finite and non-finite clauses.

The unit of analysis finally chosen was the semantic **proposition**. A proposition refers here to the set of relations among entities in an event or situation established by a logical function – a predicate.

2.2.2 Propositions

Dryer (2007) identifies several different types of predicate, including transitive and intransitive verbs, adjectives, nominals and locative adpositions. Evidence for the propositional status of some nominal structures is given by Grimshaw (1992), who distinguishes "complex event nominals" with argument structure from "simple event nominals" and "result nominals" without argument structure. Alexiadou (2010) cites several researchers who analyze semantic event structure in gerunds and deverbal nouns.

Cosme (2008) observes: "What is expressed by a phrase in one language may be expressed by a clause in another language…. Translating from English into German frequently triggers … a phenomenon whereby a clause in the source language is turned into a phrase in the target language" (p. 91). Doherty (1999: 115) gives examples of this phenomenon in German-to-English translation.

Lyons (1995) sees propositions expressed in different syntactic forms as equivalent if they meet the same truth conditions. He also discusses "whether and how the traditional classification of subordinate clauses as nominal, adjectival, adverbial, etc., should be reflected in the formalization of the propositional content of complex sentences" (p. 159). This is the basis for classifying subordinate propositions as complement (nominal), modifier (adjectival) or adjunct (adverbial) in this study.

One dimension in which the arrangement of propositions can change is horizontal: with changes in their linear order or changes in structures where one proposition is nested inside

another. The other dimension in which the arrangement of propositions can change is vertical: with hierarchical changes in the way one proposition is subordinated to another. Let's now look at research into these three types of change and the cognitive difficulty associated with each one.

2.2.3 Reordering and difficulty

"Reordering" in this study means reordering of propositions: a translator or interpreter's need or choice to move a proposition from where it was in the original version of a sentence to an earlier or later place in translation or interpretation, in relation to the other propositions.

Several studies have shown reverse recall of verbal information to be more difficult than forward recall. Donolato, Giofrè and Mammarella's (2017) review of literature on the subject concludes: "In verbal span tasks, performance is worse when recalling things in backward sequence rather than the original forward sequence." Similarly, experiments by Anders and Lillyquist (2013) and by Thomas et al. (2003) find reverse recall of information to be much slower than forward recall. Not to mention the difficulty of recalling reordered bits of split propositions.

The more the order of propositions changes from source to target language in translation or interpretation, the more the task of recalling them approaches totally reverse recall and, according to the above findings, the more difficult that task becomes. Chesterman (2011) examines the testability and implications of the "literal translation hypothesis," according to which, "during the translation process, translators tend to proceed from more literal versions to less literal ones." Schaeffer and Carl (2014) propose parallel word order as a criterion for "literal translation," which they find to be associated with lower cognitive load than non-literal solutions in English-to Spanish translation. Birch et al. (2008) find reordering to be a strong predictor of translation "difficulty" as reflected in the performance of statistical translation engines.

In studies of translation from English into Danish, German and Spanish, Bangalore et al. (2015; 2016) find differently ordered syntax to be associated with an increase in cognitive load, as reflected in reading time per source word, response time and total translation time. Experiments reported by Vanroy (2021: 155) associate linear and hierarchical differences in corresponding word groups with difficulty in English-to-Dutch translation, as measured by eye-tracking and key-logging data, concluding that "diverging syntactic properties between a source and target unit cause increased translation difficulty." Vanroy also proposes a tool

for predicting the translation difficulty of a sentence based on various features of the language pair of translation, including the need for reordering.

The studies cited in section 2.1 discuss production difficulties associated with structural difference between languages, as well as strategies for coping with those difficulties. Most of those production difficulties involve differences between source and target language in terms of the typical linear order of phrases in a complex sentence.

2.2.4 Nesting changes and difficulty

A "nesting" in this study means a structure where one proposition is syntactically surrounded by the predicate and arguments of another proposition.

Hawkins (2014) posits a number of universal efficiency principles of the human language faculty, including a preference for minimal phrasal combination domains (PCDs). A PCD is defined as the smallest linear string required by the human syntax processor to link a phrase head to a directly subordinate constituent. A universal tendency towards minimal PCDs is reflected in studies of grammaticalized phrase order preferences across languages, including studies by Greenberg (1963) and Dryer (1992). This tendency has been confirmed in corpus research and several tests of subjective phrase order preferences. Those tests have involved right-branching languages like English (Hawkins 2000), left-branching languages like Japanese and Korean (Hawkins 1994; Yamashita 2002; Yamashita and Chang 2001, 2006; Choi 2007) and languages with mixed branching direction like Cantonese (Matthews and Yeung 2001). In all languages and for all phrase types tested, the evidence indicates that "processing becomes harder, the more items are held and operated on simultaneously when reaching any one parsing decision," and that "processing complexity and difficulty increase as the size and complexity of the different processing domains increase" (Hawkins 2014: 47). Chafe's (1994: 69) findings on intonation units in spoken language also point to "a cognitive constraint on how much information can be fully active in the mind at one time."

Such views are in keeping with Gibson's (2000) dependency locality theory. That theory analyzes two kinds of human computational resource involved in the process of parsing a sentence: keeping track of a forming sentence structure (including unattached items) and integrating new items into that structure. According to the theory, the processing cost of linking two syntactic elements is a function of the linear distance between them. The theory is supported by cross-linguistic evidence involving English (Gibson and Ko 1999), Dutch and

German (Bach, Brown and Marslen-Wilson 1986), and Japanese (Babyonyshev and Gibson 1999).

Karlsson's (2007: 2) study on center-embedding (nested clauses) in various languages finds that "multiple clausal center-embedding is not a central design feature of language in use" and that "the maximal degree of center-embedding in written language is three." Quirk et al. (1989: 1040) consider even doubly nested clauses to be ungrammatical and "completely baffling." Karlsson's study involves European languages, but he suggests that "it nevertheless seems reasonable to assume a more general validity." In his view, constraints on nested clauses "have their ultimate basis in the material language-processing resources and limitations of the human organism … especially short-term memory limitations." The languages considered in Karlsson's study have largely right-branching subordinate clauses, so most of the nested clauses it finds are of the same type: a relative clause modifying the subject of its parent clause.

Hawkins (2014: 197), citing evidence from Tomlin (1986), finds cross-linguistically that "subjects precede verbs and their direct objects within VP regardless of VO or OV ordering." This is supported by Primus's (1999) generalization that higher syntactic nodes tend to precede lower ones, which may be the main reason why complex sentences with overt subjects in left-branching languages tend to have more nested structures than their equivalents in right-branching languages. This suggests that formal Japanese, Turkish or (to some extent) Mandarin can be structurally more difficult to process, even for a native speaker, than comparable discourse in a European language. Fodor et al. (1974) suggest that left-branching structures are harder to process than right-branching ones, as they require more working memory to retain elements and attach them syntactically. Uddén et al. (2022: 594) find evidence of greater cognitive burden in processing left-branching than right-branching complex sentence structures, as left-branching structures involve "many simultaneous non-attached constituents, a cost which increases with each non-attached constituent presented."

2.2.5 Changes in semantic relations

"Semantic relations" refers here to the place or type of attachment between propositions in a complex sentence. A key criterion in determining the type of attachment between propositions is the distinction between functional coordination and subordination. So this part starts by looking at that often fuzzy distinction, before considering changes in semantic relations as an indicator of difficulty in translation or interpretation.

2.2.5.1 Coordination and subordination

Cristofaro's (2003) analysis of coordination and subordination focuses on underlying meaning rather than grammatical form. Instead of the traditional unit of analysis for complex sentence structure, the clause, Cristofaro uses the state of affairs (the description of a situation or event). Her approach is based on Langacker's (1991) definition, which sees two event descriptions as being in a relation of subordination if one imposes its "profile," or functional type, on the other. Lambrecht (1994) gives a functional definition of subordination based on a distinction between presupposed and new or asserted information.

Those approaches represent a functional version of Mann and Thompson's (1988) rhetorical structure theory. That theory states that, in an asymmetric relation between two clauses, one clause (the "nucleus") is more salient than the other, subordinate clause (the "satellite"). The concept of subordination as a relation between foreground and background information is discussed in Reinhart (1984), Thompson (1987) and Tomlin (1985). Klein and Von Stutterheim (1991) see salient information as information contained in the "main structure" of a sentence, as opposed to non-salient information in the "side structure." Stede (2008) refines this view, stating that either the main or the subordinate clause can be more salient, with salience shaped by a number of factors. Blüdorn (2008) agrees that semantically "nuclear" information can be contained in a subordinate clause, with "satellite" information in the main clause. Bril (2010) highlights mismatches between syntax, function and semantics in relations between linked clauses. Similarly, Visapää (2014: 169) sees Finnish relative clauses, though "grammatically subordinate," as not always "functionally subordinate."

Langacker (1987) sees nouns as denoting "things" and verbs as denoting "processes" involving things. He sees complement clauses and nominalized forms, such as infinitives, as sharing features of both nouns and verbs. Croft (1991) also makes a semantic distinction between prototypical nouns and verbs, based on features such as predicate-argument structure. Cristofaro (2003) considers that functionally subordinate states of affairs are perceived differently from functionally independent ones. She sees the former as lacking an "autonomous profile," so they're "not scanned sequentially, but construed as a unitary whole, just like things" (p. 262). That's why, in her view, subordinate states of affairs are often described using predicates with nominal features, though preserving some or all of their argument structure.

Several authors study main clauses with little or no propositional content, which are formulaic expressions of the speaker or writer's attitude to an assertion in a subordinate clause. Such pragmatic markers have been analyzed by Brinton (2008) and others. Noonan (1985) calls the

verbs in such clauses “propositional attitude predicates,” which he describes as conveying a subjective attitude towards an event. Thompson (2002) takes a similar view, arguing that most English complement clauses aren’t functionally subordinate, and that their syntactic parents should be seen as “epistemic/evidential/evaluative” fragments. Langacker (2014: 19) sees such clauses as syntactically independent but subordinate in prominence. He says: “In presenting such assessments, we are generally not describing them for their own sake, but rather as a way of indicating the epistemic status of the event the proposition pertains to” (p. 64).

Several researchers describe cases of mismatch between syntactic and functional subordination. Hooper and Thompson (1975) and others investigate so-called “main clause phenomena” in subordinate clauses which express assertions. But they suggest that such cases are the exception, rather than the rule. Others describe areas where it’s hard to give a black-or-white answer as to whether one clause subordinates or is subordinate to or coordinate with another clause in functional terms.

Dixon (2009) sees most pairs of asymmetrically linked clauses as having one semantic “focal clause” and one “supporting clause.” He finds that there’s often a mismatch between syntactic and functional subordination. And he sets criteria for deciding which of two linked clauses is functionally subordinate to the other: a conditional clause is a “supporting clause,” the second of two clauses describing successive events is a “focal clause,” etc. Other approaches are similarly categorical, though they don’t always agree. For example, Dixon (2009) sees “but” as introducing a “focal clause”, while Karlsson (2007) assigns the same link a coordinating role.

Verhagen (2001: 349) sees the main clause in many sentences as conceptually dependent on the subordinate clause, which often “provides the most important information.” He views the main clause in such sentences as “evoking … a mental space for the contents of another clause,” describing this as “a very general function of matrix clauses of complements” (p. 346).

Culicover and Jackendoff (1997) discuss cases of “semantic subordination despite syntactic coordination,” focusing on left-subordinating uses of “and” in English. Yuasa and Sadock (2002) expand on such cases of syntactic coordinators with subordinating function, which they refer to as “pseudo-subordination.” Ross (2016) provides a cross-linguistic analysis of this phenomenon, which he calls “pseudocoordination.” Evans (2007), Schröder (2016) and others analyze the reverse phenomenon – a clause with the syntactic structure of a subordinate clause functioning as the main clause of a sentence – which they refer to as “insubordination.”

Andersson (1975: 45) distinguishes between syntactic and semantic subordination, characterizing clauses which don't "make a statement, ask a question or give a command" as semantically subordinate. Verstraete (2007) defines a subordinate clause as one which doesn't represent a full speech act. The same author (2005) discusses clause links which can function either as coordinating or subordinating, using the criterion of assertive force to distinguish between the two types.

Some languages have clause-chaining constructions, where one or more clauses are syntactically subordinate to a main verb, but each clause has similar semantic weight. This phenomenon, which is syntactically like subordination and functionally like coordination, was initially seen by Foley and Van Valin (1984) as a third type of clause link, which they called "cosubordination." Foley (2010) later revised that view, seeing such constructions as a type of coordination. Bickel's (2010) cross-linguistic research supports this latter view.

Cosme (2008: 90) sees coordination and subordination as "the two prototypical poles of a clause linking continuum allowing for a number of in-between constructions." Bril (2010: 5) cites asymmetric features in coordinating links as evidence of hierarchical structure in relations of clause coordination. Paul (2016: 185) sees links between clauses in Mandarin as "a challenge for the traditional analysis of complex sentences into a 'subordinate' and a 'main' clause." Cristofaro (2003: 22) says that "clause linkage types should not be described in terms of the binary opposition between coordination and subordination," but instead form a continuum between the two. Herlin et al. (2014: 2) agree that relations of coordination and subordination represent "a continuum rather than a dichotomy (symmetry/ asymmetry)." Langacker (2014: 68) shares this view, concluding: "There is no point asking whether a certain clause is or is not subordinate, for usually there is no simple answer."

In translation from one language to another, a syntactic subordinator can be changed into a coordinator and vice versa. Fabricius-Hansen (1999) provides examples to support her claim that some languages, like German, favor syntactic subordination, while others, like English and Norwegian, favor coordination. Cosme (2008) concludes from a corpus analysis that French prefers syntactic subordination more than English, and English in turn more than Dutch, which prefers coordination. She concludes that such tendencies have a "clear impact on the translation process." Solfjeld (2008: 116) examines the effects of raising subordinate clauses to coordinate status in German-to-Norwegian translation, concluding that this can lead to a loss of syntactic clues and misunderstanding of background information as salient. The tension between coordination and subordination in translation is illustrated by Ramm (2008), who examines the syntactic upgrading of German non-restrictive relative clauses to independent sentences in Norwegian. She says that this "almost always changes the

referential structure in the translation in some way" (p. 148), including problems in interpreting the following clause because relations of salience are lost.

A special type of subordinate clause with semantically independent function is a continuative relative clause (a non-restrictive relative clause that continues a narrative). Ramm (2008) characterizes such clauses as functionally coordinate rather than subordinate. So do Aho, Sethi and Ullman (1986: 53), who say that a series of such clauses is "always convertible to iteration." Langacker (2014: 19-23) notes that these clauses show "prosodic seriality," suggesting a "flat structure with no internal grouping." But the view of such clauses as functionally coordinate is debated. Brandt (1990: 128) says: "The subordinate clause form of a continuative RC is used to indicate that an information unit is less important than its matrix clause." Becker (1978) reports that she's never met a German speaker with an intuitive understanding of the difference between restrictive and non-restrictive relative clauses. Visapää (2014: 168-169) argues that "the subordinate status of non-restrictive relatives should also be seen as a continuum" and that "non-restrictiveness never equals non-subordination."

Langacker (2014: 69) observes that "grammar proceeds through time…. The static formulas and diagrams employed in describing it should not obscure the fact that grammar is something that *happens*" (emphasis in original). His dynamic view of cognitive grammar posits a "primary window" of attention, which opens successively onto each clause in a chain. He sees chains of clauses in relations of syntactic subordination as cognitively requiring no "grammatical constituents larger than clauses" (p. 14), with the assembly of such clauses requiring "only local connections, with no more than two clausal processes appearing in any single window" (pp. 26-27). In his view, "conceptual access proceeds on a clause-by-clause basis, with each clause being interpreted locally in relation to its head…. The clauses are successively accessed in basic level windows, each locally connected to the one that comes before" (p. 57).

Such flexibility between syntactic and functional status is harder to achieve in some languages than in others. That's because subordinate clauses in some languages tend to be grammatically deranked – formed in a way that indicates subordinate, background function. Stassen (1985) identifies two ways in which a language can describe a functionally subordinate event or situation: grammatical deranking and "balancing" – using a verb form which could appear in an independent clause. Cristofaro's (2003) functional analysis of subordination relies largely on the same distinction. She concludes that "the cross-linguistic coding of dependent [states of affairs], as manifested in the occurrence of non-independent

clause-like patterns, reflects the cognitive status" of those descriptions as subordinate (p. 298).

Bril (2010) discusses the phenomenon of grammatically deranked subordinate clauses in various languages, including the use of participles and other non-finite verb forms, as well as nominalized verb forms with adpositions or case markers. Many languages tend to describe functionally dependent events or situations using structures with features more characteristic of nouns or adjectives than of verbs. Langacker (1987) explains this by pointing to a basic cognitive distinction between "things" and "processes," with dependent events or situations perceived to some extent as things. Croft (1991) sees functionally dependent states of affairs as displaying non-prototypical correlations between the semantic classes and the pragmatic function of lexical roots.

2.2.5.2 Changes in semantic relations and difficulty

Difficulty associated with reordering and nesting changes is supported by empirical evidence from fields outside translation and interpretation, as explained above in sections 2.2.3 and 2.2.4. The evidence for difficulty associated with changes in semantic relations is more pragmatic and inherent to the act of translation and interpretation, as will be explained in section 3.3.4.

Only a handful of studies consider factors of difficulty in translation or interpretation as reflected in changes in relations between propositions.

Experiments reported by Vanroy (2021) find a significant association between changes in dependency relations among syntactic constituents and translation difficulty. From this, he concludes that a "change in the relationship between words requires more processing effort from the translator" (p. 22). The author discusses various ways of measuring the syntactic equivalence of a source and target text, which he sees as consisting in a combination of reordering, changes in dependency roles and changes in dependency relations. He concludes that such changes make the translation process more difficult.

Larson's (1984) guide to translation technique uses the same unit of analysis as this study – the semantic proposition. Her method involves first rewriting the text to be translated as a set of propositions, then translating those propositions appropriately into the syntax of the other language. This is done to eliminate the "skewing between semantics and grammar" (p. 288) in the original text – the various types of syntactic-semantic mismatch described

above. Larson sees reproduction of the semantic relations within and between propositions, regardless of syntactic form, as key to the preservation of meaning in a successful translation. This suggests that a change in semantic relations in translation or interpretation can be taken as a sign that the translator or interpreter has encountered some sort of difficulty that has prevented them from reproducing the original relations between propositions in the target language.

This literature review has considered research into the main independent variable analyzed in this study – structural difference between languages – as well as the dependent variables – the three features identified as indicators of difficulty in translation or interpretation. The study records values for those variables for each translated or interpreted version of each sentence in the corpus, based on the linear and hierarchical relations between propositions. The next chapter explains how that's done. It starts with a description of the parsing model used to segment sentences into propositions and to indicate the semantic relations between them.

3. Method and data

3.1 Semantic parsing

This section summarizes the general features of a method for parsing complex sentences into component propositions and indicating the functional relations between those propositions. That method is then applied to each sentence in the corpus, to record values for the variables fed into the statistical analysis. A detailed explanation of the semantic parsing method can be found in annex I. The method is also described briefly below.

3.1.1 The reason for semantic parsing

As explained in the literature review, in section 2.2.1, the unit of analysis chosen for this study is the semantic proposition. Dividing complex sentences into clauses or similar syntactic units wouldn't capture the semantic equivalence between a proposition as expressed in a clause in one language and the same proposition as expressed in a clause-like nominal structure in another language. An example can be seen in the original English sentence in (1) and a Japanese translation of the same sentence in (2).

(1) After we arrived, we were taken on a tour of the old town.

(2) 到着後、旧市街のツアーに連れて行かれました。
Tōchaku go, kyū shigai no tsuāni tsurete ikaremashita.
(lit.) "After arrival, we were taken on a tour of the old town."

A syntactic approach to complex sentence parsing would risk overlooking the semantic equivalence between the initial clause in (1) and the initial postpositional phrase in (2). But the features taken in this study as indicators of difficulty involve comparing the relations between segments of original complex sentences and corresponding segments of the same sentences in translation or interpretation. So a syntactic method of segmenting could well have yielded higher counts than a semantic method for the identified indicators of difficulty overall, and in some language pairs more than in others. That could have left the door open to suggestions of certain language pairs appearing to be associated with artificially high counts for the indicators of difficulty, just because translation or interpretation in those pairs may tend to involve more clauses being rendered as nominal structures than in other pairs, or vice versa.

To avoid any such suggestion, a semantic method of segmenting complex sentences has been developed for this study. That method treats all syntactic ways of saying the same thing as equal. So it yields lower counts than a syntactic method would for the indicators of difficulty overall. More importantly, it shows lower degrees of difference between various language pairs in counts for those indicators of difficulty than would be the case with a syntactic approach. There are still striking differences in rates recorded for the indicators of difficulty in some language pairs compared to others, as we'll see in the next two chapters. But the effect on those differences of some languages tending to prefer nominal structures to clauses has been eliminated by applying the semantic parsing method developed for this study.

3.1.2 Relations between propositions

One proposition can be subordinate to another, parent proposition, as illustrated in figure 1.

Figure 1
Parent and subordinate propositions

Each of the propositions in figure 1 can be expressed as a clause or as a clause-like nominal structure. The relations of semantic hierarchy between predicates and arguments in figure 2 are the same.

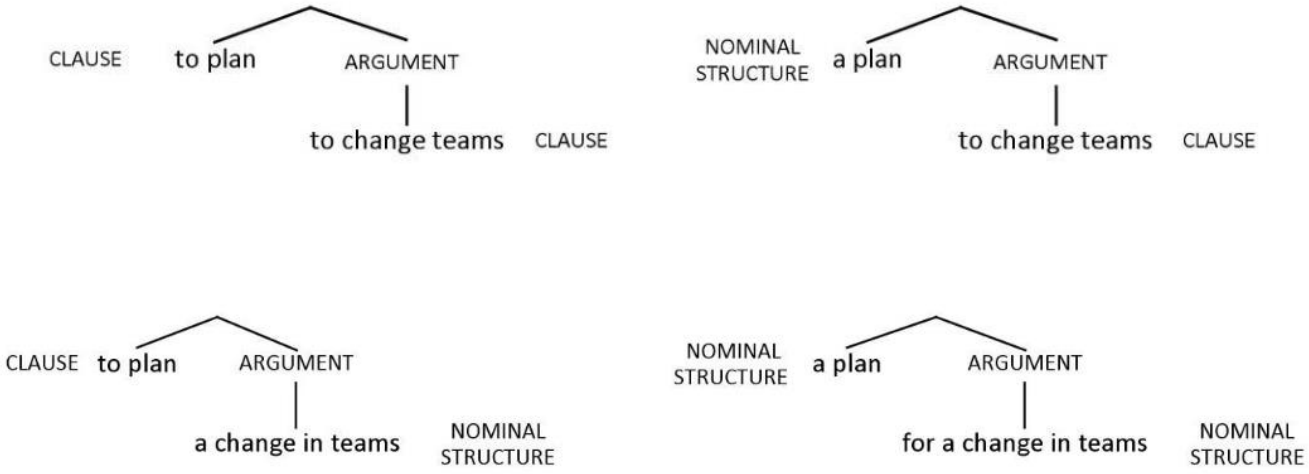


Figure 2
Parent and subordinate propositions with the same hierarchical relations

For simplicity and clarity, the parse trees used here include an overt link between propositions on the same branch as one of the propositions. If one proposition is subordinate to another, an overt link between them – like "for" in the last tree in figure 2 – is included on the same branch as the subordinate proposition.

The relations between a parent and a subordinate proposition can sometimes be recast with minimal differences in meaning from one syntactic form to another, as illustrated in figure 3.

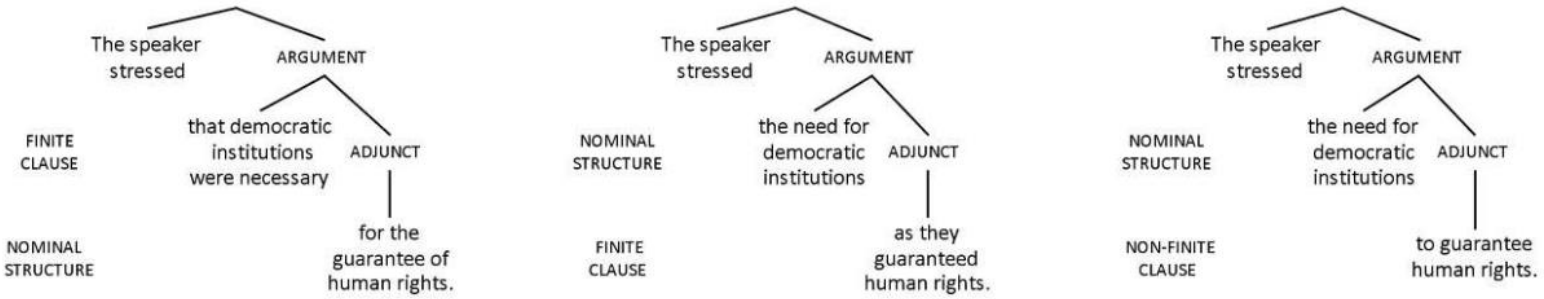


Figure 3
Propositions with similar hierarchical relations

This kind of switch is possible within a language, as in the examples in figures 2 and 3. It's also possible in translating or interpreting a message from one language to another. A method of analysis based on propositions, where clause-like nominal structures are treated in the same way as finite and non-finite clauses, reflects the semantic similarities between the different syntactic forms which various languages can use to describe an event or situation. It also helps highlight whether the hierarchical relations between propositions, whatever their syntactic form, are preserved in translation or interpretation.

Figure 4 shows a parse tree of the hierarchical relations between propositions in a complex sentence. The labels on the nodes indicate the semantic role of each subordinate proposition in relation to its parent. In this sentence, each subordinate proposition is a semantic argument of its parent.

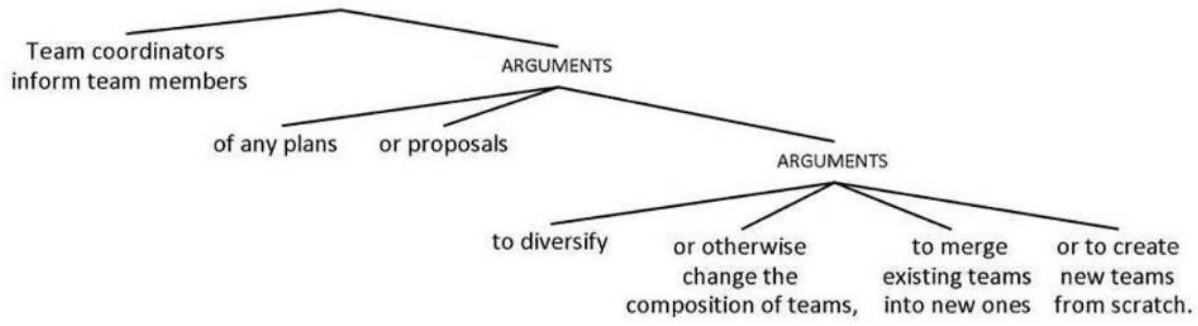


Figure 4
Semantic parse tree of complex sentence

In the parse tree in figure 4, the propositions in the bottom row function as arguments of the underlying verbs “plan” and “propose,” from which the nominal predicates in the second row are derived. “Plans” and “proposals” are treated here as process nominals – that is, predicates with argument structure. In contrast, “composition” in the second proposition in the bottom row is treated as a result nominal with no argument structure – just as if it said “names” or “numbers” instead of “composition.” The distinction between result nominals and process nominals is sometimes fuzzy. This distinction is discussed in the detailed presentation of the semantic parsing method, in section 1.7 of Annex I.

The sort of semantic parse tree used here is similar in appearance to syntactic parse trees in the tradition of generative grammar. The main difference is that each leaf on the trees used here shows the syntactic expression of a semantic proposition. This method of segmentation and display allows for one-to-one comparison of corresponding propositions in translation and interpretation, however they’re expressed in different languages. It also helps highlight problems in transferring complex sentence structure from one language to another.

The semantic parsing method illustrated briefly above is a technical tool developed for the purpose of this study. That method would be need to be refined if it were being proposed as an alternative approach to discourse segmentation in its own right. But as a technical tool, it’s more than adequate for its purpose, which is to segment complex sentences in a way that shows greater correspondence between functionally equivalent phrases than other established approaches to segmentation, like division into clauses or similar syntactic units. A detailed explanation of the semantic parsing method developed for and used in this study can be found in annex I.

3.2 Corpus

The corpus of sentences analyzed in this study consists of three legal texts, five subtitled talks and one simultaneously interpreted speech, comprising a total of 1,136 sentences. For each sentence, the analysis included the original English version and versions translated or interpreted into five languages from different families: Russian, Hungarian, Turkish, Mandarin and Japanese. That makes for a total of 6,816 language versions of sentences analyzed. 26 values were measured and recorded for each sentence. Information on each text, talk or speech, including the reasons for choosing each one, is given below.

3.2.1 Legal translation

As a genre of standard written translation, this study has chosen to focus on **legal translation**, as opposed to other genres such as literature or magazine articles. One reason for this choice is that legal texts often have long, complex sentences, which is where the translation difficulties highlighted in this study are most likely to appear. In a study of UN translations of English legal texts into Arabic, Abu-Ssaydeh and Jarad (2015: 100-101) note: "An essential feature of English legislative writing is the high frequency of complex sentences; through the use of coordination and subordination, legislative English is capable of producing long, complex patterns which represent bafflingly intricate patterns that many translators find extremely challenging." In a study of the effect of the plain English movement on translation of English legal texts into Mandarin, Lin et al. (2023: 1) observe: "Complex nominal and hypotactic structures result in a high number of propositions per sentence, placing a high demand on the cognitive processing abilities of those who read and understand the text."

Another reason this study has chosen to focus on legal translation is that, in addition to difficulty in the translation process, output-related issues, such as distortions of meaning or coherence and comprehension difficulty for the reader, can have major consequences in legal translation.

Within the category of legal translation, three major international documents are analyzed: the **Universal Declaration of Human Rights (UDHR)**, the **Paris Agreement on climate change** and the **US Foreign Corrupt Practices Act (FCPA)**. Because of their global importance, each of those documents is published online in many translated versions.

The **UDHR** is described on the UDHR website as "a milestone document in the history of human rights… [which] set out, for the first time, fundamental human rights to be universally

protected." The UDHR is the most translated document in the world, according to the website of the UDHR Translation Project, where links to each translation can be found. The English, Russian and Mandarin versions used in this study are official translations produced according to standard UN procedures. For the other language versions, the site says that "efforts have been made to select the official or best available translations" wherever possible. The original English version of the UDHR has 68 sentences.

The **Paris Agreement** is described on the Agreement website as "a landmark in the multilateral climate change process because, for the first time, a binding agreement brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects." The English, Russian and Mandarin versions of the Agreement are official translations produced according to standard UN procedures and published on the website of the UN Framework Convention on Climate Change. The Hungarian version is published on the legislation website of the European Union, the Turkish version on the website of the Turkish Official Gazette, and the Japanese version on the website of the Japanese Ministry of the Environment. The original English version of the Agreement has 225 sentences.

The **FCPA** is described on the UK website of the professional services giant PricewaterhouseCoopers as "arguably, the most wide-reaching law" in the world, leading to settlements totaling several billion dollars a year and serving as a model for similar laws in many countries. The English text of the FCPA is published on the website of the US Department of Justice, along with many unofficial translations, including the ones used in this study. The original English version of the FCPA has 205 sentences.

That makes for a total of 498 sentences and 2,988 different language versions of sentences in the three legal texts analyzed.

3.2.2 Subtitle translation

For **subtitle translation**, this study has chosen to analyze five different TED talks, as opposed to other types of subtitle translation, such as translation of subtitles for films or entertainment series. The reason for this choice is that other types of subtitle translation tend to involve a lot of dialogue consisting of simple sentences, where the translation difficulties highlighted here are unlikely to appear. In contrast, lectures by single speakers who are experts in their fields tend to have more complex sentences. Among online lecture platforms, TED is probably the most widely watched, with hundreds of millions of views.

Subtitle translators are sometimes advised to keep translated segments short and easy to read. Except for such general advice, I haven't found any studies which mention the specific challenge of translating long, complex sentences in subtitles between languages with different structure. The instructions for subtitle translators on the TED website make no reference to that challenge.

Because of their large global reach, the choice has been made to analyze the five most popular TED talks to date at the time of writing, according to the website for the most popular TED talks of all time. The site includes a video file for each talk, with original and translated subtitles. The five talks used in this study are: "Do schools kill creativity?" by **Sir Ken Robinson**, "Your body language may shape who you are" by **Amy Cuddy**, "How great leaders inspire action" by **Simon Sinek**, "The power of vulnerability" by **Brené Brown** and "Inside the mind of a master procrastinator" by **Tim Urban**.

Subtitles for each translated TED talk are produced and reviewed by experienced volunteers, following a standard set of guidelines. Translators are instructed to keep subtitle segments to a maximum of two lines and reading speed to a maximum of 21 characters per second. All 25 subtitle translations used in this study were produced by native speakers of the target language.

The original English versions of the talks by Sir Ken Robinson, Amy Cuddy, Simon Sinek, Brené Brown and Tim Urban have 69, 102, 91, 80 and 71 sentences respectively, for a total of 413 sentences. With five translated versions of each sentence, the analysis involved a total of 2,478 different language versions of sentences from the five talks.

3.2.3 Simultaneous interpretation

As a genre of interpretation, this study has chosen to focus on **simultaneous interpretation**, as opposed to other forms of spoken interpretation such as consecutive, liaison, community or telephone interpretation. The main reason for this choice is that the working memory constraints which can have a major effect on the linear order and hierarchical structure of complex sentences, particularly in language pairs where subordinate clauses branch in opposite directions, are most prevalent in simultaneous interpretation. The specific challenges posed by complex sentences in simultaneous interpretation between languages with very different structure are described in section 2.1.4. Some of the main strategies used to cope with those challenges are illustrated in section 5.2.

Within the category of simultaneous interpretation, this study has chosen to analyze recordings of interpretation of former **US President Barack Obama's speech to the UN General Assembly** on 28 September 2015. One reason for choosing to analyze a speech to the UN is that organization's unique international scope. Another reason is that three of the languages considered here – English, Russian and Mandarin – are official UN languages, so sessions of the General Assembly are interpreted simultaneously into those languages by expert UN staff interpreters.

Recordings of the original English speech and of the Russian and Mandarin interpretation were obtained with permission from the UN Audiovisual Library. Interpretation into Hungarian, Turkish and Japanese was kindly provided and recorded by expert freelance interpreters for this study. All five interpreters were working with a written copy of the original speech provided shortly beforehand, but without a prepared written translation. All five recordings used in this study were of interpretation by native speakers of the target language.

The original English version of President Obama's speech has 225 sentences. With five translated versions of each sentence, the analysis involved 1,350 different language versions of sentences from the speech.

The original and all five translated or interpreted versions of each sentence in the corpus can be seen in annex II. Each language version of each sentence is parsed and annotated using the semantic parsing method illustrated in section 3.1 above and detailed in annex I, so that values for variables can be counted and recorded. Before we see how that process of counting and recording works, let's take a closer look at the variables involved.

3.3 Variables

3.3.1 Structural difference between languages

3.3.1.1 Branching direction

A major structural feature of any language is typical **branching direction**: whether a subordinate constituent tends to be placed before the constituent which subordinates it – in a "left-branching" structure – or after it – in a "right-branching" structure (Berg 2009). Most European languages have largely right-branching phrase structure. That also means that phrases in such languages are largely "head-initial." That is, for most phrase types, the head of a phrase (like the main noun in a noun phrase or the main verb in a verb phrase) is typically at the beginning of the phrase. Chomsky and Lasnik (1993) include head directionality among the binary parameters of a language, set in the first stages of native language acquisition.

In this study, "structural difference" refers specifically to difference in the **branching direction of subordinate clauses**: whether the typical position of a subordinate clause in a given language is before or after its parent clause.

A left-branching structure in English, with the subordinate clause preceding its parent, is shown in (3).

(3) *Before you leave the room,* please make sure to switch off all the lights.

A right-branching structure, with the subordinate clause following its parent, is shown in (4).

(4) Please make sure to switch off all the lights *before you leave the room*.

The typical branching direction of subordinate clauses varies by language and type of clause.

Let's start by comparing English and Mandarin. One issue for translating or interpreting complex sentences in a language pair like this is the typical branching direction of a relative clause, as in (5).

(5) Marie is the woman *I've always dreamed of*.

A relative clause typically appears after the noun it modifies in a European language, whereas it typically appears before the modified noun in a Sinitic language, as illustrated in figure 5.

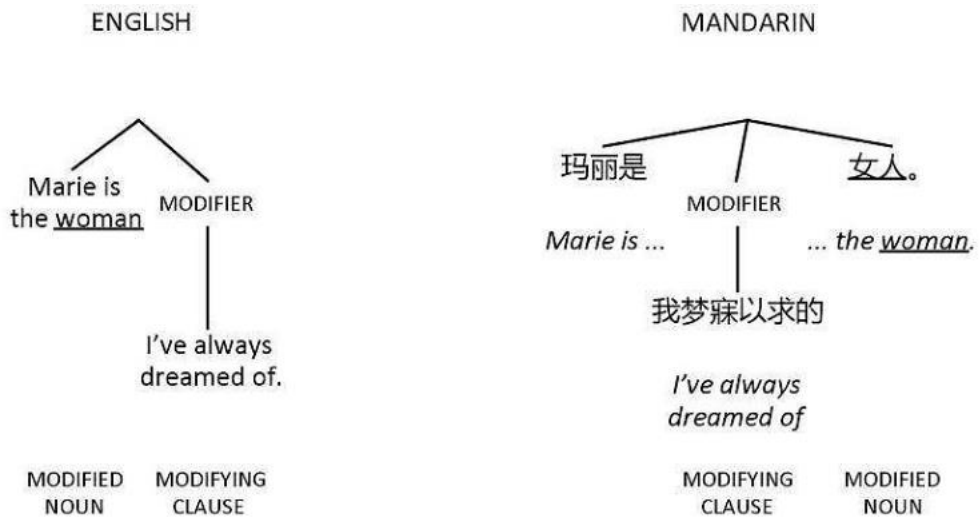


Figure 5
Typical placement of a relative clause in English and Mandarin

The English structure in figure 5 is **right-branching**, with the modifying clause coming after the modified noun in the parent clause. In the Mandarin version, the modifying clause syntactically splits the parent clause, coming before the modified noun, in a **left-branching** structure.

Another type of subordinate clause is a "complement clause." This is a clause that functions as an argument (subject or complement) of the predicate in its parent clause, as in (6).

(6) I've got a sneaking feeling *you're up to no good*.

In a Sinitic language, just as in a European language, a complement clause typically follows its parent clause in a right-branching structure, as illustrated in figure 6.

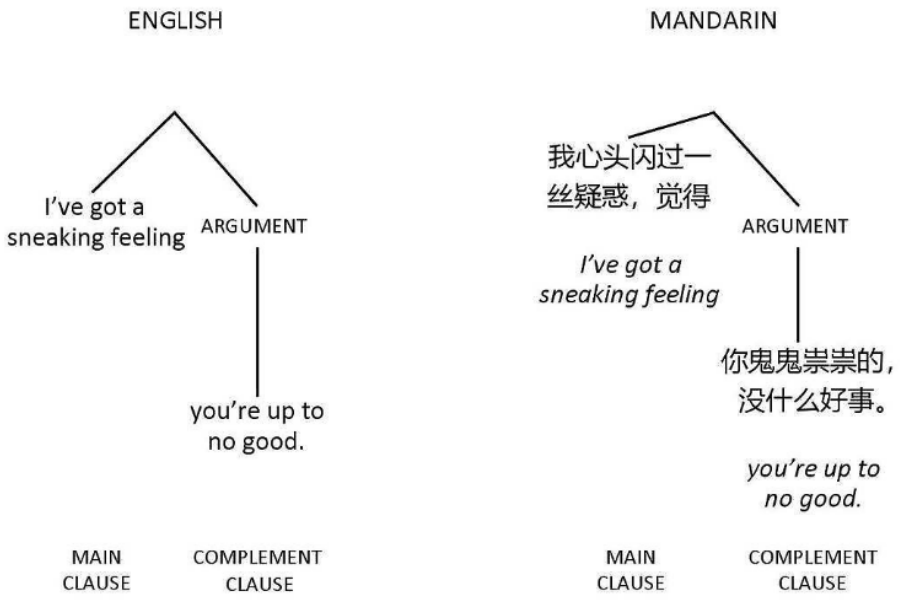


Figure 6
Typical placement of a complement clause in English and Mandarin

Some languages are even more structurally different from English than Mandarin. In a language like Japanese, Korean or Turkish, complex sentence structure is consistently left-branching. So a relative clause in one of those languages typically goes before the noun it modifies in the parent clause, as illustrated in figure 7.

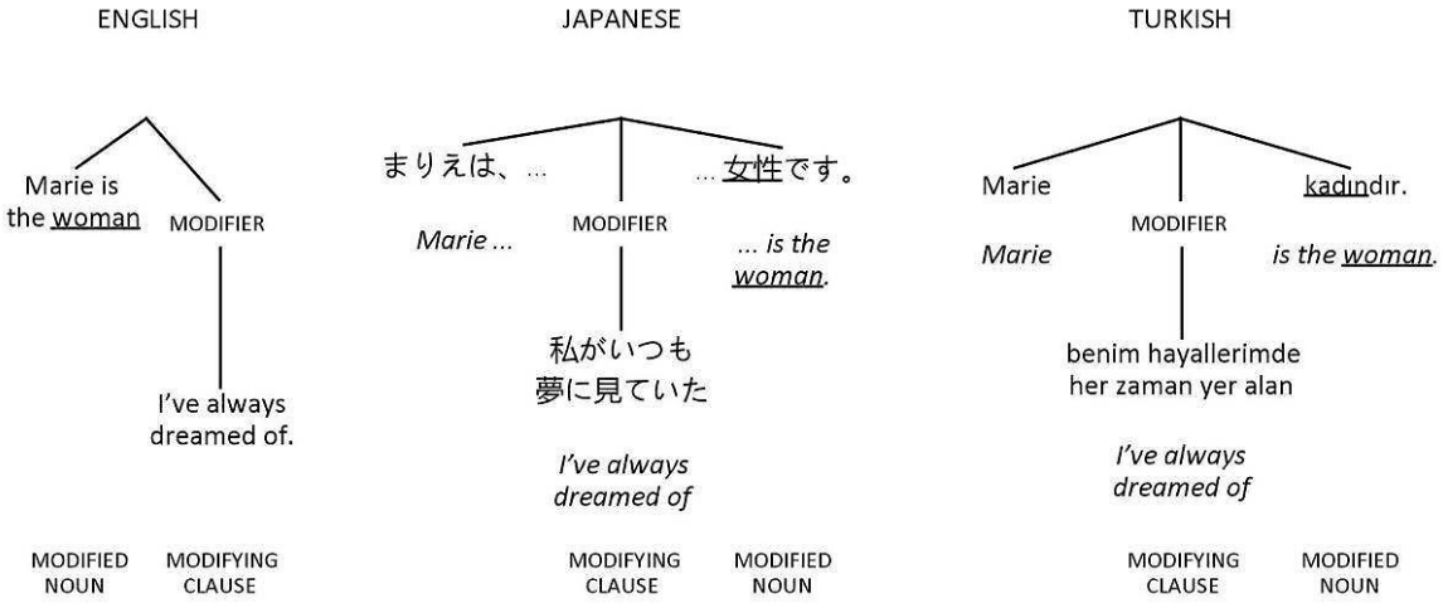


Figure 7
Typical placement of a relative clause in English, Japanese and Turkish

A complement clause in a language like Japanese, Korean or Turkish typically goes before the predicate in the parent clause, often syntactically splitting that clause, as illustrated in figure 8.

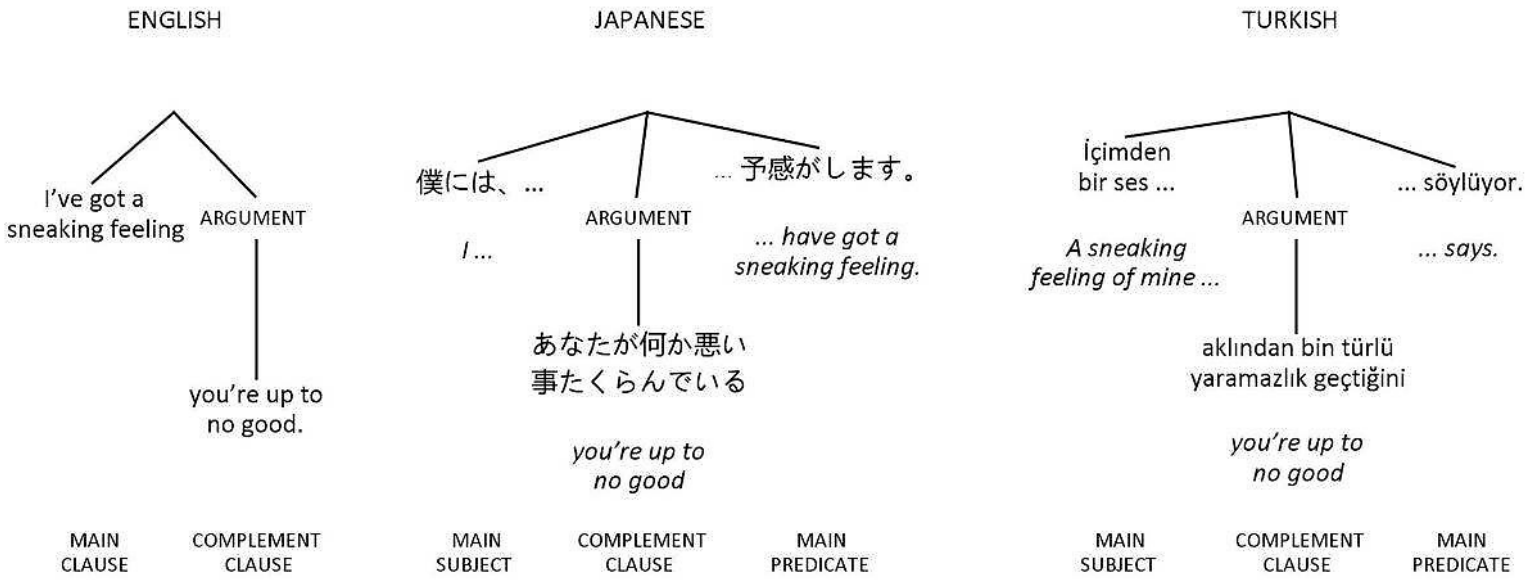


Figure 8
Typical placement of a complement clause in English, Japanese and Turkish

3.3.1.2 Branching direction typology

Languages are generally held to have three major types of subordinate clause: **relative clauses**, which act largely like adjectives; **complement clauses**, which act largely like nouns; and **adverbial clauses**, which act largely like adverbs (Quirk et al. 1989: 1047). Language typologies in terms of the typical branching direction of these three types of subordinate clause are given by Diessel (2001), Dryer (2007; 2013) and Schmidtke-Bode and Diessel (2017). These typologies are the basis for classifying the six languages in this study in terms of their complex sentence structure.

According to the typologies mentioned, a relative clause or a complement clause is typically placed after its parent in every Indo-European language, regardless of the position of a verb within its clause. Some linguists classify Hungarian and Finnish as typically right-branching and others as typically left-branching (Kiss 2002: 6). In those languages, a left-branching relative clause can occur in formal register. Otherwise, both a relative clause and a complement clause typically follow their parents, as in Indo-European languages. Sino-Tibetan languages like Mandarin are more mixed in complex sentence structure, with a relative clause typically coming before the noun it modifies and a complement clause coming after its parent.

In contrast, languages like Japanese, Korean and Turkish are typically left-branching, with any type of subordinate clause preceding its parent. The typical position of a main verb in such languages is at the end of a sentence, no matter how complex that sentence may be. Nor is there mixed phrase structure, including some typically right-branching phrase types. The result, compared to Indo-European languages, is an inverse order of constituents in most phrase types – except for clauses, where the subject is typically near the beginning – plus, crucially, a largely inverse order of clauses in a complex sentence.

Following the typological classifications cited above, Table 1 shows the typical branching direction of the three major types of subordinate clause, in the six languages considered in this study.

Table 1
Typical branching direction of subordinate clauses

Language	Relative clause	Complement clause	Adverbial clause
English	right	right	either
Russian	right	right	either
Hungarian	either	right	either
Turkish	left	left	left
Mandarin	left	right	left
Japanese	left	left	left

The second and fourth columns of table 1 show that, for all six languages considered, the typical branching direction of adverbial clauses can be uniquely predicted based on the typical branching direction of relative clauses. If one of the languages in question has relative clauses that typically branch to the right or either way, it will have adverbial clauses that typically branch either way. And if one of those languages has relative clauses that typically branch to the left, it will have adverbial clauses that also typically branch to the left. So, to avoid redundant data, our statistical analysis only considers the typical branching direction of relative clauses and complement clauses in each language pair.

For each language of translation or interpretation in our study, these two variables for branching direction are combined into a single variable for **structural difference** from English. That variable has four possible values: **same** (relative and complement clauses which both typically branch to the right, as in Russian); **somewhat different** (relative clauses which typically branch either way and complement clauses which typically branch to the right, as in Hungarian); **moderately different** (relative clauses which typically branch to the left and

complement clauses which typically branch to the right, as in Mandarin); or **opposite** (relative and complement clauses which both typically branch to the left, as in Turkish and Japanese). That combined variable for structural difference is one of the three **independent variables** recorded for each sentence in our corpus and analyzed. The other two independent variables recorded for each sentence are: **mode** of language transfer (legal translation, subtitle translation or simultaneous interpretation) and **sentence complexity** (as measured by the number of subordinate propositions in the original English version of a sentence).

Now let's have a look at the **dependent variables** recorded for each translated or interpreted version of each sentence in the corpus: the three features identified as indicators of difficulty in translation or interpretation.

3.3.2 Reordering

"Reordering" in this study means reordering of propositions: a translator or interpreter's need or choice to move a proposition from where it was in the original version of a sentence to an earlier or later place in translation or interpretation, in relation to the other propositions. For example, two propositions may appear in the order shown in (7) in the original version of a sentence.

(7) Please switch off all the lights *before you leave the room*.

But the syntax of the language a translator or interpreter is working into may lead them to switch the order of those two propositions to the order shown in (8).

(8) *Before you leave the room,* please switch off all the lights.

The need or choice to change the linear order of propositions like this, especially with many propositions criss-crossing over long distances, is taken in this study as an indicator of difficulty. Here's why:

A translator translating a long, complex sentence between languages with very different structure may have to look back and forth between various parts of the original version, keeping in mind the overall structure of the unfolding sentence, so they can reproduce the relations between propositions appropriately. In contrast, a translator working between languages with similar structure, like two European languages, can generally shift their focus of attention progressively from one proposition to the next, without having to skip around or worry about reproducing relations between propositions in a different order.

Suppose a Japanese translator is translating the Universal Declaration of Human Rights from English into Japanese. Structural or stylistic differences between the two languages may lead them to change the order of propositions between the original and the translated version of a given sentence, as illustrated in Figure 9. (Lines connect corresponding propositions in each version of the sentence. Several English propositions are split apart in Japanese.)

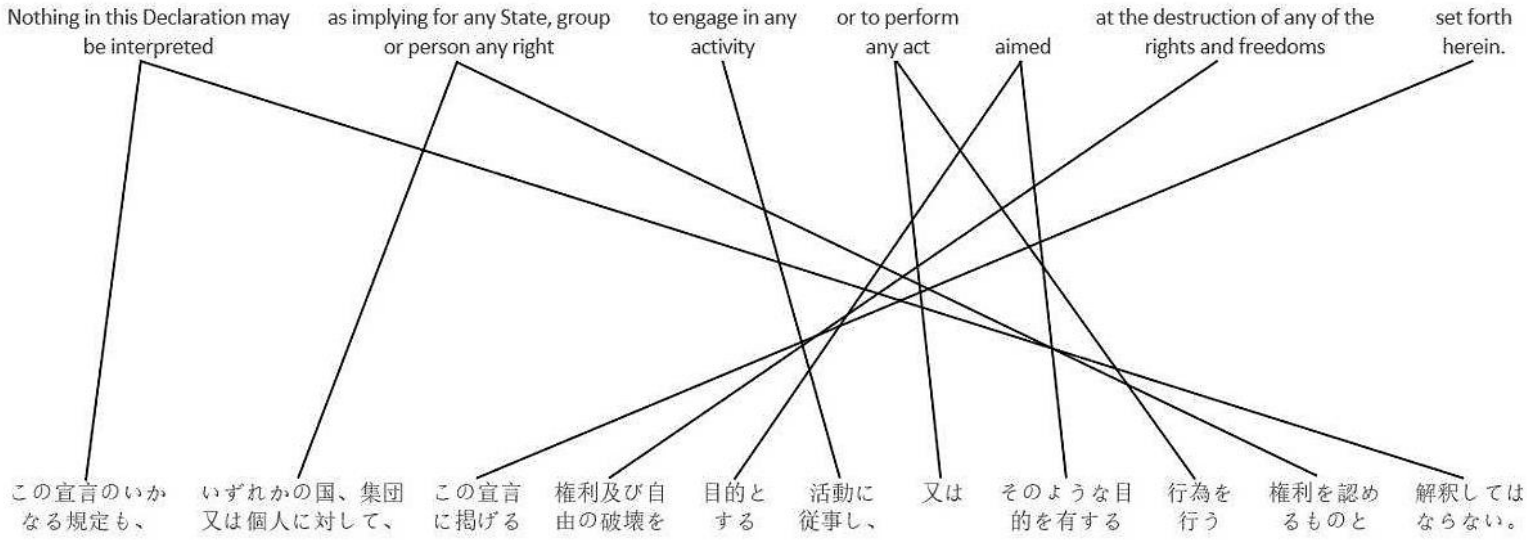


Figure 9
Universal Declaration of Human Rights, last sentence, English and Japanese versions

To produce a result like the Japanese translation in figure 9, the translator would have to read through the entire English version of the sentence, understanding its seven propositions and the relations between them, before deciding which part of which one to translate first. After translating each part, they'd have to re-examine the remaining parts of the English version and the relations between them, before deciding which one to translate next. In contrast, a translator working into a language with similar complex sentence structure to English could begin translating the sentence as soon as they'd read the first proposition, then go on to the next one and so on, without having to recall or reread the rest of the sentence each time.

The problem can be even greater in simultaneous interpretation. An interpreter hearing the English version of the sentence in figure 9 without a written copy would be unlikely to produce such a nicely reordered result as the cited Japanese translation in real time, because of the great burden that could place on their working memory. To do so, they'd have to wait till they'd heard the end of the English version, retaining seven different propositions and the relations between them, before deciding which part of which one to interpret first. After interpreting each part, they couldn't reread the sentence like a translator could. So they'd have to try to recall the remaining parts of the sentence and the relations between them before deciding which one to interpret next. To achieve a more manageable cognitive burden, they'd be liable to produce a result with less reordering, less nesting and therefore less structural accuracy. The more parts of a complex sentence an interpreter tries to retain and juggle around, the more difficult their task becomes.

Miller (1956) and others have found that a person can only retain a certain number of information chunks at a time in working memory. That suggests that an interpreter's ability to correctly recall the propositions in a complex sentence depends on: (a) their ability to organize each proposition into a conceptual chunk, (b) the number of such chunks in the sentence and (c) the order in which those chunks need to be recalled. To the extent that they managed to organize each of the propositions in a sentence like the one in figure 9 into a conceptual chunk, they might just about be able to recall them all. But then they'd be retaining each proposition as a chunk, rather than retaining the details of each one. Going for the big picture might well mean losing some of the detail. And an interpreter needs to reproduce both: the big picture as well as the detail.

What about the order of recall? What if an interpreter does more or less manage to chunk a complex sentence into propositions and retain their content, but then has to recall that content in a different order, to reproduce it in another language? In the sentence in figure 9, part of the first proposition in the English version is at the end of the Japanese version, part of the second proposition in the English version is right before the end of the Japanese version, and so on. The more the order of propositions in a translated or interpreted version of a sentence differs from their order in the original version, the more the task of recalling them approaches recalling them in entirely reverse order. Recalling verbal information in reverse order has been shown to be much more difficult than recalling it in the order it was heard in (Donolato, Giofrè and Mammarella 2017). Not to mention the difficulty of recalling reordered pieces of split propositions.

In sum, the degree to which propositions are reordered from the original version to the translated or interpreted version of a sentence is an indicator of difficulty for the translator or interpreter. This is the first indicator of difficulty measured in this study.

3.3.3 Nesting changes

A "nesting" in this study means a structure where one proposition is syntactically surrounded by the predicate and any arguments of another proposition. The positions of adjuncts and propositional links (like subordinating conjunctions or complementizers) aren't taken into account here, since they're more loosely attached to a predicate than its arguments. A nesting in English is shown in (9).

(9) The cat *the dog was chasing* ran up the tree.

In (9), the subordinate proposition syntactically splits the predicate of its parent proposition ("ran") from one of the arguments of that predicate ("the cat"). Creation or elimination of such nested structures is taken in this study as an indicator of difficulty. Here's why:

Karlsson (2007) shows that multiple nested clauses are avoided cross-linguistically. This is evidence that a nested clause increases processing difficulty.

But a semantic proposition can take different syntactic forms. It can be expressed in an independent clause, as in (10).

(10) *I love you*.

Or it can be expressed in a phrase with an abstract noun, as in (11).

(11) *My love for you* is strong.

A proposition can be expressed in a complement clause, as in (12).

(12) You know *that I love you*.

Or it can be part of a clause headed by a subordinating conjunction, as in (13).

(13) I'm here *because I love you*.

A proposition can be expressed in a relative clause, as in (14).

(14) You're the one *I love*.

Or it can be expressed in a gerund phrase, as in (15).

(15) Nothing can stop *my/me loving you*.

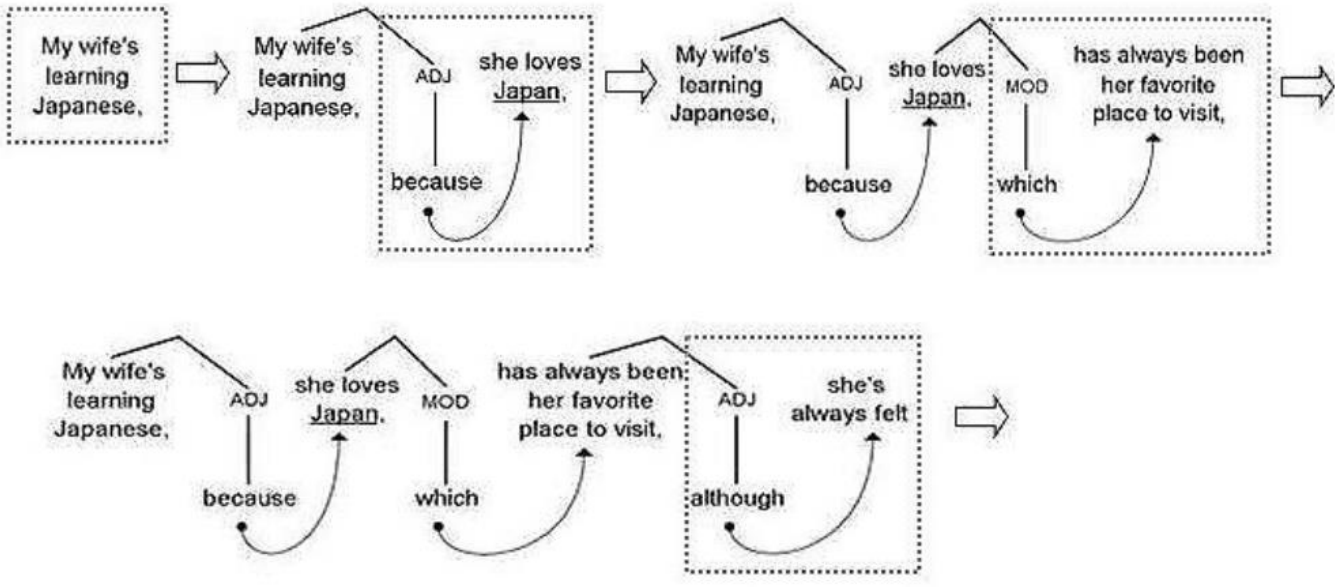
A proposition can also be part of a phrase with a preposition subordinating an abstract noun, as in (16).

(16) I'm here *because of my love for you*.

In languages with cases, it can also be part of a case phrase.

Given the variety of syntactic forms used to express propositions, it seems reasonable to assume that Karlsson's evidence that nested clauses increase processing difficulty, cited above, can apply to nested syntactic expressions of semantic propositions in general, whatever their syntactic form. Moreover, studies by Hawkins (2014) and others reveal a cross-linguistic preference for minimal distances between a phrase head and its directly subordinate syntactic constituent. A nested proposition of any type increases the distance between the predicate of the parent proposition and one or more of its arguments, thereby increasing processing difficulty.

A sentence can be complex and still relatively easy to process. This is the case if the elements of each proposition are contiguous, keeping the phrasal combination domains small. In such a sentence, a succession of logical "windows," each the size of a single proposition and a syntactic link, is enough to allow the listener or reader to process each link and proposition in turn, as illustrated in figure 10.



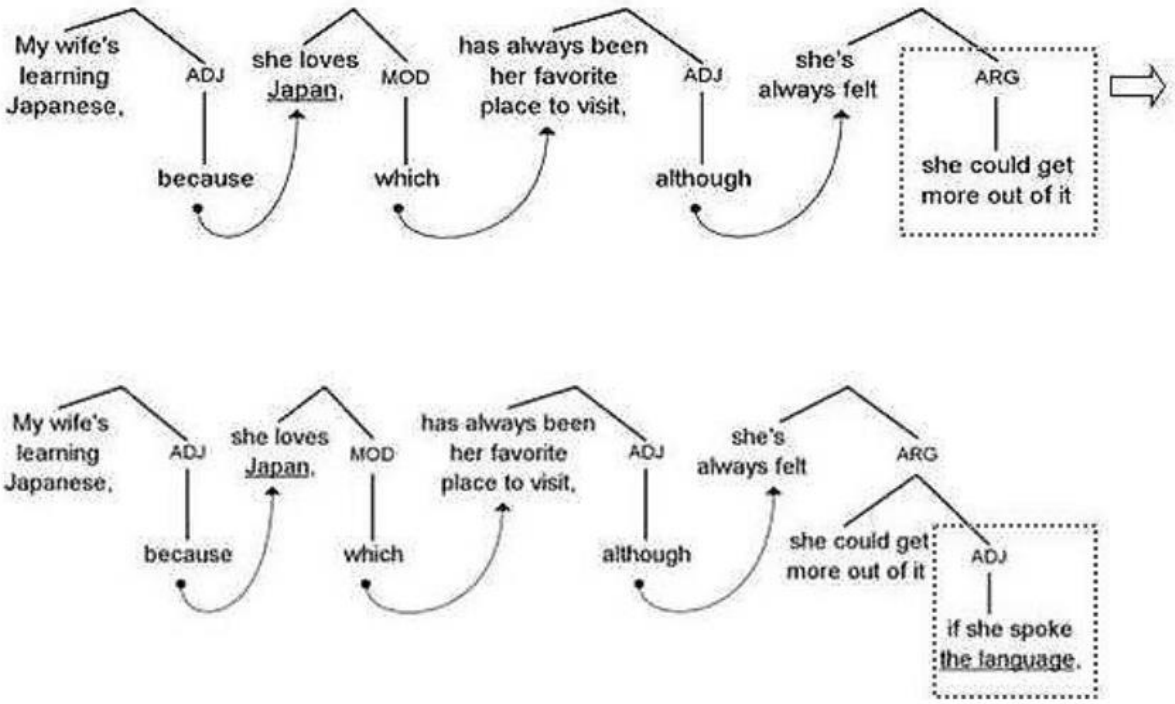


Figure 10
Dynamically unfolding semantic parse tree
with successive small logical processing windows

The problem for keeping just one small logical window open arises when one proposition interrupts another, as illustrated in figure 11.

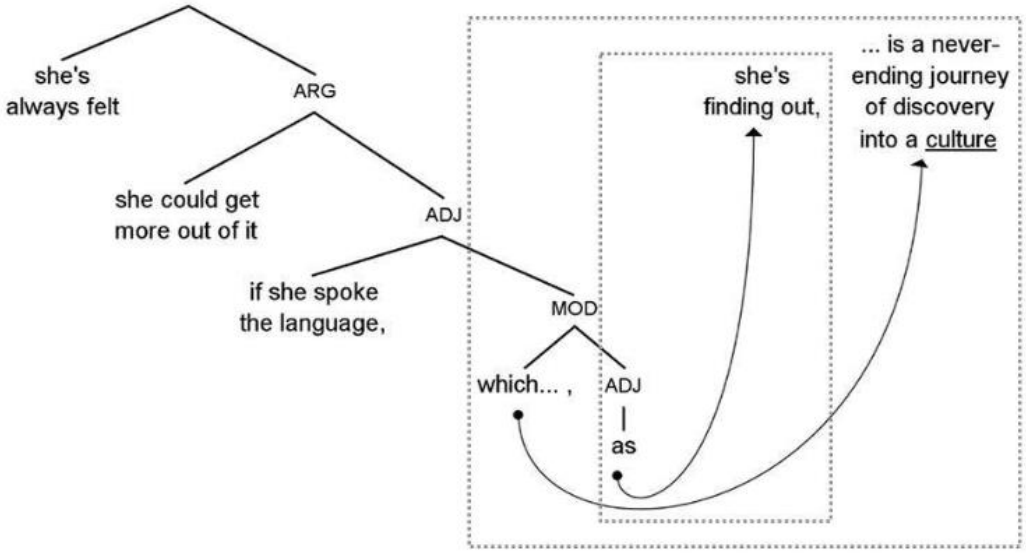


Figure 11
One proposition interrupting another

In figure 11, the process of phrasal domain construction started by the argument “which” (referring to “the language”) can’t be completed till that argument finds its predicate, “journey.” In the meantime, the logical window for that proposition has to stay open and expand to include a second window onto the intervening proposition, “as she’s finding out.” In figure 11, that second window is small, so the first window can still be managed easily enough. But the more propositions intervene before the phrasal domain is constructed and the more complex they are, the larger a logical window like this has to become to accommodate accumulating information before it can be resolved and close.

In a language with typically left-branching structure, like Japanese or Turkish, a clause or other phrase expressing a proposition generally has its subject near the beginning and its predicate in final position. So a complex sentence in a language like that can have more nestings than a comparable sentence in a language with typically right-branching structure, like a European one. This tendency towards nesting in a left-branching language can be particularly strong in formal speech and even stronger in formal writing, where long, complex sentences can be common.

The higher nesting rate that can characterize formal writing in a left-branching language, or in a language with mixed branching structure, may be compounded in translation from a right-branching language. For example, figure 12 shows a parse tree of the propositions in an English sentence from a 2016 article by A. Hill in the *Financial Times*.

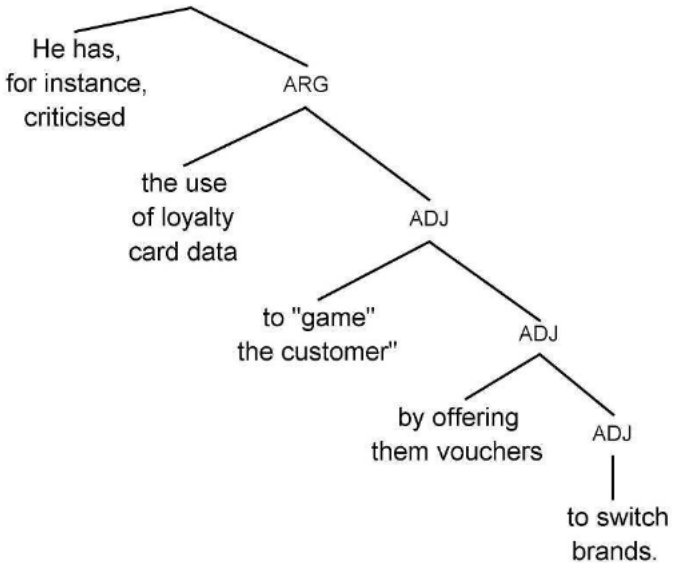


Figure 12
Original English version of sentence

As this sentence moves forward and logical windows open onto successive propositions, each proposition can be processed before or as soon as the next one begins. So each window can be kept small, as illustrated in figure 13.

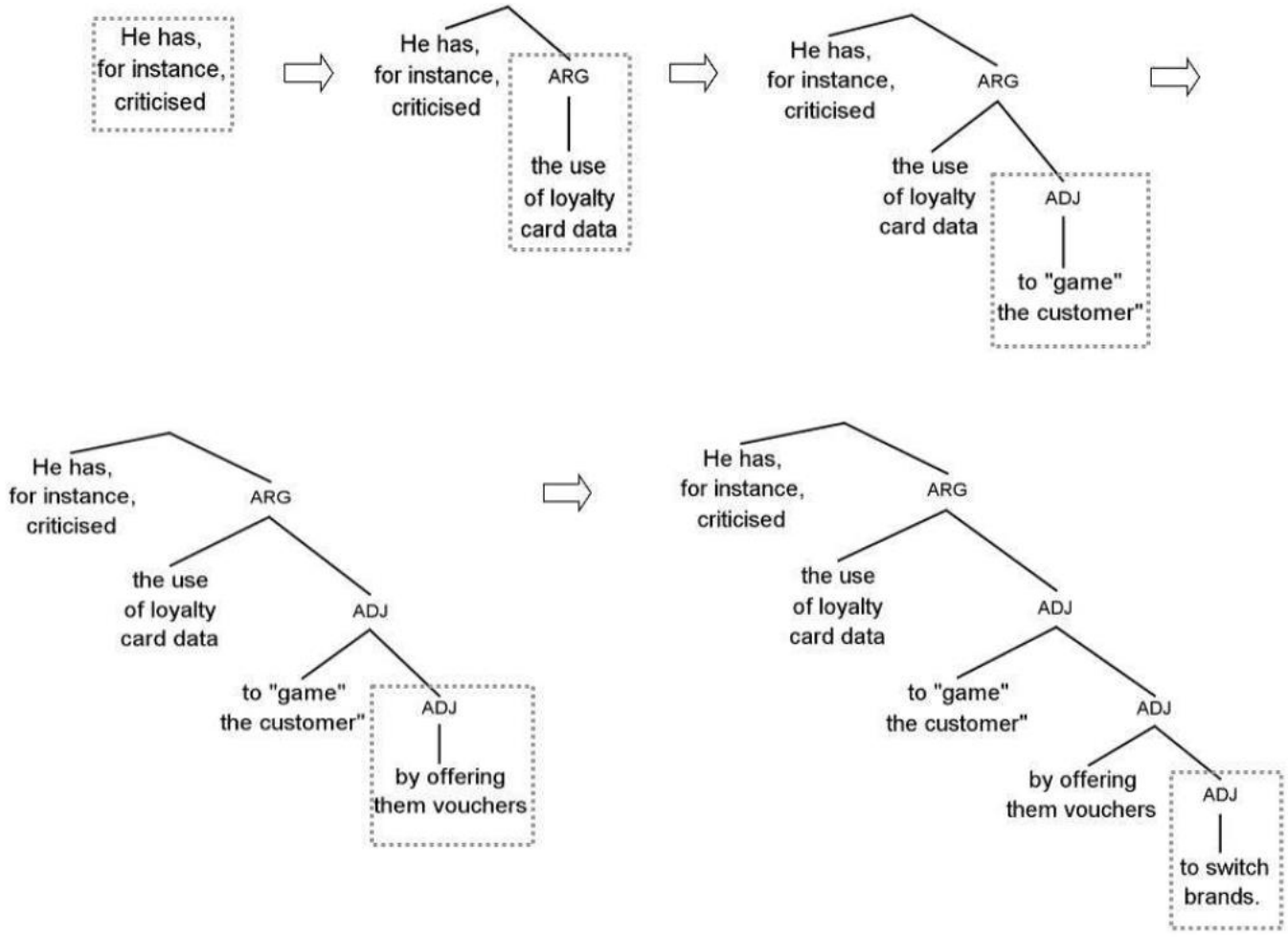


Figure 13
Successive small logical processing windows

But the same sentence from the article as it appeared in Mandarin translation in the *Financial Times Chinese* has several syntactically split propositions, with parts which stay unresolved over long distances, as illustrated in figure 14. The numbers show the order the branches need to be read in to make sense in English.

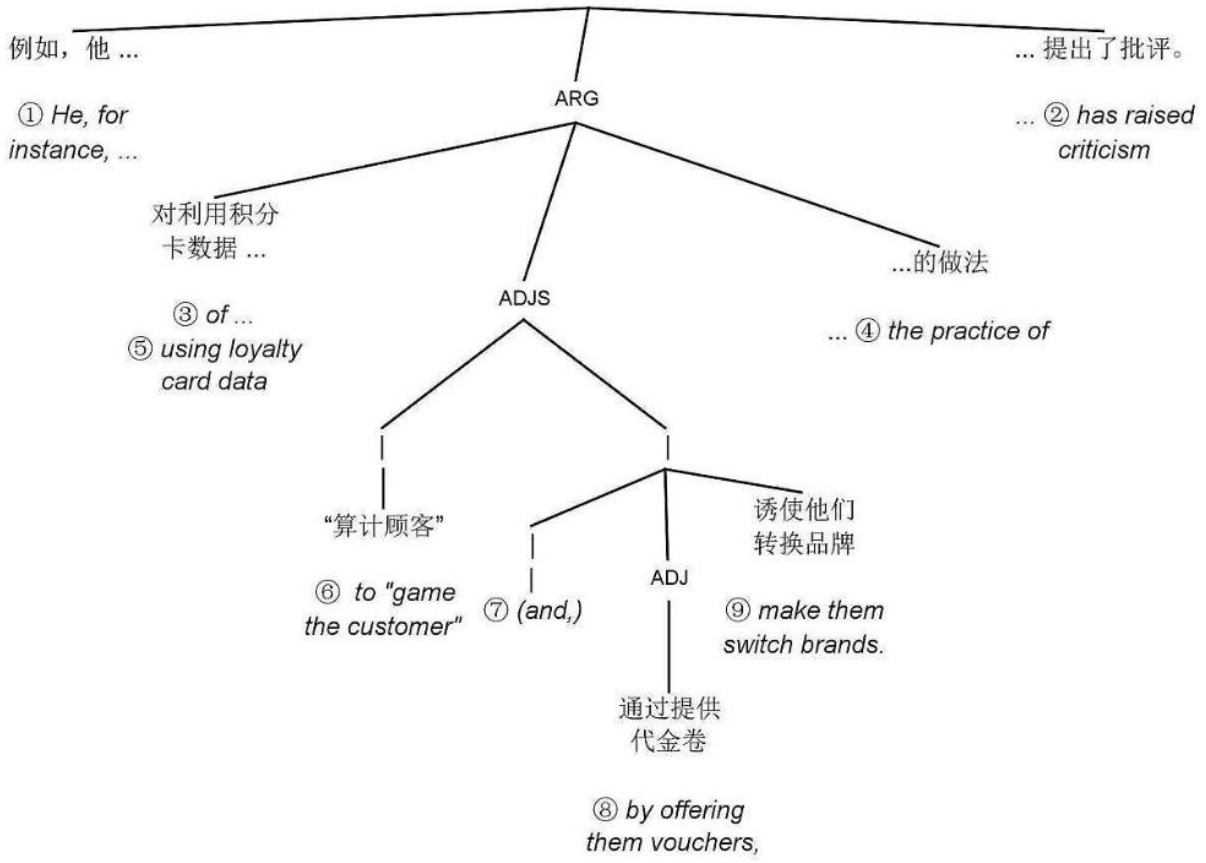
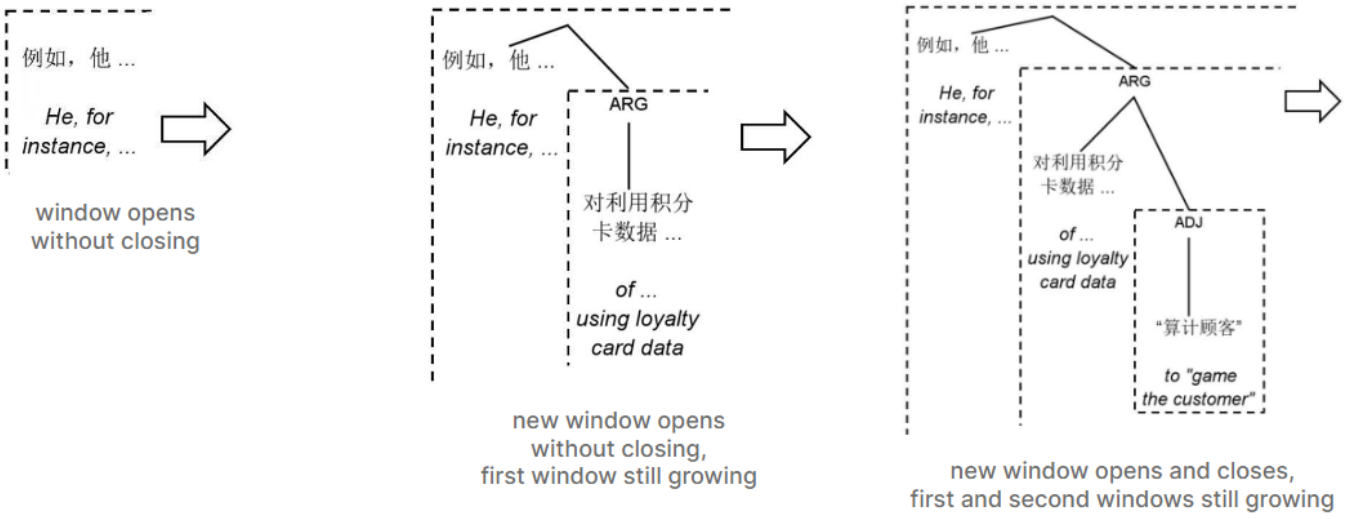
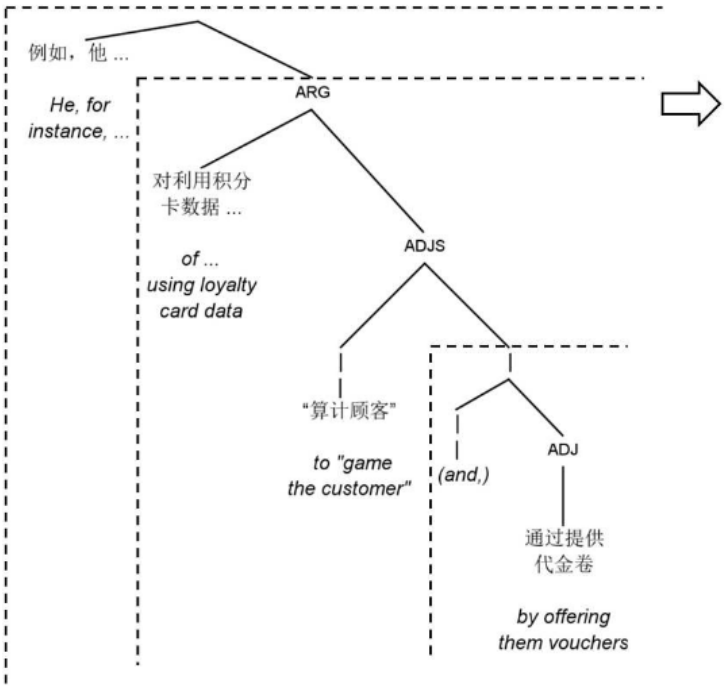


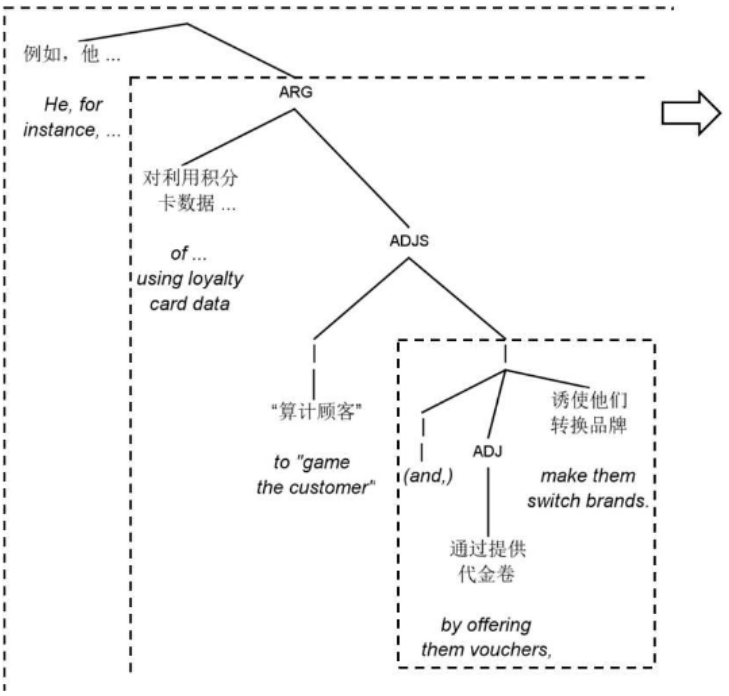
Figure 14
Mandarin translation of sentence

In the mind of the reader of the Mandarin sentence in figure 14, several logical windows have to stay open and grow as the sentence moves forward. The window opened by the argument "he" at the beginning can't close till it finds its predicate, "has raised," at the end of the sentence. Meanwhile, that window has to stay open and grow to include a new logical window for processing the next proposition. That second window also has to stay open till the first part of the phrase "of … using" can attach to "the practice of" near the end of the sentence. This process is illustrated in figure 15.

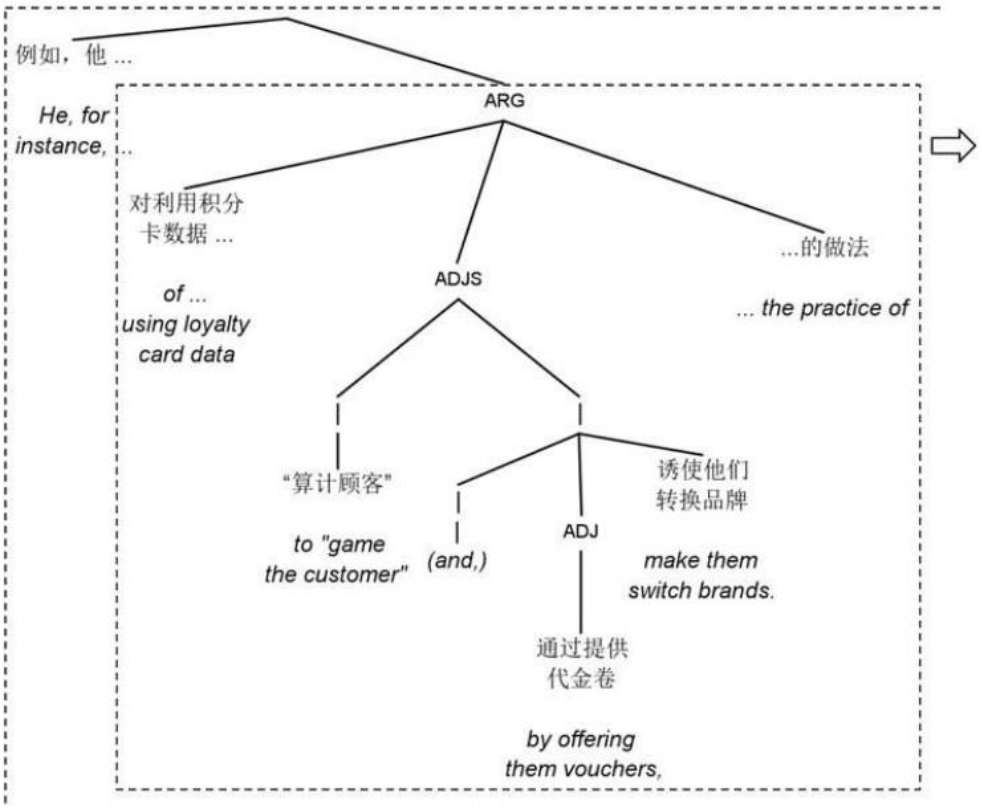




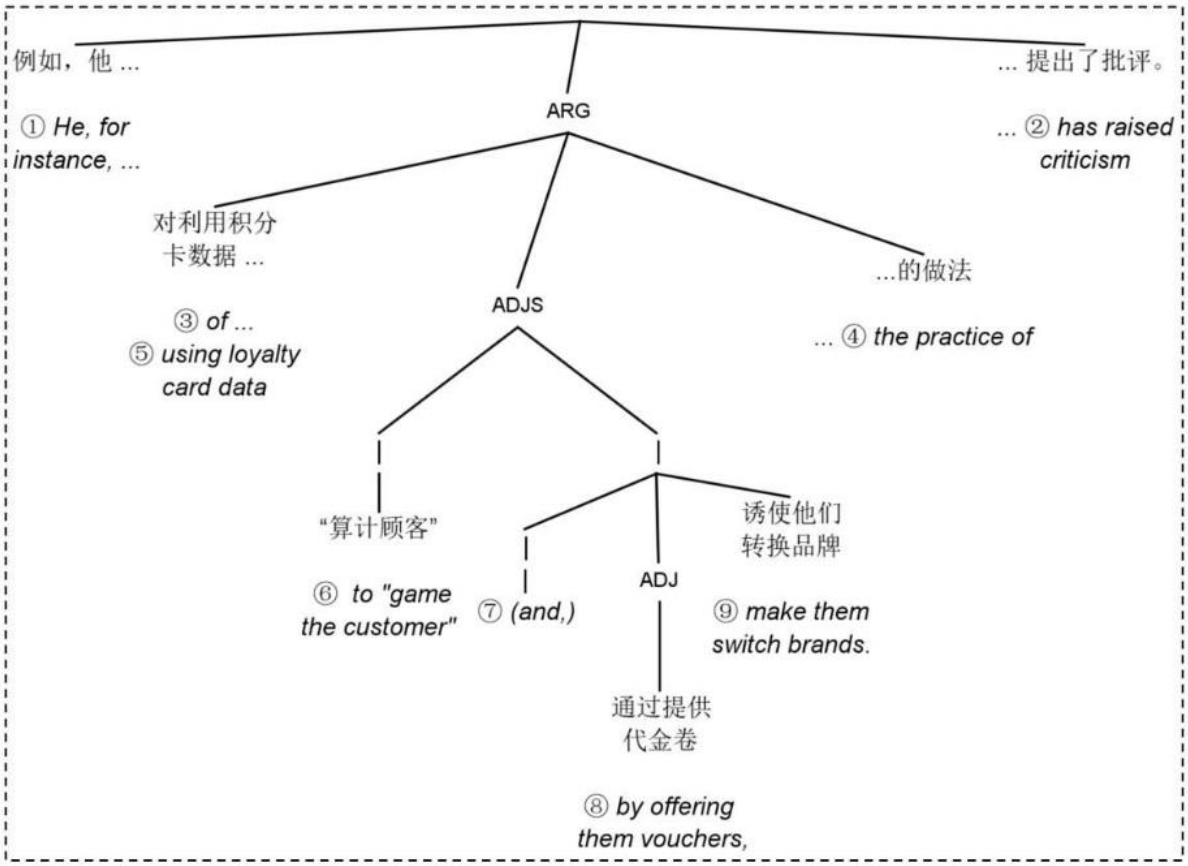
new window opens without closing,
first and second windows still growing



last window closes,
first and second windows still growing



second window finally closes,
first window still growing



first window finally closes

Figure 15
Large logical windows needed for processing multiple split propositions

Figure 16 shows a parse tree of another sentence from the same article, with one syntactically split proposition in English.

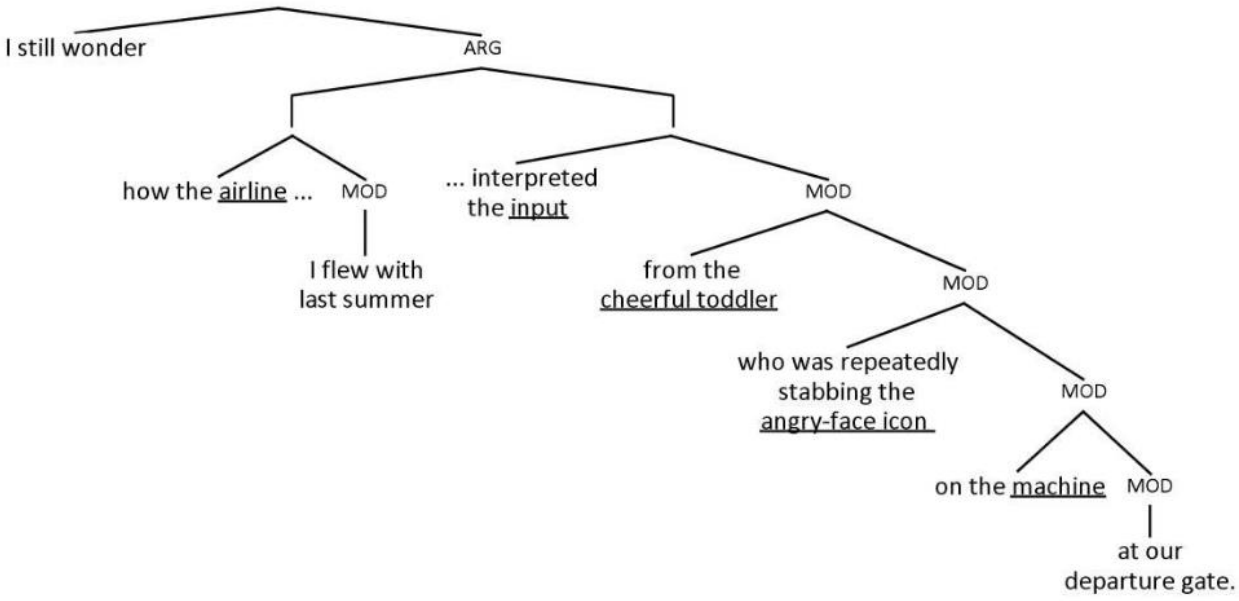


Figure 16
Original English version of sentence

Figure 17 shows a parse tree of the Mandarin translation, with many split propositions and several layers of nesting. The numbers again show the order the branches need to be read in to make sense in English.

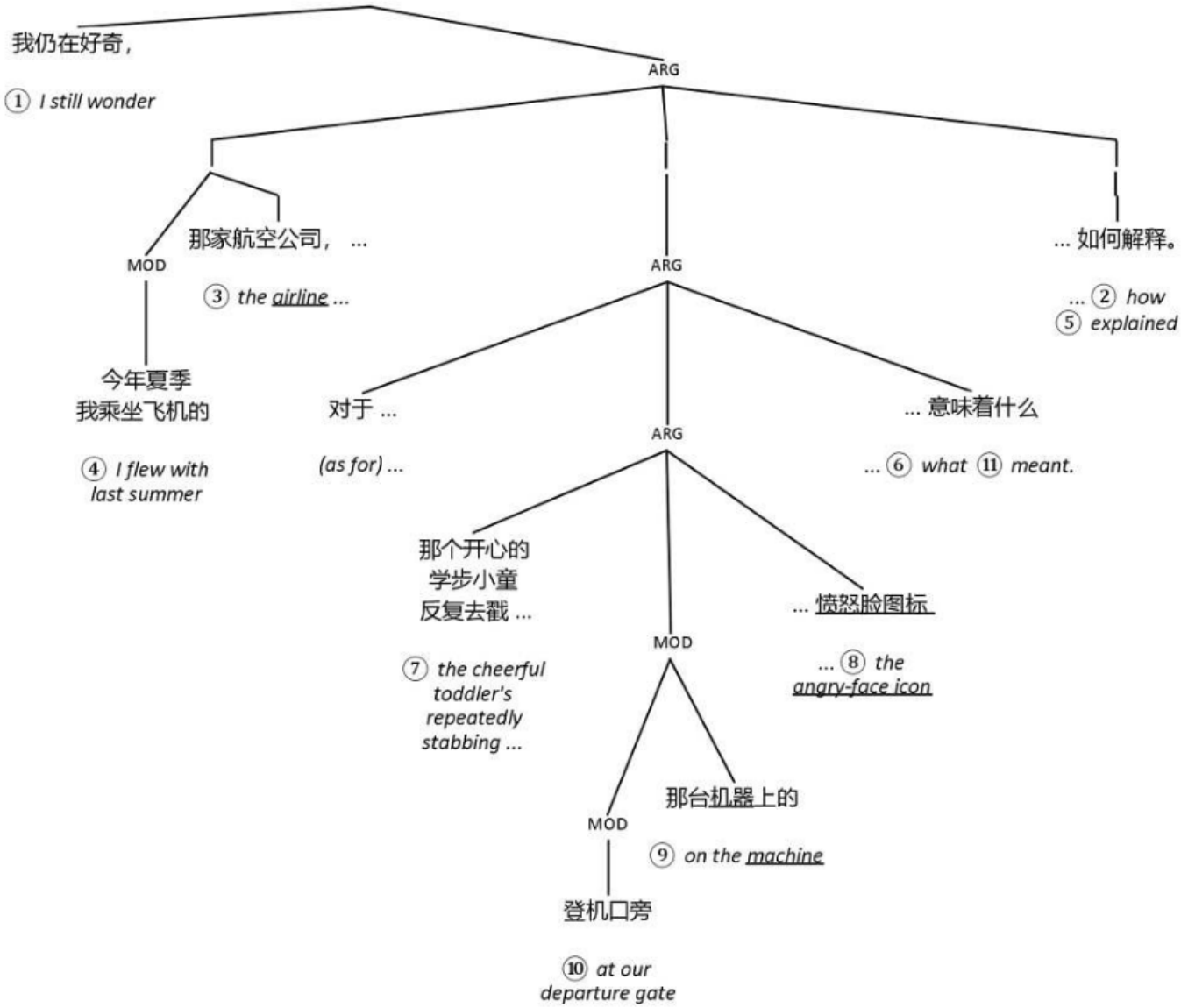


Figure 17
Mandarin translation of sentence

The original English versions of the sentences in figures 12 and 16 are both easy enough to process. But the Mandarin translations in figures 14 and 17, though structurally accurate, are much harder to process, because of the multiple nestings in each. Mandarin translations of foreign publications can be full of this sort of unwieldy structure. This may be because the translators are careful to preserve the structure of the original text. If they're translating an official text, they may feel under even more pressure to be precise. And they – or their

supervisors or editors – may be unaware of or unconcerned by the trade-off between structural accuracy and processing difficulty illustrated in these examples.

As we saw earlier, subordinate clauses in languages like Japanese and Turkish are typically left-branching. So translating a complex sentence from a right-branching European language into one of those languages can create even greater structural problems than translating into Mandarin, where the typical branching direction of subordinate clauses is mixed. For example, figure 18 shows a parse tree of the propositions in a sentence from the English version of the Universal Declaration of Human Rights.

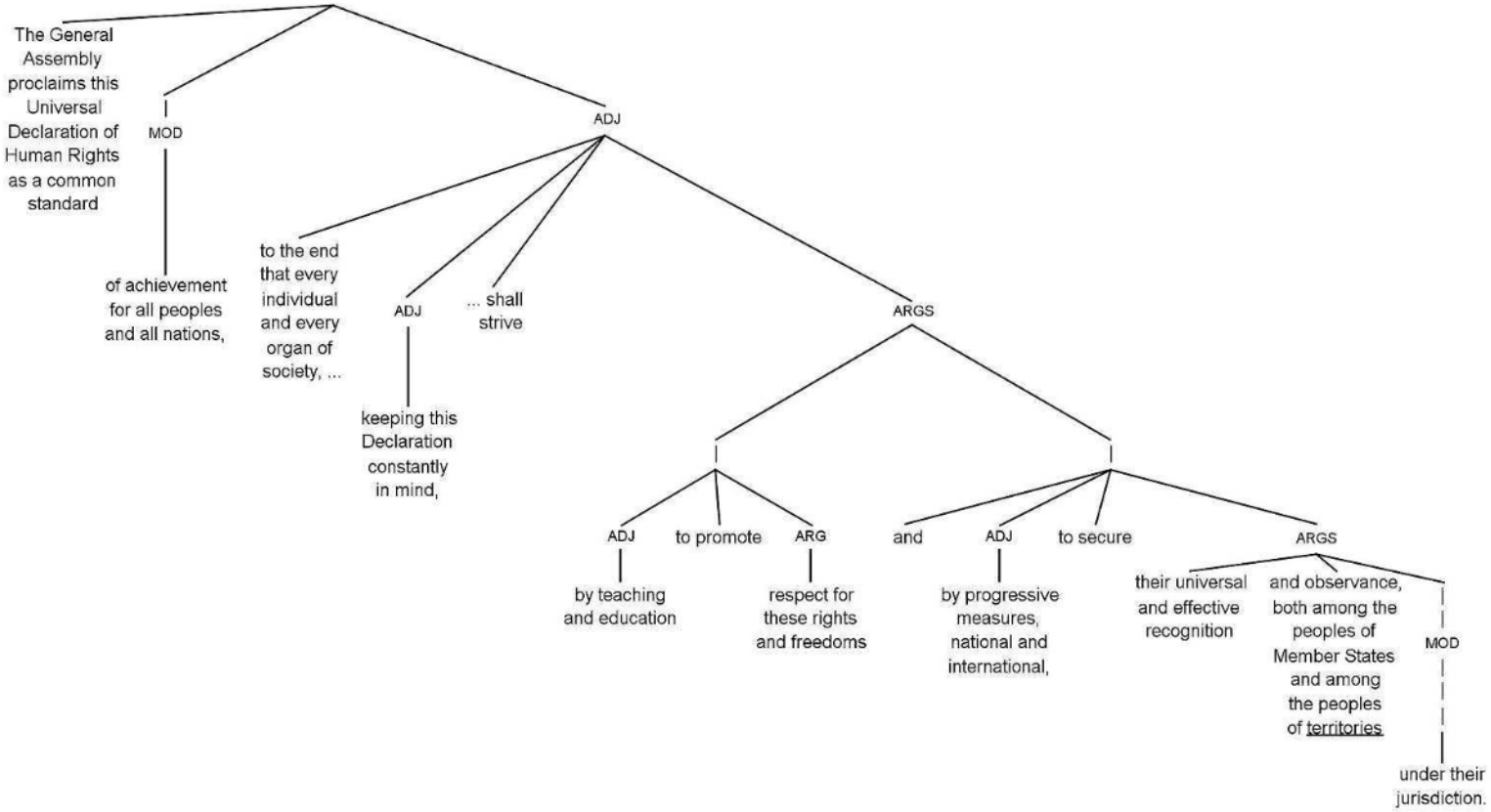


Figure 18
English version of sentence

The English version of the sentence in figure 18 has only one short nesting and no long-distance dependencies. So it's easy enough to process for the average reader, despite its length and complexity. Figure 19 shows a parse tree of the propositions in the Turkish translation of the same sentence. The numbers again show the order the branches need to be read in to make sense in English.

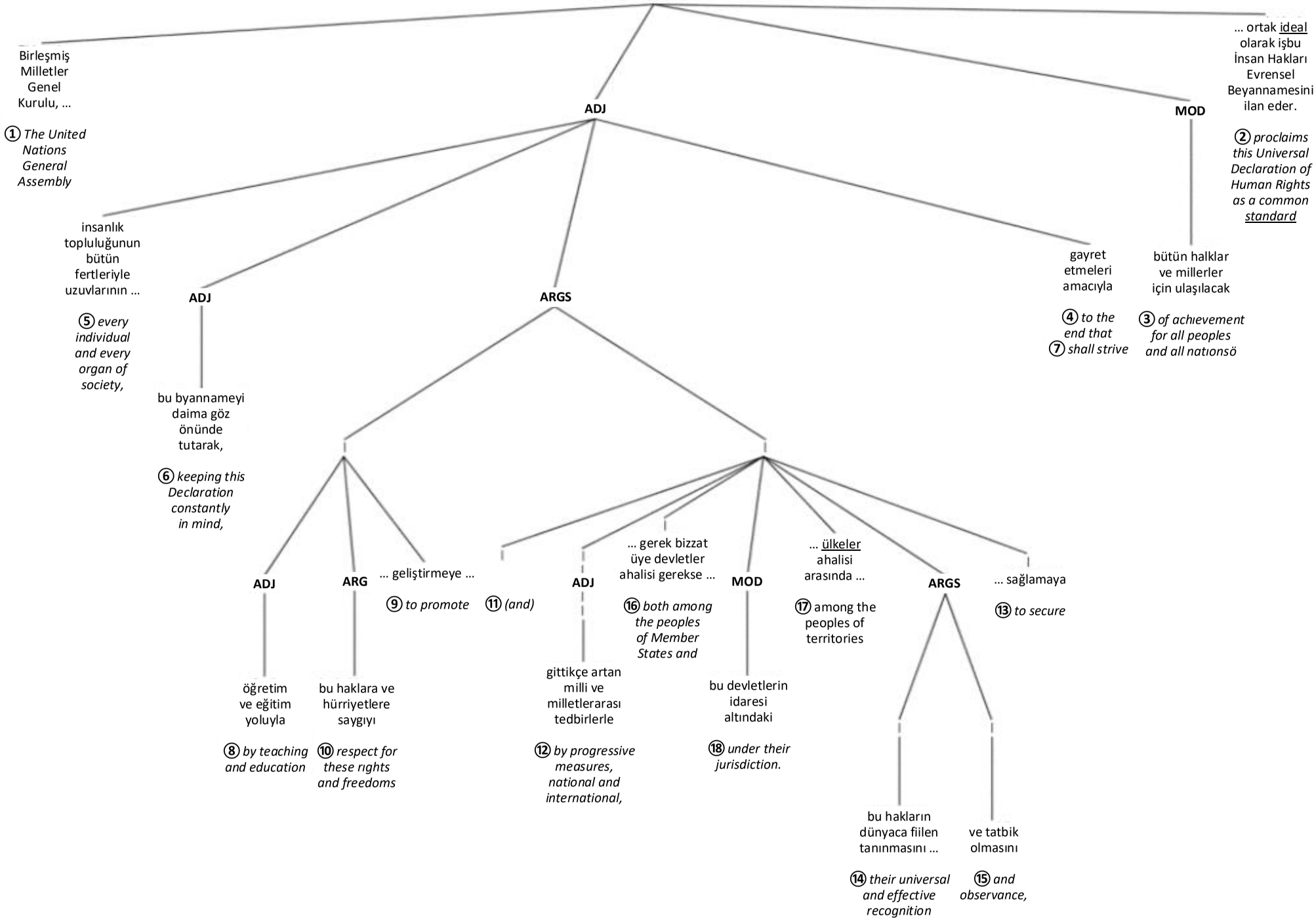


Figure 19
Turkish translation of sentence

In the Turkish translation shown in figure 19, one argument and the predicate of the main proposition are at the beginning and the end of the sentence, syntactically surrounding an enormous nested proposition. That proposition in turn surrounds three other nested propositions. One of those has two even more subordinate propositions. The other one has three, one of which is nested inside its parent.

Here the translator has opted for structural accuracy over processing ease. They may well have been influenced by the importance of the document and felt a need to reproduce its content faithfully. But the resulting message, which is supposed to be compelling and inspiring, may be nearly incomprehensible to the Turkish reader, because it's so hard to process. This case of multiple nesting is extreme. But it's very real nonetheless, characteristic of the type of language that can be found in translations of official texts. It illustrates the trade-off between structural accuracy and processing ease which can face translators and interpreters working between languages with very different structure.

As we've seen, the number and degree of nested propositions in a sentence is a factor of processing difficulty. But creating or eliminating a nested structure in translation or interpretation is a factor of production difficulty as well. If the original version of a sentence has a non-nested proposition and the corresponding proposition in translation or interpretation is placed in a nested structure, the transformation involves splitting the parent proposition. On the other hand, if the original version of a sentence has a nested proposition, the translator or interpreter may need or may choose to repackage the message in such a way that one proposition no longer splits the other. Eliminating a nesting in that way, like creating a nesting, is likely to involve extra mental effort, as both transformations involve reordering the predicate and arguments of the parent proposition.

In sum, creating or eliminating a nesting can be taken as an indicator of difficulty for the translator or interpreter. This is the second indicator of difficulty measured in this study.

3.3.4 Changes in semantic relations

A "semantic relation" in this study means the place and type of attachment of a functionally subordinate or reported proposition – in other words, which parent it's directly attached to and its semantic role in relation to that parent. For example, consider (17).

(17) Answer the questions *on the board*.

Pragmatic knowledge suggests that the phrase "*on the board*" is meant to be taken as a modifier of the noun "questions." But that phrase might instead be translated or interpreted into another language as an adjunct to the predicate "answer." So the translated or interpreted sentence would end up with the meaning shown in (18).

(18) "Answer the questions (and write your answers) *on the board*."

Similarly, consider (19).

(19) Please report any problems *using the attached complaint form*.

This English sentence might be translated or interpreted into another language as a request to report any problems involving use of the form. But pragmatic knowledge of what a complaint form is suggests that the request is in fact for the form to be used to report any problems that might arise.

A translated or interpreted version of a complex sentence which changes the hierarchical relations between propositions in the original version isn't necessarily wrong. It just means that the propositions in question aren't attached in the same ways in both versions of the sentence. The fact that a translator or interpreter made such a change suggests that they were somehow unable to reproduce or uncomfortable reproducing the original semantic relations.

Sometimes a change in semantic relations may be more or less deliberate. That is, the translator or interpreter may be aware that their version of a sentence doesn't accurately reflect the hierarchical structure of the original. But they may sacrifice that accuracy for some other benefit – because they feel the change makes the result clearer, stronger or more natural. Other times such a change may be less intentional. It may reflect mistaken parsing – misconstruing the structure of the original message. Or it may result from mistaken formulation – failing to reproduce that structure appropriately in the other language. An

interpreter may also make such a change because it eases the burden on their working memory.

Gile (2009) suggests that cognitive load in interpretation is shared among three efforts – listening, remembering and speaking. He observes that "it is difficult to assess the added cognitive load which can be attributed to each Effort at each time," and that "processing capacity requirements for each individual Effort are probably determined not only by their individual needs, but also by their interaction" (p. 169). Whatever the reason or combination of reasons for a given change in semantic relations, the fact that such a change was made is taken here as an indication that the translator or interpreter encountered some sort of difficulty that led them to do so, rather than reproducing the hierarchical structure of the original.

Even in written translation, where there's much less of a working memory or timing constraint, changes in semantic relations can be common in transferring complex sentences between languages with very different structure. And in simultaneous interpretation between such languages, some structural distortion may be practically unavoidable.

Of course, relations between parts of the original version of a sentence may be ambiguous or hard to understand in any language. But such ambiguity or unclarity can be masked in translation or interpretation between structurally similar languages, where it can often be copied directly from one language to the other. In translation or interpretation between languages with very different structure, such ambiguous or hard-to-understand relations can be more liable to lead to a mistake in parsing or formulation, potentially creating a major distortion of meaning.

Taking reordering and nesting changes as indicators of difficulty in translation or interpretation is justified empirically, as we've seen. The case for taking changes in semantic relations as an indicator of difficulty is more pragmatic. When a group of propositions attached in one way in the original version of a sentence is isolated and contrasted with the same propositions attached in a different way in translation or interpretation, it's generally clear that the meaning is different in that respect.

When dealing with a short sentence, a good translator or interpreter would be unlikely to make such obvious mistakes as the ones described for (17) and (19). It should be clear from the situation at a test that people are supposed to write their answers on paper. Or it should be clear from general knowledge that a complaint form is to be used for reporting a problem. But in long, complex sentences like those characteristic of legal texts, especially if the

translator or interpreter isn't familiar with the details or the larger context, alternative readings of the relations between propositions can be common. And failure to reproduce those relations as originally intended can have major consequences. Translators and interpreters can make and fail to spot such mistakes when the sentence parts involved are obscured by other intervening and surrounding phrases – especially if those phrases are differently placed in the two language versions of a sentence. But when that extra verbiage is stripped away and the relevant sentence parts are isolated, it should be more obvious to an informed bilingual reader or listener that the translation or interpretation doesn't reflect the original meaning.

Reordering and nesting changes both involve the linear arrangement of propositions in a sentence. Changes in semantic relations involve the hierarchical relations between propositions – whether a subordinate proposition is a semantic argument of, a modifier of or an adjunct to its parent – regardless of their linear order. Changes in one of these two dimensions can often involve changes in the other dimension as well. In translation or interpretation between languages with very different structure, a lot of reordering or nesting may be required in order to preserve the same hierarchical relations between propositions as in the original. In such language pairs, failing to reorder or to create or eliminate a nesting may result in a change in hierarchical relations.

For example, a Japanese translation which preserved the order of propositions in an original English text and was therefore incoherent would give low counts for linear changes (reordering and nesting changes). But it would give very high counts for the other indicator of difficulty, changes in semantic relations. That makes sense. Keeping propositions in the same order may require less syntactic effort than changing them round. But the fact that the semantic relations between propositions become distorted in the process suggests that the translator or interpreter has encountered difficulty in understanding or reproducing those relations.

A cleverer manipulation is illustrated in section 5.2.4, which discusses syntactic transformation as a strategy for interpretation between languages with very different structure. The example given there is of a complex Turkish sentence as actually spoken at a conference and of a hypothetical good English interpretation which preserves the linear order of propositions in the original sentence but changes all the hierarchical relations between them. Such a rendition would also give low counts for reordering and nesting changes, but a very high count for changes in semantic relations. In contrast, a structurally accurate rendition would give a zero count for changes in semantic relations, but very high counts for the reordering and nesting changes that would be required to preserve those hierarchical

relations. Either way, the count for one or more indicators of difficulty would be much higher than in a similar sentence translated or interpreted between structurally similar languages.

This study doesn't attempt to determine whether difficulty as reflected in changes in semantic relations is the result of necessity or choice. Klaudy (2004) distinguishes between necessary and optional cases of deliberately adding or removing words to make a translation more explicit or more implicit than the original. Some such changes might be counted as changes in semantic relations as defined in this study. But changes in semantic relations as defined here are generally much less intentional, making the distinction between necessary and optional changes hard to measure objectively. Plus there's often likely to be a mixture of both constraints and choice when relations between propositions are changed. How much of the incoherent Japanese translation described above would be the result of structural difference between Japanese and English, and how much would be the result of "choice"? It would be nearly impossible to tell. For this study, the fact that such a translation would give a very high count for one of the indicators of difficulty – changes in semantic relations – is enough.

For Larson (1984), preserving the semantic relations between propositions, regardless of syntactic form, is central to the preservation of meaning in a successful translation. Accordingly, a change in semantic relations in translation or interpretation can be taken as a sign that the translator or interpreter has for some reason been unable to or chosen not to reproduce the original relations among propositions in the target language. This is the third indicator of difficulty measured in this study.

To give a better idea of what sort of changes we're talking about and what effect they can have on meaning, some of the most common changes in semantic relations in translation or interpretation are illustrated below.

3.3.4.1 Common types of changes in semantic relations

What follows is a short list of what are, in my experience, the most common types of changes in relations between propositions in translating or interpreting complex sentences between languages with very different structure.

1. **Changing a modifier of an argument into an adjunct of a predicate**, as illustrated in figure 20

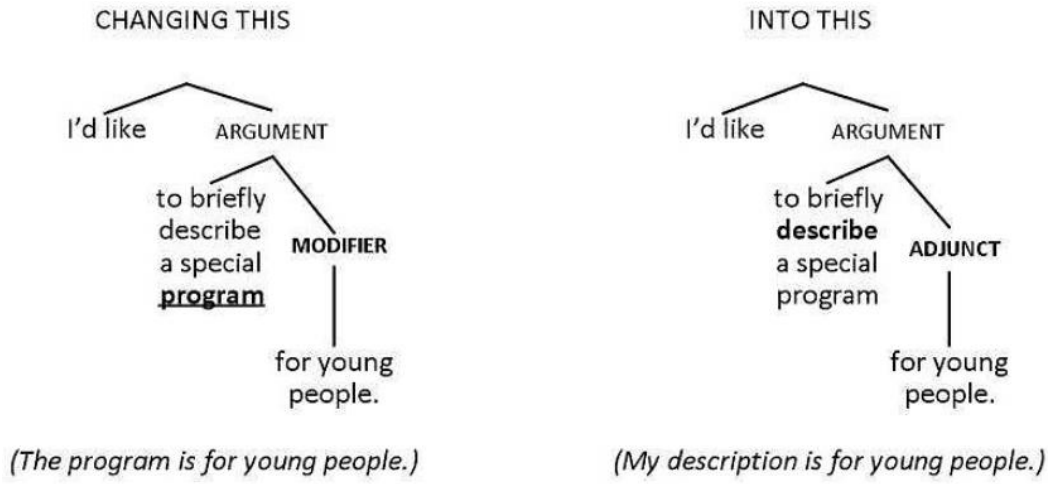


Figure 20
Changing a modifier into an adjunct

2. **Linking an adjunct to a different predicate**, as illustrated in figure 21

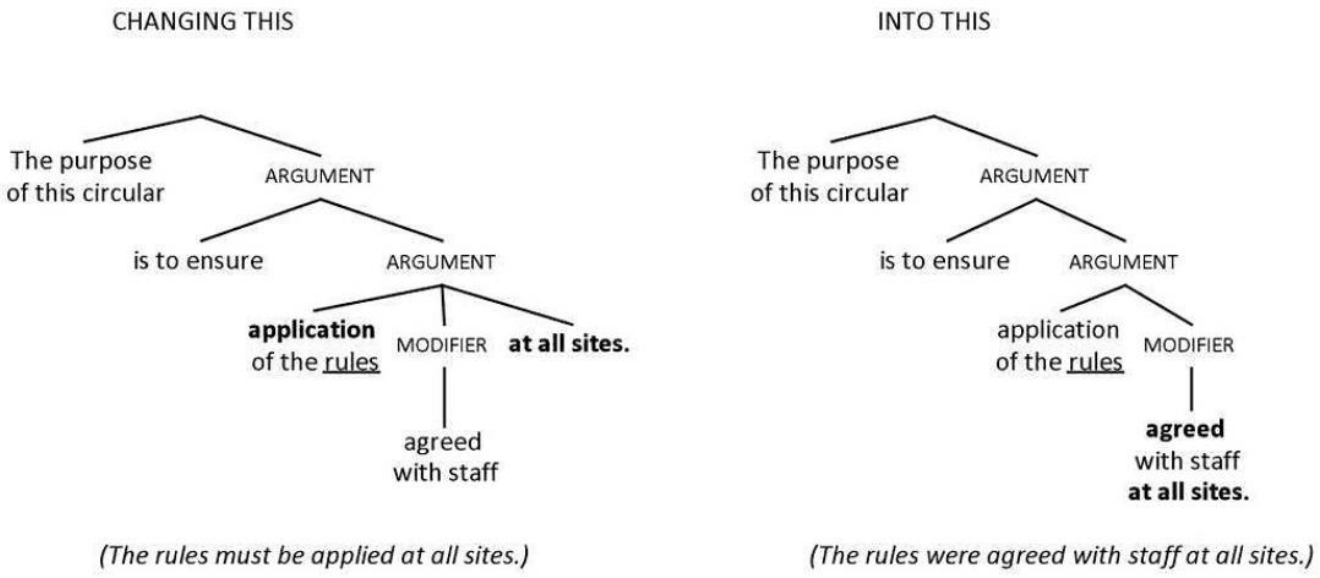


Figure 21
Linking an adjunct to a different predicate

3. **Changing an argument of a subordinate proposition into an adjunct to the parent proposition**, as illustrated in figure 22

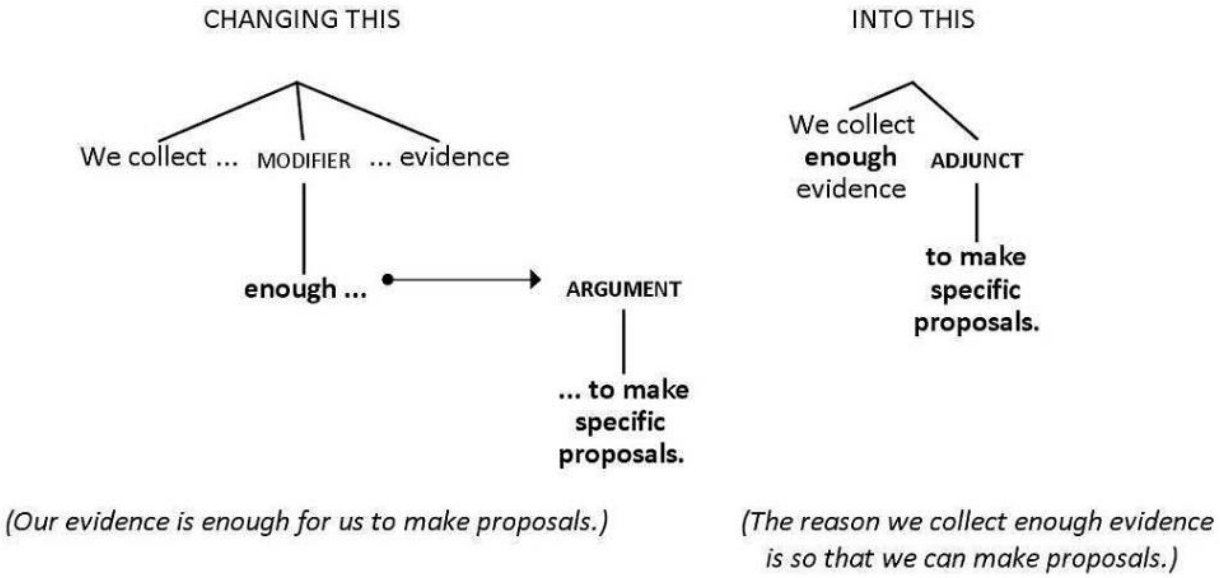


Figure 22
Changing an argument into an adjunct

4. **Changing a coordinate proposition into an argument**, as illustrated in figure 23

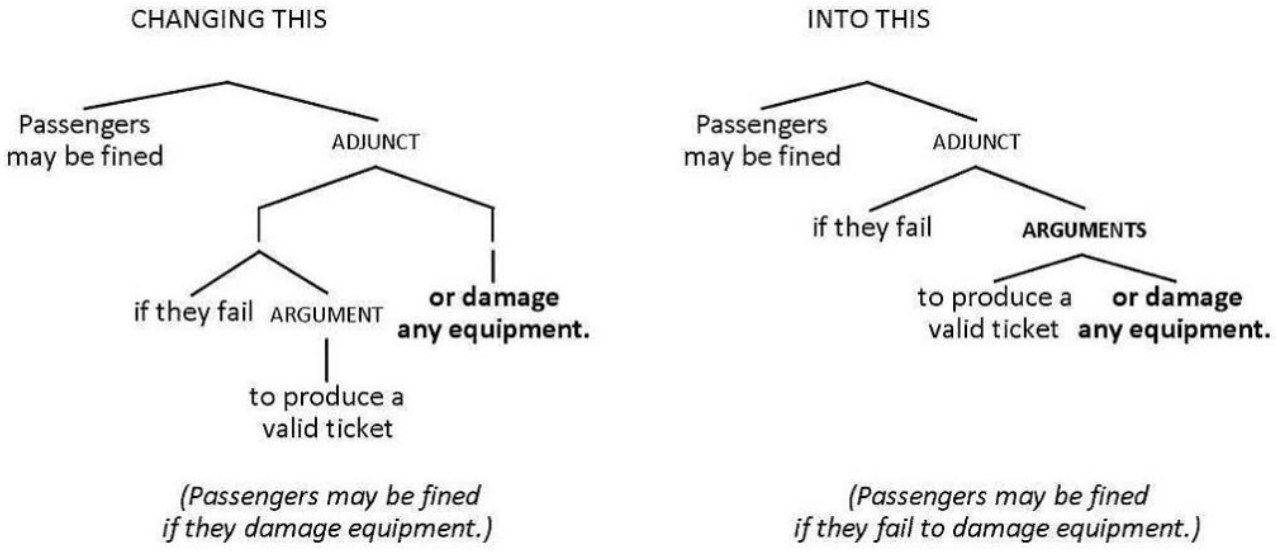


Figure 23
Changing a coordinate proposition into an argument

5. **Changing the scope of an adjunct**, as illustrated in figure 24

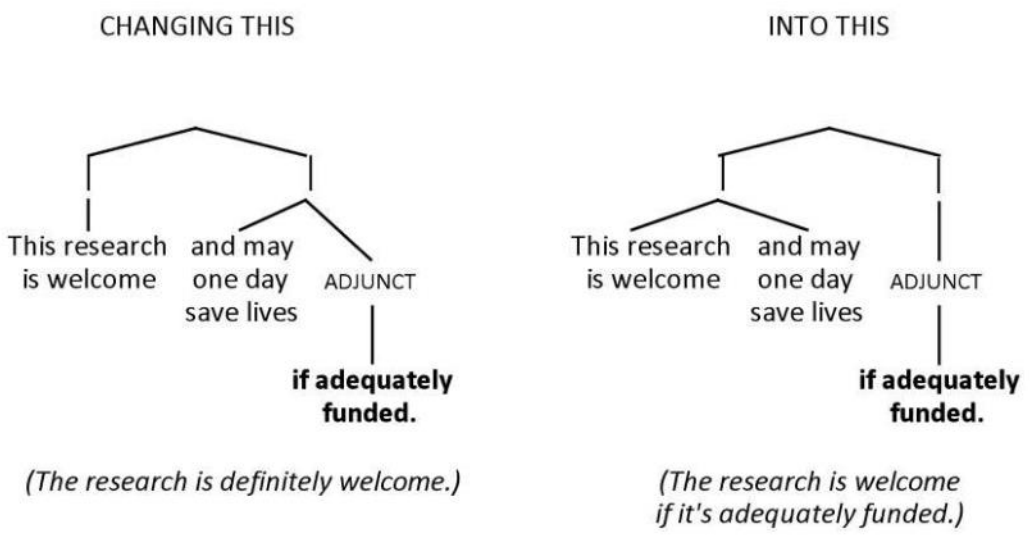


Figure 24
Changing the scope of an adjunct

6. **Changing a restrictive modifier into a descriptive, functionally independent proposition**, as illustrated in figure 25

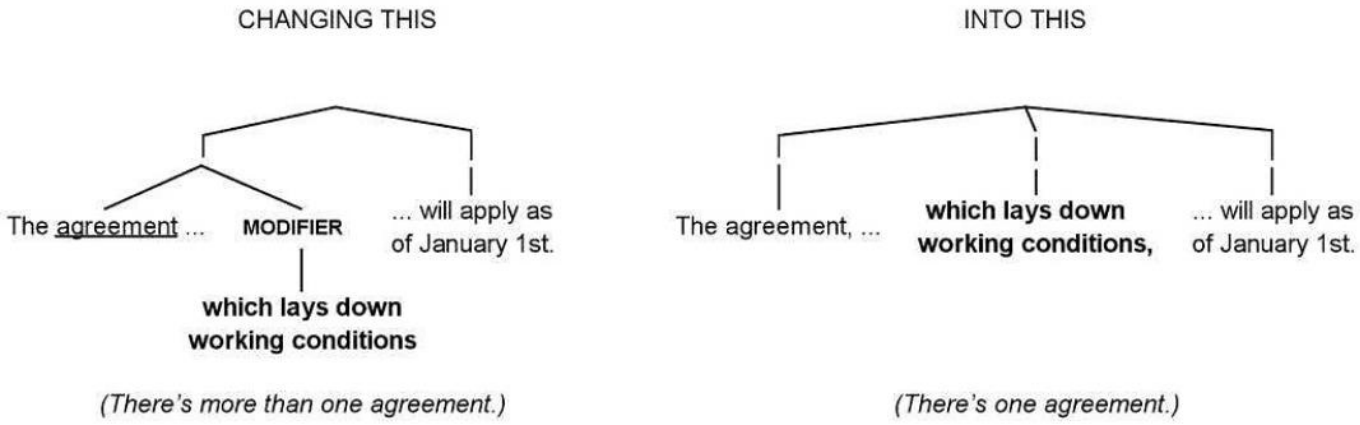


Figure 25
Changing a restrictive modifier into a descriptive, functionally independent proposition

7. **Changing the scope of a restrictive modifier or of a descriptive, functionally independent proposition**, as illustrated in figures 26 and 27

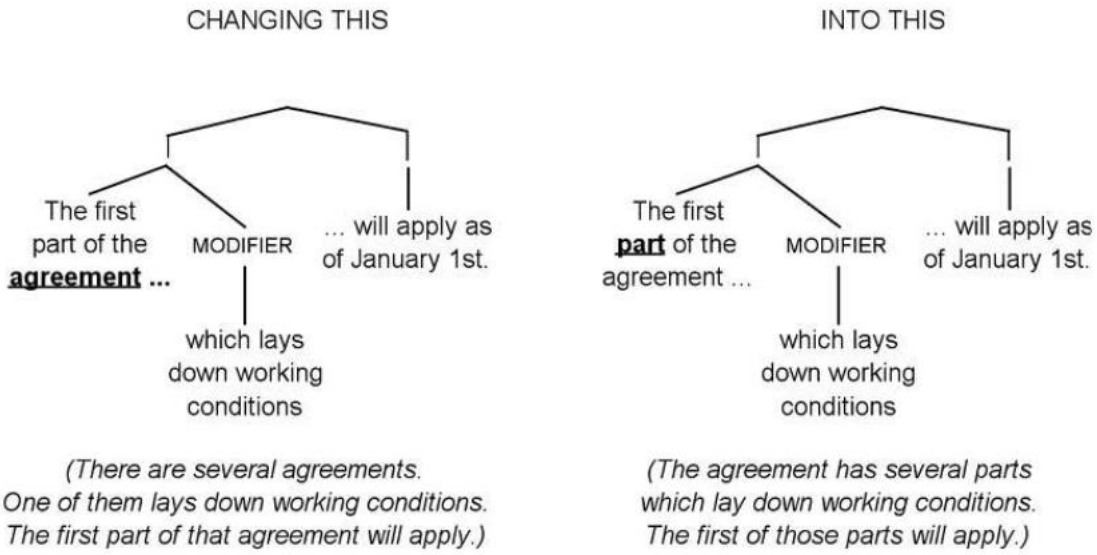


Figure 26
Changing the scope of a restrictive modifier

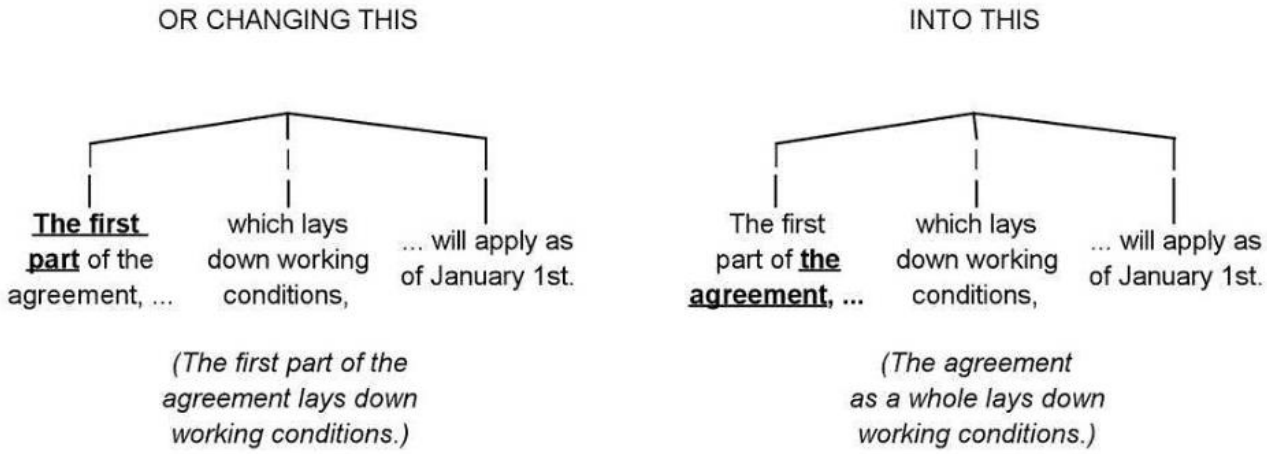


Figure 27
Changing the scope of a descriptive, functionally independent proposition

8. **Switching predicates with a shared argument**, as illustrated in figure 28

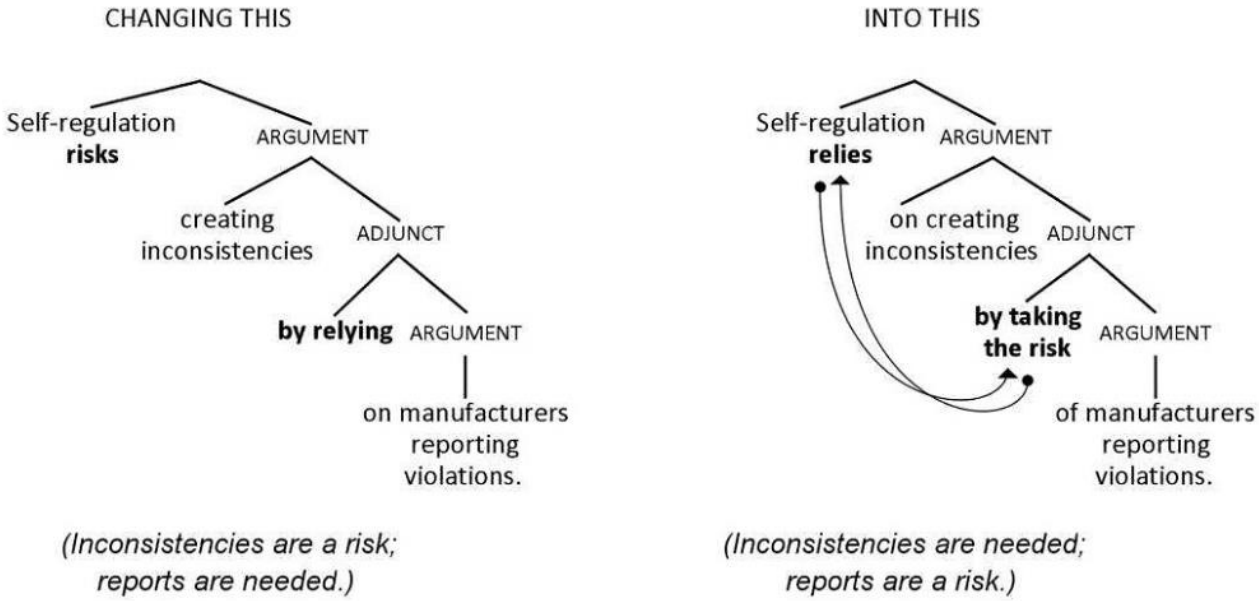


Figure 28
Switching predicates with a shared argument

9. **Linking arguments to different predicates**, as illustrated in figure 29

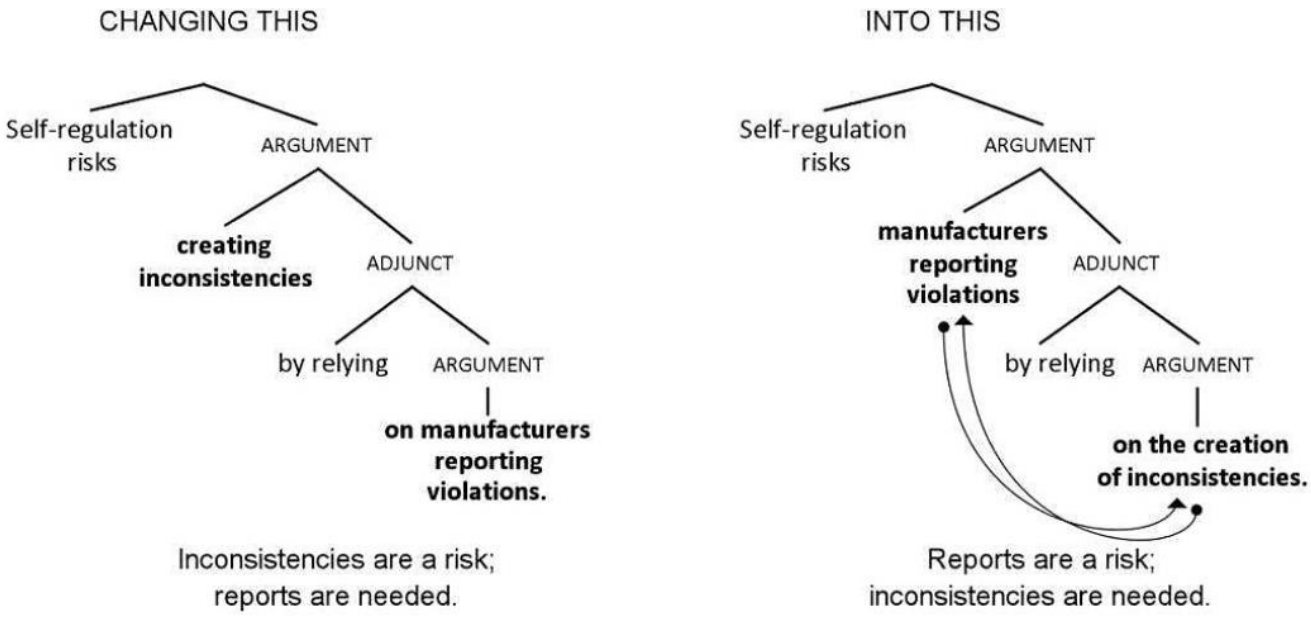


Figure 29
Linking arguments to different predicates

10. **Switching predicates with a shared argument** (No 8 above) and at the same time **linking arguments to different predicates** (No 9 above), as illustrated in figure 30

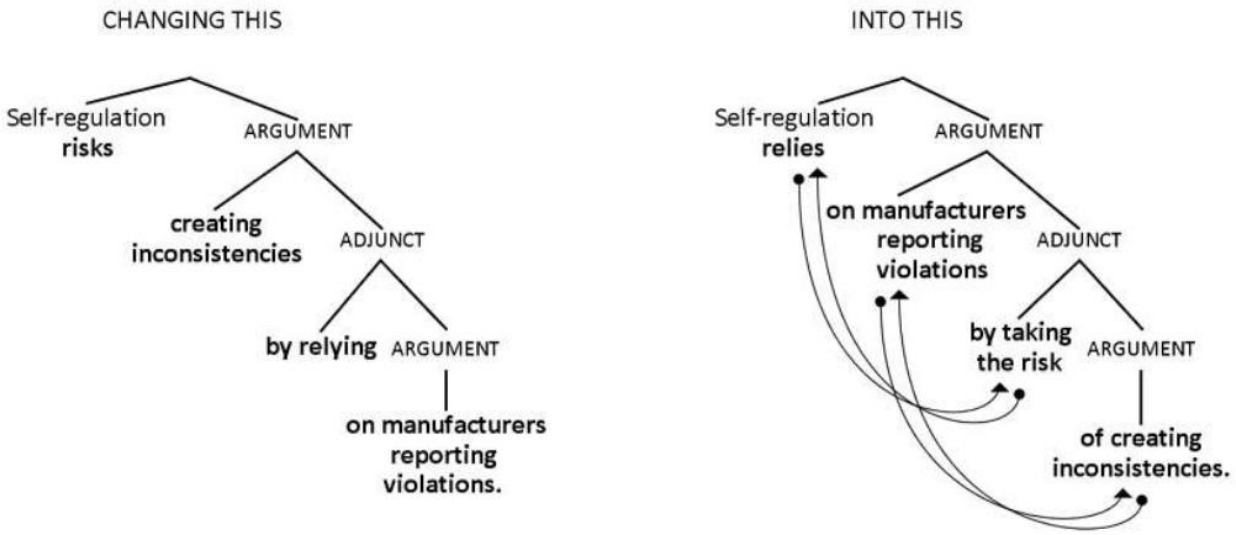


Figure 30
Switching predicates and linking arguments to different predicates

In my experience, changes like these in semantic relations are common in translation or interpretation of complex sentences between languages with very different structure. Such changes generally occur in sentences more intricate than the examples given above. Also, several such changes can be combined and interwoven, making them hard to identify and analyze. Some of these changes can of course occur in translation or interpretation between structurally similar languages too. But they may have a greater effect on how propositions are ordered and linked, and therefore be more liable to distort meaning, in a language pair with very different structure.

This chapter has presented a method for parsing complex sentences, a representative corpus of such sentences, as well as the main variables analyzed in this study. The next chapter looks at how values for those variables are counted and analyzed for each sentence in the corpus, then presents the results of that analysis.

4. Analysis and results

4.1 Collecting data

4.1.1 Sentence and data display

This study analyzes 1,136 sentences in three modes of language transfer – legal translation, subtitle translation and simultaneous interpretation. For each sentence, the semantic structure of the original English version is compared to that of its translation or interpretation into five languages from different families – Russian, Hungarian, Turkish, Mandarin and Japanese.

The analysis is carried out on a series of cross-linguistic sentence display pages, which can be found in annex II. The pages are grouped by mode of transfer and by text, talk or speech. Each display page is arranged to show the propositional structure of the original English version of a sentence and its five translated or interpreted versions. The pages count and record data on three independent variables – mode, sentence complexity and target language. The display pages also count and record data on three dependent variables, which are the three identified indicators of difficulty – reordering, nesting changes and changes in semantic relations. Each sentence and its data are displayed on a separate page, which is laid out as follows:

For each sentence, all six language versions are displayed on one page, in two rows. The original English version is segmented into the syntactic expressions of semantic propositions, using the parsing method summarized in section 3.1 and detailed in annex I. Each segment corresponding to a proposition is enclosed in brackets. Each proposition gets a number, which is placed after the closing bracket for that proposition. A proposition syntactically split by another proposition is shown in two separate bracketed parts. The central logical function of a proposition is the predicate. So in a split proposition, the bracketed part with the predicate is considered to be the main part of that proposition. When a proposition is split, that main part gets a normal black number. The syntactically isolated part gets the same number in gray. The original English version of a sentence from the Paris Agreement on climate change, segmented into propositions with brackets and numbers, is shown in figure 31.

English: [Each Party shall prepare,][1] [communicate][2] [and maintain successive][3] [nationally determined][4] [contributions][1-3] [that it intends][5] [to achieve.][6]

Figure 31
English version of sentence

Let's take a closer look at the sentence in figure 31, to see how our parsing method is applied. If an element in a sentence is shared by more than one proposition, and if it's contiguous with another part of one of those propositions, it's included in the segment for that proposition and taken as implied in the segment(s) for the other proposition(s). In the sentence in figure 31, propositions 1, 2 and 3 share an initial argument – "Each Party." That shared argument is contiguous with another part of proposition 1 – its predicate, "shall prepare." So "Each Party" is included in the segment for proposition 1 and taken as implied at the beginning of propositions 2 and 3.

An overt coordinating link between propositions is included in the segment for the proposition that follows it. In the sentence in figure 31, segment 3 includes the initial coordinating link "and." An overt subordinating link between propositions is included in the segment for the subordinate proposition. So segment 6 includes the initial subordinating link "to."

As explained in annex I, a modifier is treated as the predicate of a separate proposition if it has any arguments or adjuncts of its own. In the sentence in figure 31, "determined" modifies "contributions" and has an adjunct of its own, "nationally." So "nationally determined" is segmented separately, as proposition 4.

Besides their initial shared argument – "Each Party" – propositions 1, 2 and 3 also share a final argument – "contributions." Proposition 4 syntactically splits the main parts of propositions 1, 2 and 3 (the parts with their predicates) from that final shared argument. That final argument isn't contiguous with another part of proposition 1, 2 or 3, but is syntactically isolated. So it's bracketed separately and given gray numbers (1-3), indicating the three propositions it's part of. Gray numbers are disregarded in counting values for reordering, but the bracketed word groups they mark are important, since they affect the count for nesting changes, as we'll see below.

A modifier without any arguments or adjuncts of its own isn't segmented as a separate proposition. Instead, it's included in the proposition with the element it modifies. In the sentence in figure 31, the final shared argument of propositions 1, 2 and 3 – "contributions"

– has a first modifier – "successive." That modifier has no arguments or adjuncts of its own. So "successive" is included in propositions 1, 2 and 3, along with the element it modifies – "contributions." Unlike "contributions," which is syntactically isolated, "successive" is contiguous with another part of proposition 3 – its predicate, "maintain." So "successive" is included in the segment for proposition 3 and taken as implied in propositions 1 and 2.

We've segmented the original English version of our sentence into numbered propositions. Now we want to illustrate the linear arrangement of those propositions and the hierarchical relations between them. To do that, we can place a semantic parse tree below the segmented sentence, as shown in figure 32.

English: [Each Party shall prepare,][1] [communicate][2] [and maintain successive][3] [nationally determined][4] [contributions][1-3] [that it intends][5] [to achieve.][6]

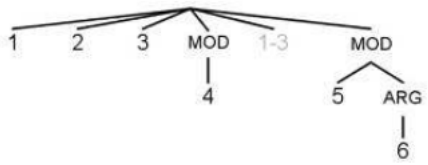


Figure 32
English version of sentence with semantic parse tree

The semantic parse tree in figure 32 is structured in the same way as the trees we saw earlier in section 3.1. The difference in figure 32 is that, for clarity, each leaf on the tree has the number rather than the text of the corresponding proposition in the segmented sentence above it. The numbers on the tree appear in the same order as in the segmented sentence.

A syntactically split proposition is shown on two separate leaves of the tree. Each of those leaves has the same number – a normal black number for the main part with the predicate and a gray number or numbers for the isolated part. In the sentence in figure 32, propositions 1, 2 and 3 are split. So they're each shown on two separate leaves of the tree. For each of those split propositions, there's one leaf of the tree with a normal black number, corresponding to the main part of the proposition. And there's a shared leaf with the numbers 1-3 in gray, corresponding to the shared final argument of propositions 1, 2 and 3, which is syntactically isolated from the rest of those propositions.

As explained in annex I, functionally independent propositions – propositions which make independent assertions – are placed at the top level of the tree, with no labels above them. Each functionally subordinate or reported proposition has a label on the node above it, on the same level as its parent. That label indicates the semantic relation of the proposition in question to its parent – ARG (argument), MOD (modifier), ADJ (adjunct) or REP (reported). In the sentence in figure 74, propositions 1, 2 and 3 are functionally independent. Proposition 4 modifies a shared noun in propositions 1, 2 and 3. Proposition 5 modifies the same noun, so it's also shown as modifying an element in propositions 1, 2 and 3. And proposition 6 is an argument of the predicate in proposition 5.

To display and count values for variables, we can also place a number line below the parse tree, as shown in figure 33. The number line has a number corresponding to each proposition in the sentence. For ease of comparison between language versions, only black numbers (corresponding to whole propositions or the main parts of split propositions) are copied from the segmented sentence and the parse tree onto the number line.

English: [Each Party shall prepare,]^{1} [communicate]^{2} [and maintain successive]^{3} [nationally determined]^{4} [contributions]$^{1-3}$ [that it intends]^{5} [to achieve.]^{6}

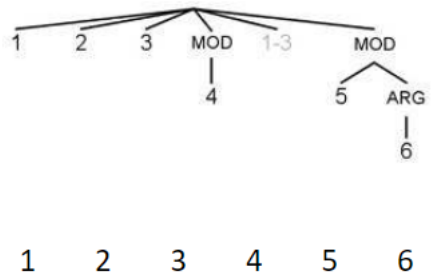


Figure 33
English version of sentence
with parse tree and number line

Now we want to segment and number each of the five translated or interpreted versions of our sentence, placing a parse tree and a number line below the segmented text for those versions, just as we've done for the original English version. To keep track of corresponding language versions of each proposition, the propositions keep the same numbers in each translated or interpreted version of the sentence as in the original English version. The Japanese translation of the sentence we've just been looking at from the Paris Agreement – including Japanese text, English gloss, parse tree and number line – can be seen in figure 34.

The segmented sentence shows the division and order of propositions in Japanese, but with the same numbers as the corresponding propositions in English. Again, for split propositions, only the normal black numbers for the main parts with the predicates are copied onto the number line. The syntactically isolated parts have gray numbers in the segmented sentence and on the parse tree. Those gray numbers aren't copied onto the number line.

Japanese: [各締約国は、]$^{1\text{-}3}$ [自国が]^{5} [達成する]^{6} [意図を有する]^{5} [累次の]$^{1\text{-}3}$ [国が決定する]^{4} [貢献を作成し、]^{1} [通報し、]^{2} [及び維持する。]^{3}

Gloss: [Each party,]$^{1\text{-}3}$ [it]^{5} [to achieve]^{6} [that … intends]^{5} [successive]$^{1\text{-}3}$ [nationally determined]^{4} [shall prepare contributions,]^{1} [communicate]^{2} [and maintain.]^{3}

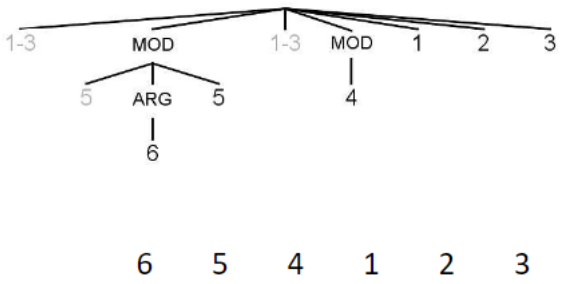


Figure 34
Japanese translation of sentence from Paris Agreement

In the Japanese translation of the sentence in figure 34, propositions 1, 2 and 3 are each syntactically split (by propositions 6, 5 and 4) into three parts. Proposition 5 is itself split (by proposition 6) into two parts. Propositions 1, 2 and 3 in the Japanese translation are functionally independent, just as they were in the original English version. So the numbers 1, 2 and 3 are at the top of the Japanese parse tree in figure 34, just as they were for the English tree in figure 33. Propositions 4, 5 and 6 in the Japanese translation are functionally subordinate, just as they were in the original English version. And they're attached to the same parents, with the same semantic roles in relation to those parents, as in English. So the nodes above the numbers 4, 5 and 6 in the Japanese parse tree in figure 34 have the same labels as the nodes above those numbers in the English tree in figure 33. The propositions appear in a different linear order and are syntactically split in different ways in the English and Japanese versions of the sentence. But the semantic parse trees in figures 33 and 34 show that the hierarchical relations between those propositions are the same in both language versions.

At the bottom of the display page for each sentence is a table recording the data for that sentence. The top rows of the table record the mode, the title of the text or speech, the sentence number and (as a measure of complexity) the number of functionally subordinate or reported propositions in the original English version of the sentence. Our sample sentence is sentence number 29 from the Paris Agreement, which is a legal text. So we enter "Legal translation," "Paris Agreement" and "29" in the corresponding boxes along the top row of the table. As we can see from the parse tree in figure 33, the original English version of the sentence has 6 propositions. Three of those propositions – numbers 4, 5 and 6 – are functionally subordinate or reported. So we enter "3" for the number of functionally subordinate or reported propositions in the upper right corner of the table.

Table 2

Sample data table showing entries for mode, text/speech, sentence number and sentence complexity

Mode	**Text / Speech**	**Sentence #**	**Subordinations**
Legal translation	**Paris Agreement**	**29**	**3**
Target language	Reordering $\sum_{i=1}^{n-1} \sum_{j=i+1}^{n} I(x_j<x_i)$	± Nestings { } {{ }} {{{ }}}	Semantic changes Δ
Russian			
Hungarian			
Turkish			
Mandarin			
Japanese			

The remaining part of the data table records counts for our three indicators of difficulty – reordering, nesting changes and changes in semantic relations – for each translated or interpreted version of the sentence. Next we'll see how those three indicators are counted.

4.1.2 Reordering

The first indicator of difficulty recorded is **reordering** – the need or choice to move a proposition from where it was in the original version of a sentence to an earlier or later place in translation or interpretation.

As explained in the previous section, when a proposition is syntactically split in one version of a sentence, only the main part of the proposition in question – the part with the predicate – is copied onto the number line for that version of the sentence. So, when counting the reordering value for a version of a sentence with a split proposition, we're recording the fact that its predicate has been reordered, even though not all arguments of that predicate may have changed place in translation or interpretation. That's still reordering. Taking a proposition which is syntactically whole, say, at the beginning of an English sentence and splitting it in Japanese translation, so that the subject is at the beginning of the Japanese sentence and the predicate is at the end, is reordering the predicate and involves greater mental effort than would be needed if the whole proposition could be left together at the beginning of the translated sentence.

To calculate the reordering value for a translated or interpreted version of a sentence, we count the total place shifts that would be needed to restore the order of propositions in that version to the ascending order (1 2 3 …) of the original English version. To do that, we take each number in the number line for the translated or interpreted version in turn as a temporary reference number. And we count the numbers to the right of that reference number that are out of ascending order – that is, smaller than it. Then we total those counts for each number in the line. To see how this works on the Japanese translation of our sample sentence, shown in figure 34 in the previous section, let's take another look at the number line for that translation, which is reproduced in figure 35.

6 5 4 1 2 3

Figure 35
Number line for Japanese translation of sentence

From the number line for the Japanese translation of our sample sentence, we see that the first proposition in that version is number 6 (the sixth proposition in the original English version). The second proposition in the Japanese translation is number 5 (the fifth one in the original English version). And so on. Now we want to count the total place shifts that would be needed to restore the numbers in the number line for the Japanese translation to the

ascending order of the original English version. So we take each number in the Japanese line in turn as a temporary reference number and count the numbers to the right of that reference number that are smaller than it. For the first number (6), there are **5** such numbers. For the next number (5), there are **4** such numbers. For the next one (4), there are **3**. For the next one (1), there are **0**. And for the next one (2), there are also **0**. There are of course no numbers to the right of the last number. So the total number of place shifts needed to restore the numbers in the number line for the Japanese translation to the ascending order of the original English version is: **5 + 4 + 3 + 0 + 0 = 12**.

This calculation process can be expressed in a formula as a sum of sums, shown in (20).

(20) $$\sum_{i=1}^{n-1} \sum_{j=i+1}^{n} I(x_j<x_i)$$

I( ) is a function of an expression returning a value of 1 if the expression is true and 0 otherwise. In the formula in (158), the first sum function says: “For each reference number (i) in the number line, starting with the first one and ending with the next-to-last one, find the value of the following expression, then total those values.” The next sum function says: “For each number (j) in the line to the right of the reference number (i), find the value of the following expression, then total those values.” The I( ) function says: “Return a value of 1 if a number to the right of the reference number is smaller than the reference number.”

The result of this calculation for each translated or interpreted version of a sentence is entered in the data table on the display page for that sentence, in the row for the language in question, under **Reordering**. For the **Japanese** translation of our sample sentence, we’ll enter a reordering value of **12**.

Table 3

Sample data table showing reordering count in Japanese translation of sentence

Mode	Text / Speech	Sentence #	Subordinations
Legal translation	Paris Agreement	29	3
Target language	**Reordering** $\sum_{i=1}^{n-1} \sum_{j=i+1}^{n} I(x_j<x_i)$	± Nestings { } {{ }} {{{ }}}	Semantic changes
Russian			
Hungarian			
Turkish			
Mandarin			
Japanese	**12**		

4.1.3 Nesting changes

The second indicator of difficulty recorded is **nesting changes** – creation or elimination of structures where one proposition is syntactically surrounded by the predicate and any arguments of another proposition.

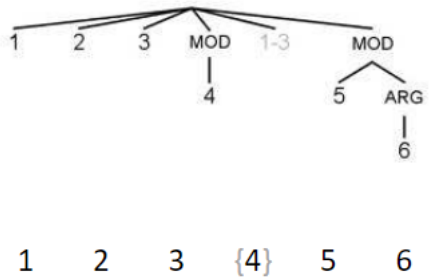
This definition is deliberately conservative, counting as a nesting only a proposition which syntactically splits the predicate and arguments of its parent. If we broadened our definition of a nesting to include a proposition which splits a predicate from an adjunct, an argument from a modifier or a complementizer from the rest of its clause, we'd get much higher counts for nestings overall, especially in structurally different language pairs. This conservative approach was chosen deliberately, to avoid any suggestion that the counts for indicators of difficulty in language pairs with very different structure have been artificially inflated.

Recall that, when a proposition is syntactically split in one version of a sentence, only the main part of that proposition – the part with the predicate – is copied onto the number line for that version. So the reordering value for that version of the sentence reflects the fact that the predicate of the split proposition has been reordered, which is taken as an indication of added mental effort. However, when counting nesting values for a sentence with a split proposition, we need to look at the predicate of that proposition as well as its arguments. That's because it's the syntactic splitting of a predicate from any of its arguments that's associated with added mental effort, as explained before.

This feature is recorded in the number line below each translated or interpreted version of a sentence. That's done by placing **curly brackets { }** around a number for a proposition where a **nesting is created** – that is, a proposition that's not nested in the original English version but is nested in translation or interpretation. A number for a proposition where a **nesting is eliminated** – that is, a proposition that's nested in the original English version but not in translation or interpretation – is surrounded by **crossed-out brackets { }** and counted as well. A number for a proposition where a **double or triple nesting** is **created** is placed in **double or triple brackets**. And a number for a proposition where a **double or triple nesting** is **eliminated** is placed in **double or triple crossed-out brackets**. Single, double and triple nestings are recorded separately. A number for a proposition in an **unchanged nesting** – that is, a proposition that's nested in the same proposition(s) in the original English version and in translation or interpretation – is surrounded by **gray brackets { }** and not counted. Any number for a nested proposition in the original English version of a sentence is also surrounded by gray brackets, as a reference for comparison with the other versions.

To see how this works, consider figure 36, which again shows the segmented text with parse tree and number line for the original English version of our sample sentence. One proposition in that version – number 4 – is syntactically surrounded by the predicates and arguments of other propositions – numbers 1, 2 and 3. So the number 4 in the English number line is surrounded by curly brackets, to show that it's nested. Those brackets are gray, since they're in the number line for the original English version of the sentence, which will be the reference for comparison with the other versions.

English: [Each Party shall prepare,]^{1} [communicate]^{2} [and maintain successive]^{3} [nationally determined]^{4} [contributions]$^{1-3}$ [that it intends]^{5} [to achieve.]^{6}



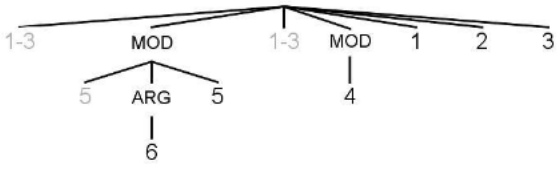
1 2 3 {4} 5 6

Figure 36
Nesting in English version of sentence

The Japanese translation of the same sentence, including Japanese text, English gloss, semantic parse tree and number line, is again shown in figure 37. This time the number line shows the propositions that are nested in the Japanese translation.

Japanese: [各締約国は、]$^{1-3}$ [自国が]^{5} [達成する]^{6} [意図を有する]^{5} [累次の]$^{1-3}$ [国が決定する]^{4} [貢献を作成し、]^{1} [通報し、]^{2} [及び維持する。]^{3}

Gloss: [Each party,]$^{1-3}$ [it]^{5} [to achieve]^{6} [that … intends]^{5} [successive]$^{1-3}$ [nationally determined]^{4} [shall prepare contributions,]^{1} [communicate]^{2} [and maintain.]^{3}



{{6}} {5} {4} 1 2 3

Figure 37
Nestings in Japanese translation of sentence

As can be seen in the parse tree for the Japanese translation of the sentence in figure 37, one proposition – number 6 – is syntactically surrounded by the predicate and arguments of another proposition – number 5. And proposition 5 is itself surrounded by the predicates and arguments of other propositions – numbers 1, 2 and 3. The same is true of proposition 4.

Proposition 6 isn't nested in the original English version of the sentence in figure 36. But it's in a double nesting in the Japanese translation in figure 37. So the number 6 in the Japanese number line in figure 37 is enclosed in double curly brackets and counts as creation of a double nesting. Proposition 5 isn't nested in the original English version either, but it's in a single nesting in the Japanese translation. So the number 5 in the Japanese number line in figure 37 is enclosed in single brackets and counts as creation of a single nesting. Proposition 4 is nested in the same propositions – numbers 1, 2 and 3 – in the original English version and in the Japanese translation. So the number 4 in the Japanese number line in figure 37 is enclosed in gray brackets and won't be counted as a nesting change.

The total numbers of single, double and triple nestings created or eliminated in each translated or interpreted version of a sentence are entered in the data table on the display page for that sentence, in the row for the language in question, under **± Nestings**. The pairs of surrounding brackets (solid or broken) directly adjacent to a number in the number line represent single nestings. In the Japanese translation of our sentence in figure 37, there are two such pairs of brackets (immediately surrounding the numbers 6 and 5). So we'll enter **2**

for **changes in single nestings** in the **Japanese** translation of that sentence. A double nesting contains a single nesting, so it counts as a single nesting too. The pairs of surrounding brackets one position away from a number in the number line represent double nestings. In the Japanese translation in figure 37, there's one such pair of outer brackets (surrounding the number 6). So we'll enter **1** for **changes in double nestings** in the Japanese translation of our sentence. There's also a space in the table to record **changes in triple nestings**, which are rare.

Table 4
Sample data table showing counts for nesting changes in Japanese translation of sentence

Mode	Text / Speech	Sentence #			Subordinations
Legal translation	Paris Agreement	29			3
Target language	Reordering	**± Nestings** { }	{{ }}	{{{ }}}	Semantic changes
Russian					
Hungarian					
Turkish					
Mandarin					
Japanese	12	**2**	**1**	**—**	

4.1.4 Changes in semantic relations

The third indicator of difficulty recorded for each translated or interpreted version of a sentence is **changes in semantic relations** – that is, changes in which propositions are directly attached to which other propositions and in the type of attachment. To measure this feature, we can use the same number lines as before. But now we want to show how the propositions represented by the numbers in those lines are attached to each other hierarchically. We want to show which propositions are functionally independent. And for each functionally subordinate or reported proposition, we want to show which parent proposition it's attached to and what role it plays in relation to that parent.

So far in this section, we've been placing semantic parse trees below the segmented texts for various language versions of our sample sentence. Those trees have included a label at each node above a functionally subordinate or reported proposition, indicating the semantic relation of that proposition to its parent – MOD (modifier), ARG (argument), ADJ (adjunct) or REP (reported speech or thought). Now we want to compare those semantic relations in different language versions of the sentence.

To do that, we place those same relation labels over the numbers in the number line for each language version. So each number for a functionally subordinate or reported proposition gets a label indicating the relation of that proposition to its parent. We also add the number of the parent to the label. A number for a proposition which is syntactically subordinate but functionally independent doesn't get a label. Guidelines for indicating relations between propositions on number lines are detailed in section 1.4 of annex I.

To see how this works, consider figure 38, which shows the original English version of the same sample sentence we've been looking at, including segmented text, semantic parse tree and number line. This time, relation labels are placed above the numbers for functionally subordinate or reported propositions in the number line. Each label indicates the semantic role of that proposition in relation to its parent(s), plus the number(s) of the parent(s).

English: [Each Party shall prepare,][1] [communicate][2] [and maintain successive][3] [nationally determined][4] [contributions][1-3] [that it intends][5] [to achieve.][6]

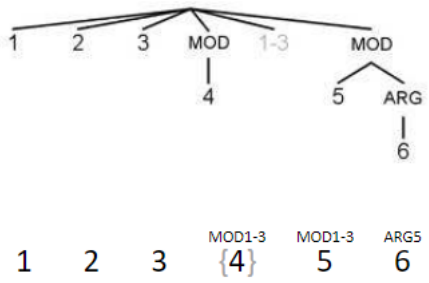


Figure 38
English version of sentence with relation labels

In the original English sentence in figure 38, propositions 1, 2 and 3 are functionally independent. So the numbers 1, 2 and 3 are placed at the top level of the English parse tree; and the numbers 1, 2 and 3 in the number line have no labels. Propositions 4 and 5 each modify a noun in propositions 1, 2 and 3 (their shared argument, "contributions"). So the nodes above the numbers 4 and 5 in the tree are labeled "MOD" and are at the same level of the tree as the numbers 1, 2 and 3; and the numbers 4 and 5 in the number line are labeled "MOD1-3." Proposition 6 is an argument of proposition 5. So the node above the number 6 in the tree is labeled "ARG" and is at the same level of the tree as the number 5; and the number 6 in the number line is labeled "ARG5."

The Turkish translation of the same sentence, including Turkish text, English gloss, parse tree and number line, is shown in figure 39. Relation labels are again placed above the numbers for functionally subordinate propositions.

Turkish: [Tarafların her biri][1-3] [ulaşmayı][6] [amaçladığı][5] [ulusal katkıları hazırlar,][1] [tebliğ eder][2] [ve muhafaza eder.][3]

Gloss: [Each party,][1-3] [to achieve][6] [that it intends][5] [shall prepare national contributions,][1] [communicate][2] [and maintain.][3]

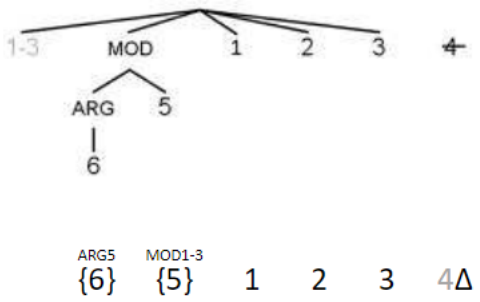


Figure 39
Turkish translation of sentence with relation labels

Most propositions in the Turkish translation of the sentence in figure 39 are hierarchically attached to each other in the same way as in the original English version in figure 38, despite the differences in their linear order. The three propositions which were functionally independent in the original English version – propositions 1, 2 and 3 – are independent in the Turkish translation too. So the numbers 1, 2 and 3 aren't labeled in the Turkish number line in figure 39, just as they weren't labeled in the English number line in figure 38. Propositions 5 and 6 in both English and Turkish are functionally subordinate, and are attached to the same parents and in the same way in both versions. Proposition 5 modifies a noun in propositions 1, 2 and 3. And proposition 6 is an argument of proposition 5. So the numbers 5 and 6 in the Turkish number line in figure 39 have the same relation labels as in the English number line in figure 38, even though their linear positions in the sentence are different.

There's one difference in semantic relations, as recorded here, between the English and Turkish versions of the sentence in figures 38 and 39. The original English version of proposition 4 in figure 38 says "nationally determined," consisting of a predicate and an adjunct. So it's segmented as a separate proposition in that version. The Turkish translation in figure 39 says "national" – just a modifier with no arguments or adjuncts. As explained in annex I, the semantic parsing method used in this study doesn't segment a modifier with no arguments or adjuncts as a separate proposition. So there's no proposition in the Turkish translation of our sentence in figure 39 corresponding to proposition 4 in the original English version in figure 38. Our method records that as a change in semantic relations.

If there was a proposition in the Turkish translation corresponding to proposition 4 in the original English version, but with a different type of attachment or a different parent, the number 4 would be included in the Turkish number line in figure 39 and marked accordingly with a relation label. That label would be different from the label over the number 4 in the English number line. So the number 4 in the Turkish number line would be followed by a "Δ" ("delta" for "change"). As it is, there's no proposition in the Turkish translation corresponding to proposition 4 in the original English version. So the number 4 is removed from the sequence of numbers representing propositions in the Turkish number line in figure 39. Instead it's moved to the end of the line, in gray – to indicate that what was proposition 4 in the English version is missing as a separate proposition in the Turkish version. And it's followed by a "Δ," to mark that as a change in semantic relations.

Again, that doesn't mean the Turkish translation of the sentence in figure 39 is wrong. When a proposition in a translated or interpreted version of a sentence is marked here as a change in semantic relations, that means it isn't attached to the same parent and in the same way as in the original English version, with no value judgement as to the appropriateness of that change. And omitting the central part of a proposition (its predicate), as in the Turkish translation of our sample sentence, makes the semantic relations in that version different from the semantic relations in the original English version in that respect.

Such a change in semantic relations can lead to a greater or lesser change in meaning. The Turkish translation in figure 39 may have a slightly different meaning compared to the original English version. The phrase "national contributions" in the Turkish translation may suggest that contributions are just *made* by countries, rather than that they're *determined* by countries, as in the English version. In other cases, a change in semantic relations can lead to a much greater change in meaning.

The total number of changes in semantic relations in each translated or interpreted version of a sentence compared to the original English version is entered in the data table on the display page for that sentence, in the row for the language in question, under **Semantic changes**. There's one "Δ" in the number line for the Turkish translation of our sentence in figure 39. So we'll enter "1" for the number of semantic changes in the Turkish translation of that sentence.

Table 5

Sample data table showing count for changes in semantic relations in Turkish translation of sentence

Mode	Text / Speech	Sentence #			Subordinations
Legal translation	Paris Agreement	29			3
Target language	Reordering $\sum_{i=1}^{n-1} \sum_{j=i+1}^{n} I(x_j<x_i)$	± Nestings { }	{{ }}	{{{ }}}	**Semantic changes Δ**
Russian					
Hungarian					
Turkish					**1**
Mandarin					
Japanese	12	2	1	—	

4.1.5 Completed display

The procedure described so far in this section has been performed on each translated or interpreted version of each sentence in the corpus, with the original English version as a reference for comparison. Each translated or interpreted version of a sentence is divided into segments corresponding to the propositions in the original English version. In the website format of this study, hovering the mouse over the Mandarin version switches between traditional and simplified characters.

Below each language version is a number line showing the order of propositions in that version, with brackets around the numbers for any nested propositions, and relation labels above any functionally subordinate or reported propositions. The number lines below each language version contain all the information needed to count values for reordering, nesting changes and changes in semantic relations in that version. So we don't need parse trees anymore. Values for all variables for each language version are recorded in the corresponding rows of the data table at the bottom of the page.

A completed display for the sample sentence we've been looking at is shown in figure 40.

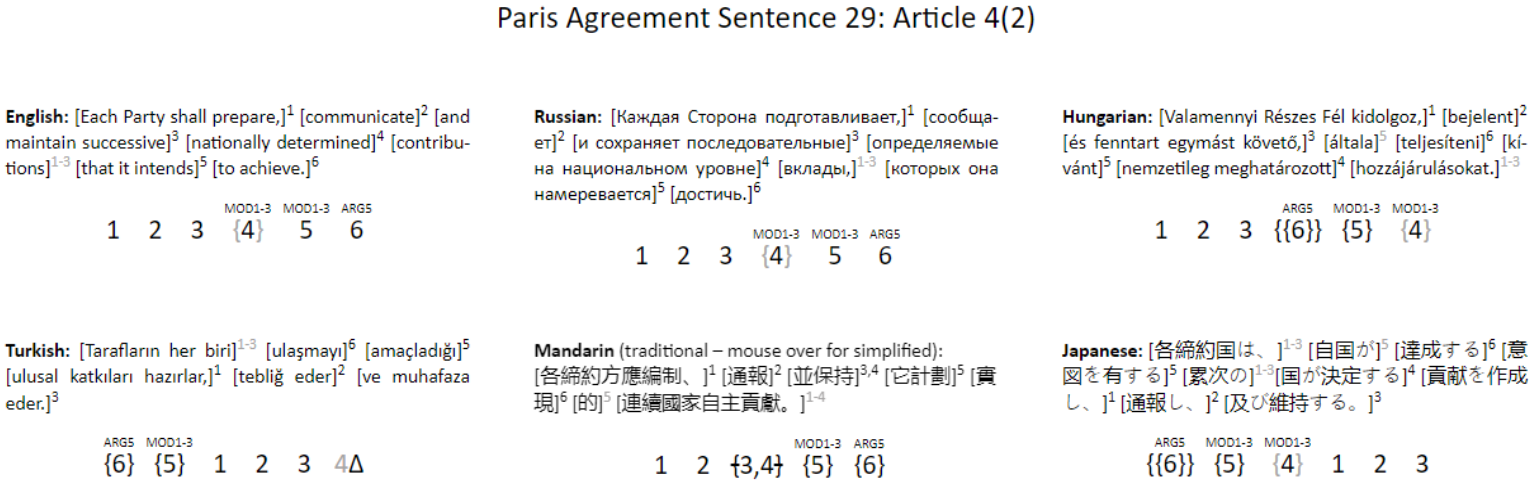


Figure 40
Completed display for sample sentence from Paris Agreement, with number lines indicating reordering, nesting changes and changes in semantic relations for each translated or interpreted version

The number lines below each language version of the sentence in figure 40 give us all the data we need to record for that sentence. A completed data table for our sample sentence is shown in table 6.

Table 6

Completed data table for sample sentence

Mode	Text / Speech	Sentence #			Subordinations
Legal translation	Paris Agreement	29			3
Target language	Reordering $\sum_{i=1}^{n-1} \sum_{j=i+1}^{n} I(x_j<x_i)$	{ }	± Nestings {{ }}	{{{ }}}	Semantic changes Δ
Russian	—	—	—	—	—
Hungarian	3	2	1	—	—
Turkish	7	2	—	—	1
Mandarin	—	3	—	—	—
Japanese	12	2	1	—	—

A similar display page with a data table for each sentence in our corpus can be found in annex II.

We've seen here how values are counted and recorded for the three dependent variables in this study, using the semantic parsing method detailed in annex I. Now we're ready to have a look at our findings, starting with the statistical procedure used to produce them.

4.2 Statistical analysis

4.2.1 Procedure

4.2.1.1 Variables

The corpus of sentences analyzed in this study consists of three legal texts, five subtitled talks and one simultaneously interpreted speech. That makes for a total of 1,136 original English versions of sentences, translated or interpreted into 5,680 other language versions, with 29,536 variable values recorded.

The statistical analysis on that data was carried out by an expert at the Statistical Methodology and Computing Service at the University of Louvain. The analysis first produced descriptive statistics on translated or interpreted versions of English sentences as observed in the corpus data. Based on those results, the analysis also produced predictive statistics on the response of each dependent variable to each pair of independent variables, and to all three independent variables acting together. Those predictions can be applied to similar texts, talks and speeches not in the corpus.

The descriptive analysis included **three independent variables**: **mode**, **target language** and **sentence complexity**.

The first independent variable, **mode**, refers to the mode of language transfer. This variable could take one of three values: **legal translation**, **subtitle translation** or **simultaneous interpretation**.

The second independent variable, **target language**, refers to the language into which a given English sentence is translated or interpreted. This variable could take one of five values: **Russian**, **Hungarian**, **Turkish**, **Mandarin** or **Japanese**. Based on those values, the descriptive analysis included **two structural sub-variables** involving the branching direction of subordinate clauses as established in studies of language typology. One independent sub-variable was **difference in the branching direction of relative clauses**. This sub-variable could take one of three values: **same** (for Russian, where relative clauses typically branch to the right, as in English), **moderately different** (for Hungarian, where relative clauses typically branch either way) or **opposite** (for Turkish, Mandarin and Japanese, where relative clauses typically branch to the left). The other independent sub-variable was **difference in the branching direction of complement clauses**. This sub-variable could take one of two values: **same** (for Russian, Hungarian and Mandarin, where complement clauses typically branch to

the right, as in English) or **opposite** (for Turkish and Japanese, where complement clauses typically branch to the left).

Based on those two structural sub-variables in the descriptive analysis, the predictive analysis included a single combined independent variable for **structural difference of the language pair**. That combined variable refers to the difference between English and each other language in the typical branching direction of subordinate clauses in general. As we saw in section 3.3.1.2 on branching direction typology, for the five target languages in this study, the typical branching direction of relative clauses can be used to uniquely predict the typical branching direction of adverbial clauses, which constitute the third broad category of subordinate clause recognized cross-linguistically. So, to avoid redundant data, our combined structural variable suffices with reflecting the typical branching direction of relative and complement clauses in the target language compared to English. This variable could take one of four values: **same** (for Russian, where both relative and complement clauses typically branch to the right, as in English), **somewhat different** (for Hungarian, where relative clauses typically branch either way and complement clauses typically branch to the right), **moderately different** (for Mandarin, where relative clauses typically branch to the left and complement clauses typically branch to the right) or **opposite** (for Turkish and Japanese, where both relative and complement clauses typically branch to the left).

The third independent variable, **sentence complexity**, refers to the number of functionally subordinate or reported propositions in the original English version of a sentence. (A functionally subordinate proposition is one which doesn't make an assertion or ask a question and can't be rephrased as an independent sentence.) This variable could take any **integer** value. (The highest number observed in a single sentence in the corpus was 30.) To simplify calculation, the model used in the predictive analysis considered five sample values for this variable, covering a representative range of sentence complexity: **simple** (3 subordinate propositions), **somewhat complex** (6 subordinate propositions), **moderately complex** (9 subordinate propositions), **very complex** (12 subordinate propositions) and **extremely complex** (15 subordinate propositions).

The statistical analysis also included **three dependent variables**, recorded separately for each translated or interpreted version of a sentence. Those dependent variables were counts for the three features identified as indicators of difficulty in translation or interpretation – **reordering**, **nesting changes** and **changes in semantic relations**. Counts for nesting changes were subdivided into counts for changes in **single nestings**, **double nestings** and **triple nestings**.

4.2.1.2 Formulas

The analysis first produced descriptive statistics reflecting the value of each dependent variable corresponding to the values of the independent variables as observed in the corpus data. Based on those descriptive statistics, linear regression analysis was then used to produce formulas predicting the mean response of each dependent variable to the independent variables. The predictive formulas were produced with the glmmTMB (generalized linear mixed models using Template Model Builder) statistical modeling package for the R computing environment. Generalized linear models are used to predict mean rates for dependent variables which take count values, like the dependent variables in this study. Mixed models are used to reflect the effects on the dependent variables of factors other than the independent variables being tested, as explained below.

The statistical analysis found significant interactions among all three independent variables. So each of the predictive formulas described here was based on those interactions. Section 4.2.3 details those interactions and explains why, when such interactions are present, testing independent variables on their own can produce misleading results.

The predictive formula for each dependent variable was based on the counts for that variable corresponding to counts for the three independent variables and their interactions as observed in the corpus. Each of those independent variables (mode, structural difference of the language pair and sentence complexity) has a set of possible values, one of which is taken as a reference value. The predictive formula for each dependent variable consists of a long sum of terms. For each possible value (except the reference value) for each independent variable on its own, the formula contains one term consisting of an estimated coefficient and a single binary element, which can be equal to 0 or 1. For each observed two-way or three-way interaction between possible values of the independent variables, the formula has one term consisting of an estimated coefficient and two or three such binary elements.

Let's say we want to predict the mean response of a dependent variable to a set of test values for the three independent variables in the study. To do that, we take the predictive formula for the dependent variable in question. Into that formula we substitute 1 for the binary elements in each term corresponding to the three values being tested. Each independent variable can only have one test value at a time. So, when the binary element corresponding to a particular test value for an independent variable is 1, the binary elements corresponding to all the other possible values of that same independent variable are 0. That simplifies the formula in effect to a shorter sum of terms corresponding to the set of values being tested.

In each term remaining in that simplified formula, all the binary elements are equal to 1. So each term in the formula is equal to the value of its estimated coefficient.

Such a simplified formula predicting the mean response of a dependent variable to a set of test values for the three independent variables can be presented as shown in (21).

(21) [reordering/nesting/sem.rels] = $a(mode_{val}) + a(diff_{val}) + a(comp_{val}) + a(mode_{val}diff_{val}) + a(diff_{val}comp_{val}) + a(mode_{val}comp_{val}) + a(mode_{val}diff_{val}comp_{val}) + n + o$

In the simplified formula in (21):

[reordering/nesting/sem.rels] is the predicted mean value of one of the dependent variables – reordering, nesting changes or changes in semantic relations;

$mode_{val}$, **$diff_{val}$** and **$comp_{val}$** are test values for the independent variables mode, structural difference of the language pair and sentence complexity;

a($mode_{val}$), **a($diff_{val}$)** and **a($comp_{val}$)** are estimated coefficients which predict the mean response of the dependent variable to the test values of the three independent variables on their own;

a($mode_{val}diff_{val}$), **a($diff_{val}comp_{val}$)** and **a($mode_{val}comp_{val}$)** are estimated coefficients which predict the mean response of the dependent variable to two-way interactions between the test values of the independent variables;

a($mode_{val}diff_{val}comp_{val}$) is an estimated coefficient which predicts the mean response of the dependent variable to the three-way interaction between the test values of the independent variables;

n is a baseline constant, applied to all sentences; and

o is an "other effects" parameter, reflecting the shared effects of untested factors on all translated or interpreted versions of each original English sentence.

In addition to estimating coefficients for terms corresponding to possible values of independent variables and their interactions, each such predictive formula for a dependent variable involved calculating a separate baseline constant, **n**. That baseline constant took into account the mean observed values of the variables in question in the corpus. The baseline constant can be thought of as being like the y-intercept on a four-dimensional graph, indicating the theoretical value of a dependent variable when the three independent variables are all equal to their reference values.

Finally, each formula predicting the mean response of a given dependent variable to the three independent variables involved calculating an “other effects” parameter, **o**. The first step in doing that was to calculate a separate sentence-level parameter for each original English sentence. Each of those separate sentence-level parameters took into account the difference between the mean observed values of the variables in question throughout the corpus and their observed values in the five translated or interpreted versions of that sentence.

The sentence-level parameter for each original English sentence was calculated so as to reflect the shared effects of untested factors on the various translated or interpreted versions of that sentence. It may be that a given original English sentence contains one or more propositions which are longer or contain more dense information than the average sentence in the same mode and with the same degree of complexity in the corpus. That could lead to a higher count for one or more dependent variables (indicators of difficulty) in one or more translated or interpreted versions of the sentence in question. The sentence in question would then appear to be more difficult as a whole than the average sentence, as measured by those dependent variables, for reasons other than the independent variables being tested. The separate sentence-level parameters calculated in this way were then offset against each other, to calculate an overall “other effects” parameter, **o**.

The main benefit of including an “other effects” parameter in each predictive formula is that that parameter isolates the effects of untested factors on related groups of observed results. The related groups in question here were the various translated or interpreted versions of each original English sentence in the corpus. With statistical modeling software such as that used in this study, isolating the effects of untested factors in this way greatly increases the accuracy of the coefficients estimated for each term in the predictive formulas. As a result, those coefficients were estimated with a very high degree of statistical confidence ($p < 0.001$).

The statistical models used in this study produced formulas, as described above, to predict the mean response of each dependent variable to the three independent variables in interaction. As with all statistical models, the actual predictions produced by those formulas are off most of the time. But it’s the best we can do. And, thanks to the inclusion of the “other effects” parameter in each predictive formula, we can have great statistical confidence in the coefficients estimated for each of their terms.

4.2.1.3 Consistency

Another factor which could have a potential effect on the results of our statistical analysis is different segmenting decisions in borderline cases – that is, different decisions applied to the original English version of different sentences as to how to segment a certain structure which could be treated in more than one way. Examples of such borderline segmenting decisions are given in the parsing guidelines, in section 4.5 of annex I.

Applying one or another segmenting decision to a given borderline structure in the original English version of a sentence may result in a higher or lower number of functionally subordinate propositions (a higher or lower complexity count) recorded for that sentence. If such a decision results in a higher complexity count, the additional subordinate proposition as it appears in another language version of the sentence may be in a different linear position with respect to its parent than in the original English version. Or the additional subordinate proposition in another language version of the sentence may split or bring together the predicate and arguments of its parent differently than in the original English version. That would yield a higher complexity count, along with a higher count for reordering or for nesting changes in the language pair in question than would be the case if a decision was made to segment the borderline structure in a way that resulted in a lower complexity count. Either way, the association between complexity and difficulty in the language pair in question would be reinforced.

Finally, some general segmenting rules given in the semantic parsing method in annex I could have been established differently. For example, section 1.7 of annex I explains that a process nominal (a nominal describing a process, event or situation) is to be segmented as the predicate of a separate proposition if it has any arguments or adjuncts. The parsing method as described in annex I recognizes that phrases like “climate change” and “sustainable development” are set terms and, as such, may be less internally processed than other constructions and may have established equivalents in other languages. But such phrases still have argument structure, and there’s no objective way to determine to what extent they may or may not be internally processed. So this study segments all such constructions consistently as separate propositions.

But what if that general segmenting rule had been established differently? What if a decision had been made not to segment set phrases like "climate change" and "sustainable development" as separate propositions throughout the corpus? Aside from the greater uncertainty that would have been created by the impossible-to-pin-down criteria for what constitutes a "set phrase," what effect would such a decision have had on the statistical

results? Not segmenting such phrases as separate propositions would have resulted in a lower number of functionally subordinate propositions (a lower complexity count) being recorded for some sentences. In such a sentence, the eliminated subordinate proposition may have been one that our actual analysis, applying the segmenting rules as established, shows as being in a different linear position with respect to its parent in another language version of the sentence than in the original English version. Or the eliminated subordinate proposition may have been one that, applying the rules as established, splits or brings together the predicate and arguments of its parent differently in another language version of the sentence than in the original English version. In such a case, establishing a rule that didn't treat a set phrase like "climate change" or "sustainable development" as a separate proposition would have yielded a lower complexity count for the sentence, along with a lower count for reordering or for nesting changes in the language pair in question than was actually recorded in the statistical analysis. That would again have reinforced the association between complexity and difficulty in the language pair in question.

As explained in section 4.5 of annex I, care has been taken in this study to segment equivalent propositions in all language versions of a given sentence the same way. If the original English version of a sentence is segmented as one proposition – or two or three – and if the equivalents of those propositions in other language versions are judged to have the same information content and functional status as in English, those versions are divided into the same number of segments as the English version. This makes the various language versions of each sentence easier to compare, minimizing the impact of minor phrasing differences between languages on the values of variables in the data. This represents a deliberately conservative choice to refrain from recording some information, in order to avoid any suggestion that the counts for indicators of difficulty in structurally different language pairs – which are already comparatively high – have been inflated by the inclusion of irrelevant data.

Guided by these principles of consistency in parsing, the formulas described above were calculated to predict, as accurately as possible, the mean response of each dependent variable to each pair of independent variables, and to all three independent variables acting together. If our corpus is considered representative, those predictions can be applied to other similar texts, talks and speeches. The results of the descriptive analysis are presented in the next section. The results of the predictive analysis are presented in section 4.2.3.

4.2.2 Observations

For each translated or interpreted version of sentences in our corpus, descriptive data was gathered for three independent variables – **mode**, **target language** and **sentence complexity** – as well as three dependent variables identified as indicators of difficulty in translation or interpretation – **reordering**, **nesting changes** and **changes in semantic relations**. Summary statistics for the rates of each dependent variable corresponding to each pair of independent variables are presented below. For nesting changes, observations on changes in double and triple nestings are presented, but not included in the frequency comparisons because of the low values involved. For changes in triple nestings, few non-zero values were observed, so only mean rates are shown.

This section simply reports descriptive observations on data in the corpus. The next section will present the results of statistical tests predicting the mean response of each dependent variable to groups of independent variables in interaction, as well as the statistical significance of those responses.

Let's start our observations with summary statistics for the three indicators of difficulty observed for various combinations of **mode** and **target language**. The figures are shown in **table 7**.

Table 7
Statistics for indicators of difficulty observed per sentence
for combinations of mode and target language
(R = Reordering, N1/N2/N3 = Changes in single/double/triple nestings, S = Changes in semantic relations)

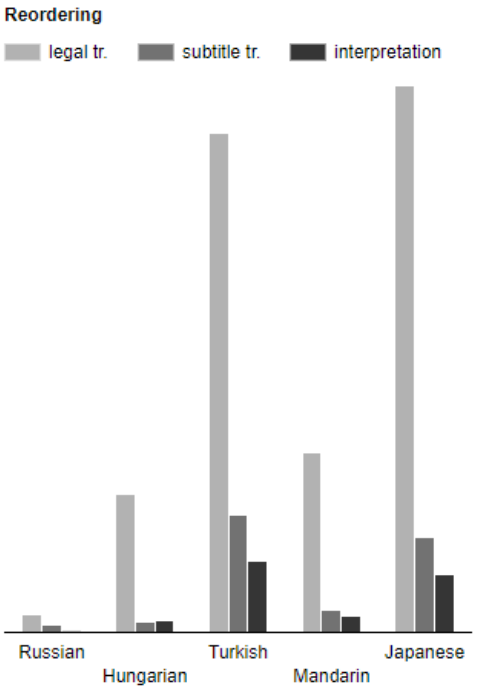
Mode	Target language	Minimum	First quartile			Median			Mean			Third quartile			Maximum			Standard deviation			Number of observations
			R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2 / N3	S	R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S	
legal translation	Russian	0	0	0 / 0	0	0	0 / 0	0	0.31	0.26 / 0.01 / 0.00	0.30	0.00	0 / 0	0	7	5 / 1	8	0.87	0.73 / 0.08	1.04	
	Hungarian	0	0	0 / 0	0	1	1 / 0	0	2.31	1.29 / 0.10 / 0.00	0.55	3.00	2 / 0	1	38	12 / 5	11	3.57	1.68 / 0.50	1.31	
	Turkish	0	1	0 / 0	0	5	2 / 0	1	8.33	3.07 / 0.27 / 0.01	1.58	9.75	4 / 0	2	140	31 / 11	25	13.41	3.82 / 0.96	2.63	498
	Mandarin	0	0	0 / 0	0	1	1 / 0	0	3.00	1.99 / 0.36 / 0.03	0.75	3.00	3 / 0	1	39	17 / 11	10	4.90	2.38 / 0.93	1.26	
	Japanese	0	1	1 / 0	0	2	2 / 0	0	9.13	3.22 / 0.35 / 0.02	0.79	10.00	5 / 0	1	170	27 / 10	17	15.25	3.75 / 1.16	1.56	
subtitle translation	Russian	0	0	0 / 0	0	0	0 / 0	0	0.12	0.12 / 0.00 / 0.00	0.44	0.00	0 / 0	0	4	3 / 0	5	0.47	0.41 / 0.00	0.91	
	Hungarian	0	0	0 / 0	0	0	0 / 0	0	0.17	0.21 / 0.00 / 0.00	0.32	0.00	0 / 0	0	6	4 / 1	4	0.55	0.58 / 0.07	0.75	
	Turkish	0	0	0 / 0	0	1	0 / 0	0	1.97	0.97 / 0.27 / 0.00	0.46	3.00	1 / 0	1	18	10 / 5	5	2.58	1.46 / 0.39	0.92	413
	Mandarin	0	0	0 / 0	0	0	0 / 0	0	0.38	0.44 / 0.01 / 0.00	0.62	0.00	1 / 0	1	10	6 / 1	6	0.94	0.85 / 0.09	1.08	
	Japanese	0	0	0 / 0	0	1	0 / 0	0	1.59	0.71 / 0.01 / 0.00	1.15	2.00	1 / 0	2	27	8 / 2	10	2.38	1.24 / 0.14	1.59	
simultaneous interpretation	Russian	0	0	0 / 0	0	0	0 / 0	0	0.02	0.11 / 0.00 / 0.00	0.72	0.00	0 / 0	1	1	3 / 0	9	0.13	0.40 / 0.00	1.28	
	Hungarian	0	0	0 / 0	0	0	0 / 0	1	0.20	0.21 / 0.00 / 0.00	1.50	0.00	0 / 0	2	4	2 / 0	9	0.54	0.51 / 0.00	1.92	
	Turkish	0	0	0 / 0	0	1	0 / 0	1	1.19	0.64 / 0.02 / 0.00	1.72	1.00	1 / 0	3	11	5 / 2	8	1.78	1.00 / 0.18	1.94	225
	Mandarin	0	0	0 / 0	0	0	0 / 0	0	0.27	0.47 / 0.01 / 0.00	1.07	0.00	1 / 0	2	3	5 / 1	7	0.63	0.89 / 0.09	1.58	
	Japanese	0	0	0 / 0	0	0	0 / 0	1	0.98	0.68 / 0.03 / 0.00	1.76	1.00	1 / 0	3	8	7 / 1	9	1.41	1.05 / 0.17	1.90	

In table 7, the two highest mean rates in the column for each indicator of difficulty (R, N1 and S) corresponding to each mode are underlined. Those underlined values show that, among the five target languages for translation or interpretation in this study, the highest mean rates for **all three indicators** were generally observed in **Turkish** and **Japanese**.

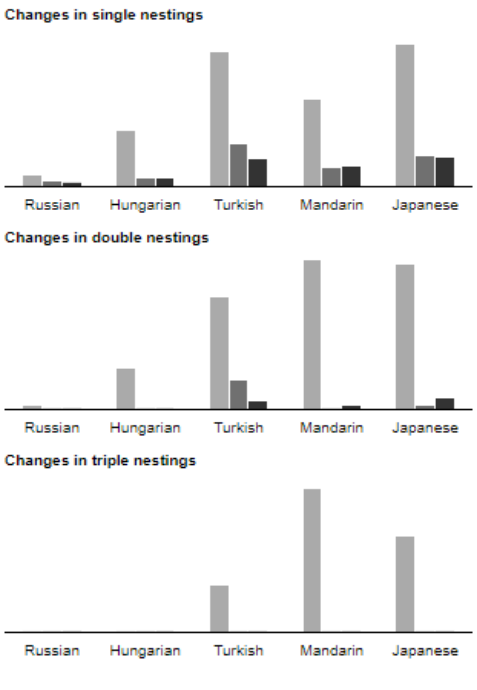
Of the underlined values in the column for each indicator of difficulty, the two highest values are also in boxes. Those boxed values show that the highest mean rates for **reordering** were observed in **legal translation**, where the mean rate for reordering was more than 8 place shifts per sentence in both Turkish and Japanese (with counts for reordering in individual sentences reaching 140 in Turkish and 170 in Japanese). The highest mean rates for **nesting changes** were also observed in **legal translation**, where the mean rate for changes in single nestings was more than 3 changes per sentence in both Turkish and Japanese (with counts for changes in single nestings in individual sentences reaching 31 in Turkish and 27 in Japanese). The highest mean rates for **changes in semantic relations** were observed in **simultaneous interpretation**, where the mean rate was over 1.7 changes per sentence in both Turkish and Japanese (with counts for changes in semantic relations in individual sentences reaching 17 in both languages).

The **mean rates** for each indicator of difficulty observed for various combinations of **mode** and **target language** are visualized in **chart 1**.

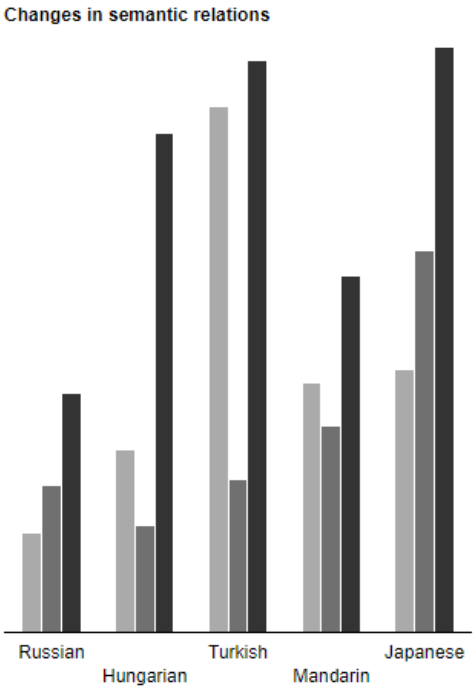
Chart 1. Mean rates for indicators of difficulty observed per sentence for combinations of mode and target language



Reordering:
highest in **Turkish** and **Japanese**,
especially in **legal translation**



Changes in single nestings:
highest in **Turkish** and **Japanese**,
especially in **legal translation**



Changes in semantic relations:
highest in **Turkish** and **Japanese**,
especially in **simultaneous interpretation**

[In the website version of this study, the reader can hover the mouse over each bar to see its exact value.]

Similar trends were found in all three **legal translation** texts (the UDHR, the Paris Agreement and the FCPA). **Table 8** shows summary statistics for the three indicators of difficulty observed for various combinations of **legal text** and **target language**.

Table 8
Statistics for indicators of difficulty observed per sentence
for combinations of legal text and target language
(R = Reordering, N1/N2/N3 = Changes in single/double/triple nestings, S = Changes in semantic relations)

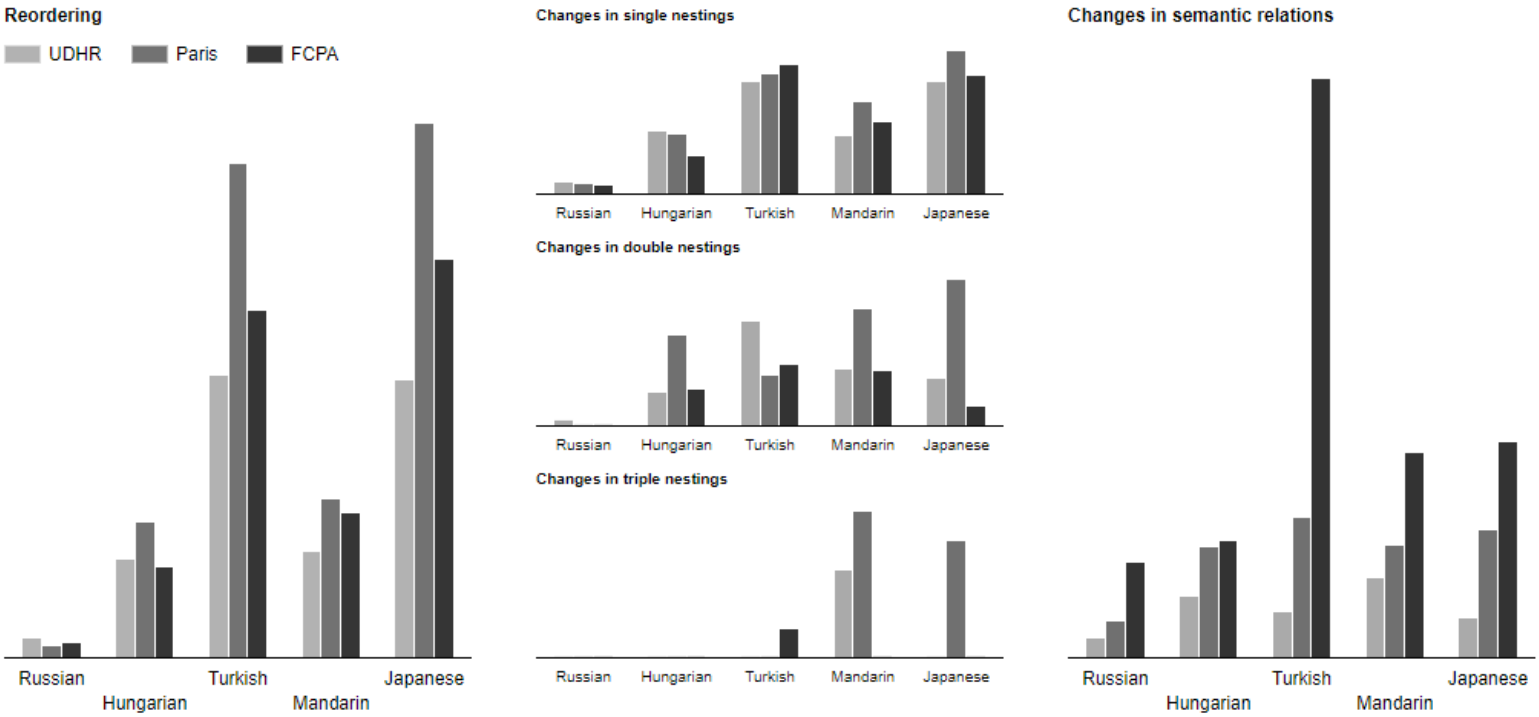
Legal text	Target language	Minimum	First quartile			Median			Mean			Third quartile			Maximum			Standard deviation			Number of observations
			R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2 / N3	S	R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S	
UDHR	Russian	0	0	0 / 0	0	0.0	0 / 0	0	0.40	0.32 / 0.03 / 0.00	0.10	0.00	0.00 / 0	0	6	5 / 1	3	1.16	0.97 / 0.17	0.46	68
	Hungarian	0	0	0 / 0	0	1.0	1 / 0	0	2.04	1.56 / 0.15 / 0.00	0.32	3.00	2.00 / 0	0	10	9 / 5	4	2.38	1.97 / 0.72	0.82	
	Turkish	0	1	0 / 0	0	3.0	3 / 0	0	5.82	2.81 / 0.46 / 0.01	0.24	8.00	4.00 / 0	0	61	16 / 11	4	8.61	3.82 / 0.96	0.77	
	Mandarin	0	0	0 / 0	0	1.0	1 / 0	0	2.18	1.46 / 0.24 / 0.03	0.41	3.00	2.00 / 0	1	13	11 / 6	3	3.42	3.02 / 1.65	0.76	
	Japanese	0	1	0 / 0	0	3.0	3 / 0	0	5.72	2.82 / 0.21 / 0.00	0.21	8.25	4.00 / 0	0	52	13 / 7	7	7.78	2.93 / 1.04	0.91	
Paris Agreement	Russian	0	0	0 / 0	0	0.0	0 / 0	0	0.26	0.26 / 0.00 / 0.00	0.19	0.00	0.00 / 0	0	5	5 / 1	4	0.79	0.68 / 0.07	0.64	225
	Hungarian	0	0	0 / 0	0	1.0	1 / 0	0	2.80	1.49 / 0.04 / 0.00	0.57	4.00	2.00 / 0	1	38	12 / 2	11	4.24	1.80 / 0.22	1.28	
	Turkish	0	1	0 / 0	0	6.0	2 / 0	0	10.16	2.99 / 0.22 / 0.00	0.72	13.00	4.00 / 0	1	140	22 / 8	7	15.99	1.46 / 0.39	1.17	
	Mandarin	0	0	0 / 0	0	1.0	2 / 0	0	3.28	2.32 / 0.52 / 0.05	0.58	4.00	3.00 / 1	1	27	12 / 5	7	5.07	3.63 / 0.76	1.10	
	Japanese	0	1	1 / 0	0	6.0	2 / 0	0	11.00	3.57 / 0.63 / 0.04	0.66	14.00	5.00 / 1	1	170	25 / 10	7	18.53	3.87 / 1.54	1.11	
FCPA	Russian	0	0	0 / 0	0	0.0	0 / 0	0	0.33	0.24 / 0.00 / 0.00	0.49	0.00	0.00 / 0	0	7	5 / 0	8	0.84	0.71 / 0.00	1.42	205
	Hungarian	0	0	0 / 0	0	1.0	1 / 0	0	1.86	0.98 / 0.16 / 0.00	0.60	2.00	1.00 / 0	1	19	11 / 5	10	2.98	1.38 / 0.61	1.46	
	Turkish	0	1	0 / 0	1	5.0	2 / 0	2	7.16	3.25 / 0.27 / 0.01	2.98	9.00	5.00 / 0	4	116	31 / 7	25	11.23	1.00 / 0.18	3.43	
	Mandarin	0	0	0 / 0	0	1.0	1 / 0	0	2.97	1.79 / 0.23 / 0.00	1.06	3.00	3.00 / 0	2	39	17 / 11	10	5.11	4.26 / 0.84	1.48	
	Japanese	0	1	0 / 0	0	6.0	1 / 0	0	8.21	2.98 / 0.09 / 0.00	1.11	9.00	4.00 / 0	2	117	27 / 3	17	12.71	3.85 / 0.35	2.02	

In table 8, the two highest values in the columns showing the mean rates for each indicator of difficulty (R, N1 and S) corresponding to each legal text are underlined. Those underlined values show that, among the three legal translation texts as in the entire corpus, the highest mean rates for **all three indicators** were generally observed in **Turkish** and **Japanese**.

Of the underlined values in the columns showing the mean rates for each indicator of difficulty, the two highest values are also in boxes. Those boxed values show that, among the three legal texts, the highest mean rates for **reordering** were observed in the **Paris Agreement**, where the mean rate for reordering was more than 10 place shifts per sentence in Turkish and Japanese. The mean rates for **nesting changes** were **similar** in all three legal texts. The highest mean rates for **changes in semantic relations** were observed in the **FCPA**, where the mean rate was nearly 3 changes per sentence in Turkish.

The **mean rates** for each indicator of difficulty observed for various combinations of **legal text** and **target language** are visualized in **chart 2**.

Chart 2. Mean rates for indicators of difficulty observed per sentence for combinations of legal text and target language



Reordering:
highest in **Turkish** and **Japanese**, especially in the **Paris Agreement**

Changes in single nestings:
similar in all three legal texts

Changes in semantic relations:
highest in **Turkish**, especially in the **FCPA**

Similar trends were also found in all five **subtitle translation** talks (the talks by Sir Ken Robinson, Amy Cuddy, Simon Sinek, Brené Brown and Tim Urban). **Table 9** shows summary statistics for the three indicators of difficulty observed for various combinations of **subtitled talk** and **target language**. The table doesn't show any data on changes in triple nestings, since there weren't any triple nestings in the talks.

Table 9

Statistics on indicators of difficulty observed per sentence

for combinations of subtitled talk and target language

(R = Reordering, N1/N2 = Changes in single/double nestings, S = Changes in semantic relations)

Subtitled talk by	Target language	Minimum	First quartile			Median			Mean			Third quartile			Maximum			Standard deviation			Number of observations
			R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S	
Sir Ken Robinson	Russian	0	0	0 / 0	0	0.0	0 / 0	0	0.19	0.14 / 0.03	0.48	0.00	0.00 / 0	1	3	2 / 0	4	0.55	0.43 / 0.00	0.85	69
	Hungarian	0	0	0 / 0	0	0.0	0 / 0	0	0.23	0.19 / 0.00	0.20	0.00	0.00 / 0	0	2	2 / 0	3	0.49	0.43 / 0.00	0.61	
	Turkish	0	0	0 / 0	0	1.0	0 / 0	0	1.32	0.54 / 0.03	0.48	2.00	1.00 / 0	0	7	4 / 1	5	1.49	0.81 / 0.17	1.08	
	Mandarin	0	0	0 / 0	0	0.0	0 / 0	0	0.64	0.36 / 0.00	0.55	1.00	1.00 / 0	1	7	5 / 0	5	1.21	0.75 / 0.00	1.01	
	Japanese	0	0	0 / 0	1	1.0	0 / 0	1	1.19	0.64 / 0.01	1.23	2.00	1.00 / 0	2	7	6 / 1	7	1.40	1.18 / 00.12	1.39	
Amy Cuddy	Russian	0	0	0 / 0	0	0.0	0 / 0	0	0.21	0.19 / 0.00	0.54	0.00	0.00 / 0	1	4	3 / 0	5	0.65	0.54 / 0.00	1.00	102
	Hungarian	0	0	0 / 0	0	0.0	0 / 0	0	0.16	0.25 / 0.00	0.18	0.00	0.00 / 0	0	3	4 / 0	4	0.52	0.67 / 0.00	0.53	
	Turkish	0	0	0 / 0	0	1.5	1 / 0	0	2.04	1.25 / 0.13	0.34	3.00	2.00 / 0	0	11	10 / 5	4	2.16	1.67 / 0.59	0.76	
	Mandarin	0	0	0 / 0	0	0.0	0 / 0	0	0.29	0.39 / 0.00	0.57	0.00	0.75 / 0	1	3	4 / 0	4	0.67	0.77 / 0.00	0.97	
	Japanese	0	0	0 / 0	1	1.0	0 / 0	1	1.67	0.72 / 0.00	1.23	3.00	1.00 / 0	2	8	5 / 0	5	1.81	1.21 / 0.00	1.50	
Simon Sinek	Russian	0	0	0 / 0	0	0.0	0 / 0	0	0.04	0.07 / 0.00	0.36	0.00	0.00 / 0	0	3	2 / 0	5	0.33	0.33 / 0.00	0.84	91
	Hungarian	0	0	0 / 0	0	0.0	0 / 0	0	0.16	0.18 / 0.10	0.46	0.00	0.00 / 0	1	2	3 / 1	3	0.40	0.55 / 0.10	0.86	
	Turkish	0	0	0 / 0	0	1.0	1 / 0	0	1.52	0.96 / 0.04	0.67	2.50	1.00 / 0	1	9	5 / 2	4	1.88	1.23 / 0.25	0.99	
	Mandarin	0	0	0 / 0	0	0.0	0 / 0	0	0.36	0.55 / 0.01	0.46	0.00	1.00 / 0	1	4	6 / 1	4	0.77	0.99 / 0.10	0.87	
	Japanese	0	0	0 / 0	0	1.0	0 / 0	0	1.38	0.84 / 0.01	0.95	2.00	2.00 / 0	2	7	6 / 1	9	1.73	1.28 / 0.10	1.46	
Brené Brown	Russian	0	0	0 / 0	0	0.0	1 / 0	0	0.06	0.12 / 0.09	0.40	0.00	0.00 / 0	0	2	2 / 0	5	0.29	0.37 / 0.00	0.92	80
	Hungarian	0	0	0 / 0	0	0.0	0 / 0	0	0.24	0.29 / 0.10	0.59	0.00	0.00 / 0	1	6	3 / 1	4	0.83	0.72 / 0.11	1.01	
	Turkish	0	0	0 / 0	0	2.0	0 / 0	0	3.01	1.18 / 0.06	0.51	4.00	2.00 / 0	1	18	8 / 1	4	3.84	1.79 / 0.24	0.99	
	Mandarin	0	0	0 / 0	0	0.0	0 / 0	0	0.48	0.51 / 0.03	1.05	0.00	1.00 / 0	2	10	4 / 1	5	1.36	1.01 / 0.16	1.40	
	Japanese	0	0	0 / 0	1	1.0	0 / 0	1	2.44	0.92 / 0.03	1.68	3.25	2.00 / 0	3	27	8 / 1	10	4.01	1.59 / 0.16	2.11	
Tim Urban	Russian	0	0	0 / 0	0	0.0	1 / 0	0	0.08	0.08 / 0.09	0.38	0.00	0.00 / 0	0	2	1 / 0	4	0.37	0.28 / 0.00	0.90	71
	Hungarian	0	0	0 / 0	0	0.0	0 / 0	0	0.08	0.14 / 0.00	0.18	0.00	0.00 / 0	1	2	2 / 0	3	0.37	0.39 / 0.00	0.54	
	Turkish	0	0	0 / 0	0	1.0	0 / 0	0	1.93	0.76 / 0.08	0.27	3.00	1.00 / 0	0	13	7 / 3	5	2.67	1.37 / 0.44	0.74	
	Mandarin	0	0	0 / 0	0	0.0	0 / 0	0	0.15	0.34 / 0.00	0.45	0.00	0.50 / 0	0	2	2 / 0	6	0.40	0.63 / 0.00	1.03	
	Japanese	0	0	0 / 0	0	1.0	0 / 0	0	1.17	0.37 / 0.03	0.66	1.00	1.00 / 0	1	10	4 / 0	5	1.90	0.68 / 0.24	1.12	

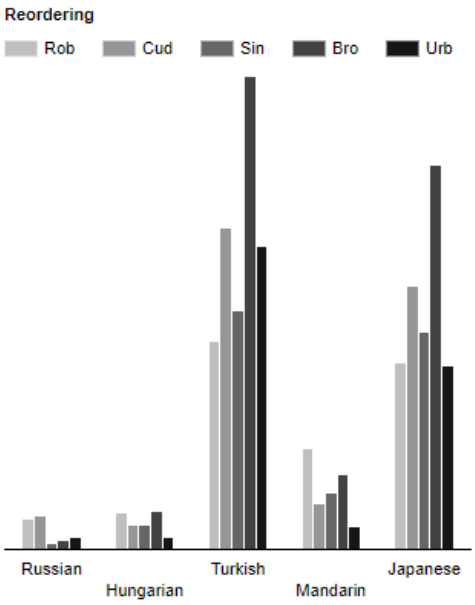
In table 9, the two highest values in the columns showing the mean rates for each indicator of difficulty (R, N1 and S) corresponding to each subtitled talk are underlined. Those underlined values show that, among the five subtitle translation talks as in the entire corpus, the highest mean rates for **reordering** and **nesting changes** were observed in **Turkish** and **Japanese**. The highest mean rates for **changes in semantic relations** were generally observed in **Mandarin** and **Japanese**.

Of the underlined values in the columns showing the mean rates for each indicator of difficulty, the two highest values are also in boxes. Those boxed values show that, among the five subtitled talks, the highest mean rates for **reordering** were observed in the talk by **Brené Brown**, where the mean rate was more than 3 place shifts per sentence in Turkish, and nearly

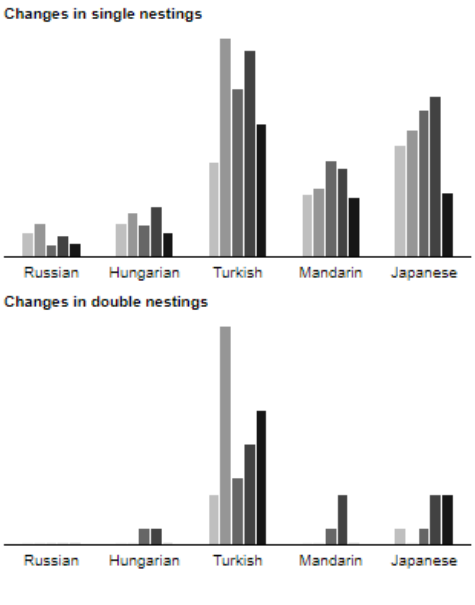
2½ place shifts per sentence in Japanese. The highest mean rates for nesting changes were observed in the talks by **Amy Cuddy** and **Brené Brown**, where the mean rate for changes in single nestings was more than 1 change per sentence in Turkish. The highest mean rates for **changes in semantic relations** were observed in the talks by **Sir Ken Robinson, Amy Cuddy** and **Brené Brown**, where the mean rate was well over 1 change per sentence in Japanese.

The **mean rates** for each indicator of difficulty observed for various combinations of **subtitled talk** and **target language** are visualized in **chart 3**.

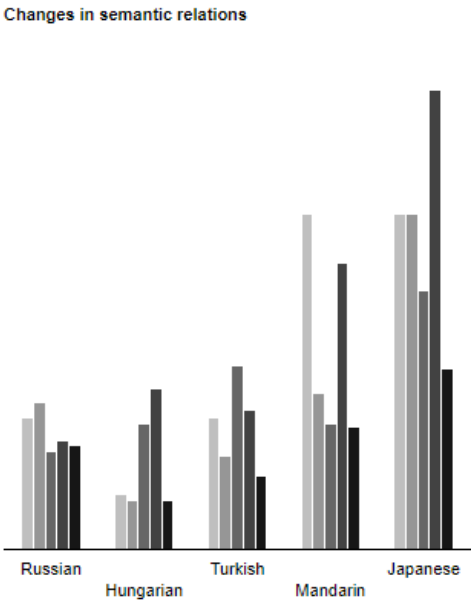
Chart 3. Mean rates for indicators of difficulty observed per sentence for combinations of subtitled talk and target language



Reordering:
highest in **Turkish** and **Japanese**, especially in the talk by Brené Brown



Changes in single nestings:
highest in **Turkish** and **Japanese**, especially in the talks by Amy Cuddy and Brené Brown



Changes in semantic relations:
highest in **Mandarin** and **Japnese**, especially in the talks by Sir Ken Robinson, Amy Cuddy and Brené Brown

Now let's look at sentence complexity, as measured by the number of functionally subordinate or reported propositions per sentence. **Table 10** shows the calculations for the **mean number of subordinate propositions per original sentence** observed in each **mode**, each **legal text** and each **subtitled talk** in the corpus.

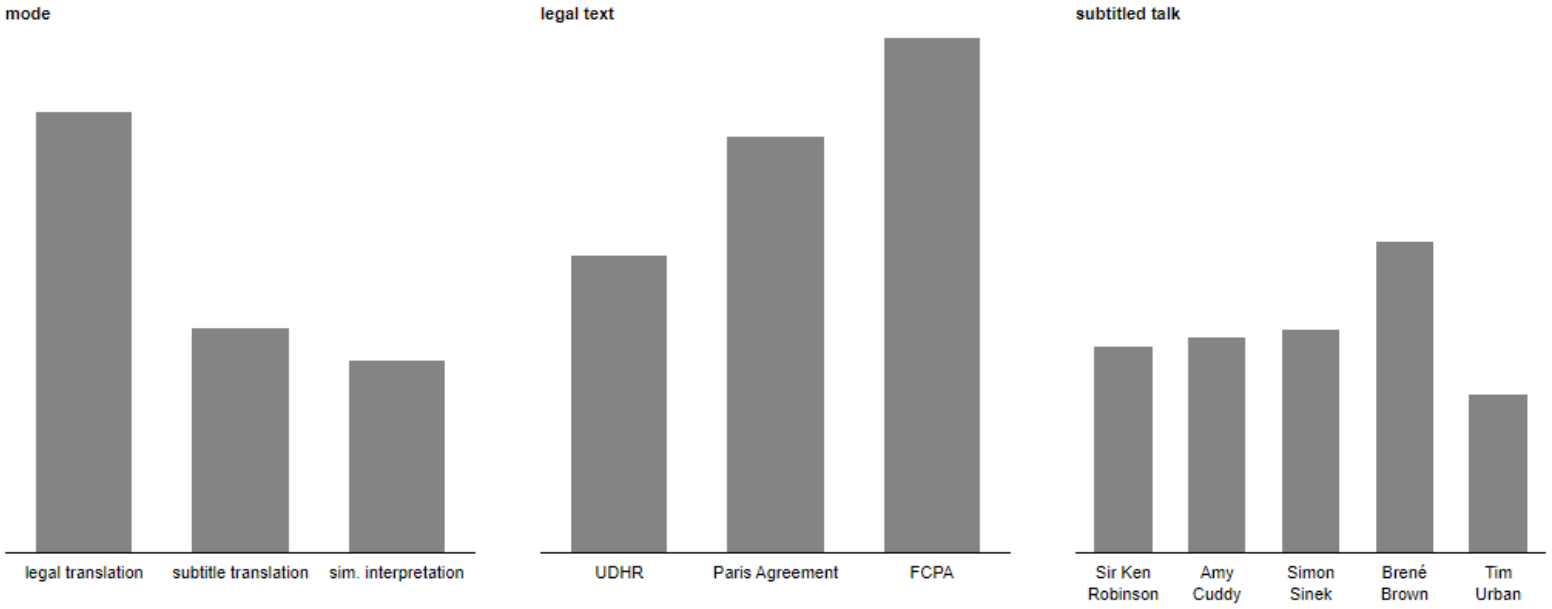
Table 10
Mean number of subordinate or reported propositions per original sentence observed in each mode, each legal text and each subtitled talk

Mode	Legal text	Subtitled talk	Minimum	First quartile	Median	Mean	Third quartile	Maximum	Standard deviation	No of observations
legal translation			0	2	4	**4.72**	6	30	3.88	498
subtitle translation			0	1	2	**2.41**	3	12	1.99	413
interpretation			0	1	2	**2.08**	3	10	1.91	225
	UDHR		0	1	3	**3.18**	4.0	14	2.73	68
	Paris Agreement		0	2	4	**4.46**	6.0	22	3.54	225
	FCPA		0	3	5	**5.52**	7.5	30	4.35	205
		Sir Ken Robinson	0	1	2	**2.22**	3	12	1.86	69
		Amy Cuddy	0	1	2	**2.32**	3	6	1.57	102
		Simon Sinek	0	1	2	**2.40**	3	12	1.87	91
		Brené Brown	0	1	3	**3.33**	5	11	2.52	80
		Tim Urban	0	1	1	**1.70**	2	8	1.71	71

In table 10, the highest value in the column showing the mean degree of sentence complexity within each mode, each legal text and each subtitled talk is in a box. Those boxed values show that the **mode** with the most **complex sentences** on average was **legal translation**, where there were nearly 5 functionally subordinate or reported propositions on average per original sentence. The **most complex legal text** was the **FCPA**, where there were more than 5½ subordinate or reported propositions on average per original sentence. (Counts for sentence complexity in individual sentences reached 30 subordinate or reported propositions.) The **most complex subtitled talk** was the one by **Brené Brown**, where there were more than 3 subordinate or reported propositions on average per original sentence. (Counts for sentence complexity in individual sentences reached 11 subordinate or reported propositions.)

The **mean number of subordinate or reported propositions** per original sentence observed in each mode, each legal text and each subtitled talk are visualized in **chart 4**.

Chart 4. Mean number of subordinate propositions observed per original sentence in each:



Sentence complexity among **modes:** highest in **legal translation**

Sentence complexity **similar** among **legal texts,** highest in **FCPA**

Sentence complexity **similar** among **subtitled talks,** highest in talk by **Brené Brown**

Finally, let's look at data involving structural variables. The first structural variable considered was difference in the branching direction of relative clauses. **Table 11** shows summary statistics for the three indicators of difficulty observed for various combinations of **mode** and **difference in the branching direction of relative clauses**.

Table 11

Statistics on indicators of difficulty observed per sentence for combinations of mode and difference in branching direction of relative clauses

(R = Reordering, N1/N2/N3 = Changes in single/double/triple nestings, S = Changes in semantic relations)

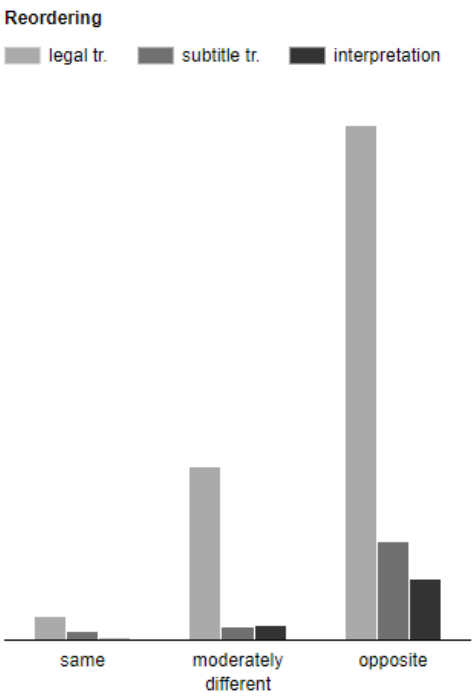
Mode	Branching direction of relative clauses	Minimum	First quartile			Median			Mean			Third quartile			Maximum			Standard deviation			Number of observations
			R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2 / N3	S	R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S	
legal translation	same	0	0	0 / 0	0	0	0 / 0	0	0.31	0.26 / 0.01 / 0.00	0.30	0	0 / 0	0	7	5 / 1	8	0.87	0.73 / 0.08	1.04	498
	moderately different	0	0	0 / 0	0	1	1 / 0	0	2.31	1.29 / 0.10 / 0.00	0.55	3	2 / 0	1	38	12 / 5	11	3.57	1.68 / 0.50	1.31	498
	opposite	0	1	0 / 0	0	3	2 / 0	0	6.82	2.73 / 0.33 / 0.05	1.04	8	4 / 0	1	170	31 / 11	25	12.36	3.43 / 1.02	1.95	1494
subtitle translation	same	0	0	0 / 0	0	0	0 / 0	0	0.12	0.12 / 0.00 / 0.00	0.44	0	0 / 0	0	4	3 / 0	5	0.47	0.41 / 0.00	0.91	413
	moderately different	0	0	0 / 0	0	0	0 / 0	0	0.17	0.21 / 0.00 / 0.00	0.32	0	0 / 0	0	6	4 / 1	4	0.55	0.58 / 0.07	0.75	413
	opposite	0	0	0 / 0	0	1	0 / 0	0	1.31	0.70 / 0.03 / 0.00	0.74	2	1 / 0	1	27	10 / 5	10	2.21	1.23 / 0.24	1.26	1239
simultaneous interpretation	same	0	0	0 / 0	0	0	0 / 0	0	0.02	0.59 / 0.00 / 0.00	0.72	0	0 / 0	1	1	3 / 0	9	0.13	0.40 / 0.00	1.28	225
	moderately different	0	0	0 / 0	0	0	0 / 0	1	0.20	0.21 / 0.00 / 0.00	1.50	0	0 / 0	2	4	2 / 0	9	0.54	0.51 / 0.00	1.92	225
	opposite	0	0	0 / 0	0	0	0 / 0	1	0.81	0.64 / 0.02 / 0.00	1.52	1	1 / 0	2	11	7 / 2	9	1.42	0.99 / 0.15	1.84	675

In table 11, the highest value in the column showing the mean rates for each indicator of difficulty (R, N1 and S) corresponding to each mode is underlined. Those underlined values show that, in all three modes, the highest mean rates for **all three indicators** were observed when the **branching direction of relative clauses** was **opposite**.

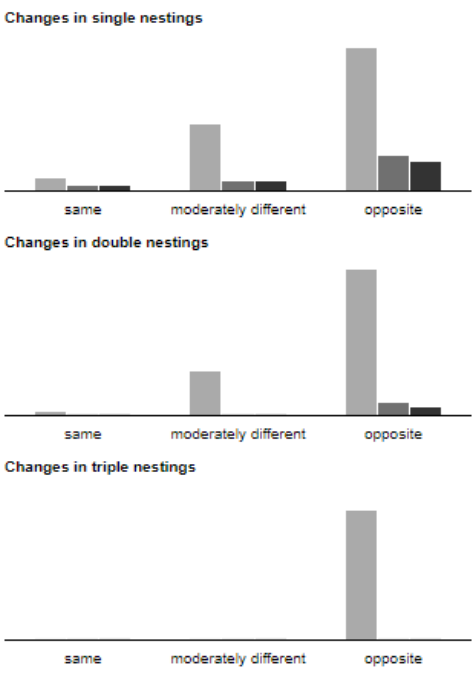
Of the underlined values in the column showing the mean rates for each indicator of difficulty, the highest value is also in a box. Those boxed values show that the highest mean rates for **reordering** and **nesting changes** were again observed in **legal translation**, where the mean rate for reordering was nearly 7 place shifts per sentence when the branching direction of relative clauses was opposite, and the mean rate for changes in single nestings was nearly 3 changes per sentence when the branching direction of relative clauses was opposite. The highest mean rate for **changes in semantic relations** was again observed in **simultaneous interpretation**, where the mean rate was more than 1½ changes per sentence when the branching direction of relative clauses was opposite.

The **mean rates** for each indicator of difficulty observed for various combinations of **mode** and **difference in the branching direction of relative clauses** are visualized in **chart 5**.

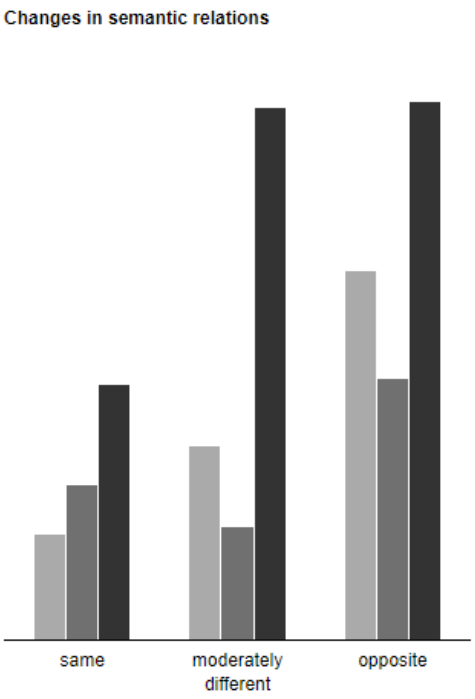
Chart 5. Mean rates for indicators of difficulty observed per sentence for combinations of mode and difference in branching direction of relative clauses



Reordering:
highest with **opposite branching direction of relative clauses**, especially in **legal translation**



Changes in single nestings:
highest with **opposite branching direction of relative clauses**, especially in **legal translation**



Changes in semantic relations:
highest with **opposite branching direction of relative clauses**, especially in **simultaneous interpretation**

The other structural variable considered was difference in the branching direction of complement clauses. **Table 12** shows summary statistics for the three indicators of difficulty observed for various combinations of **mode** and **difference in the branching direction of complement clauses**.

Table 12

Statistics on indicators of difficulty observed per sentence

for combinations of mode and difference in branching direction of complement clauses

(R = Reordering, N1/N2/N3 = Changes in single/double/triple nestings, S = Changes in semantic relations)

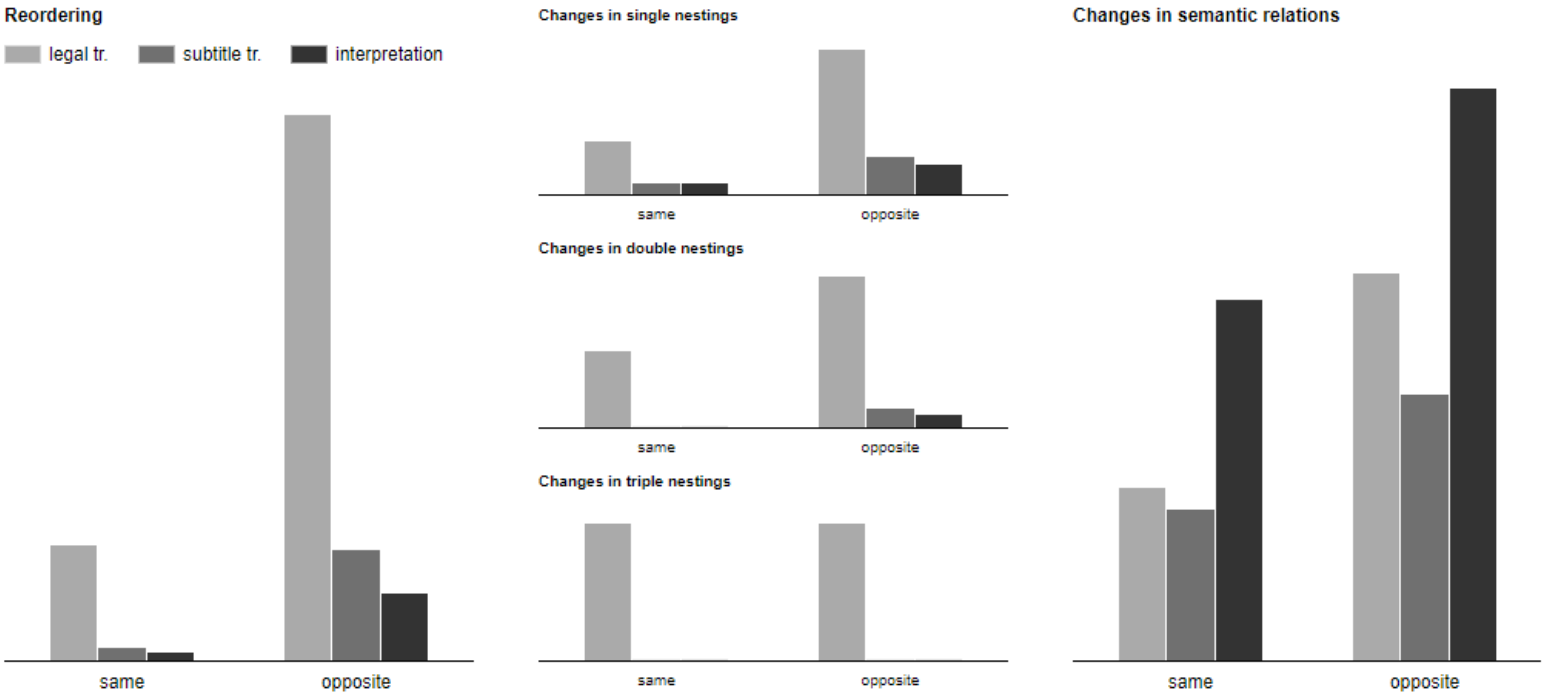
Mode	Branching direction of complement clauses	Minimum	First quartile			Median			Mean			Third quartile			Maximum			Standard deviation			Number of observations
			R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2 / N3	S	R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S	
legal translation	same	0	0	0 / 0	0	0	0 / 0	0	1.87	1.18 / 0.16 / 0.03	0.53	2	2 / 0	1	39	17 / 11	11	3.71	1.87 / 0.63	1.22	1494
	opposite	0	1	0 / 0	0	5	2 / 0	0	**8.73**	**3.15** / 0.31 / 0.03	1.18	10	4 / 0	2	170	31 / 11	25	14.36	3.79 / 1.06	2.20	996
subtitle translation	same	0	0	0 / 0	0	0	0 / 0	0	0.22	0.26 / 0.00 / 0.00	0.46	0	0 / 0	1	10	6 / 1	6	0.69	0.65 / 0.06	0.93	1239
	opposite	0	0	0 / 0	0	1	0 / 0	0	1.78	0.84 / 0.04 / 0.00	0.81	3	1 / 0	1	27	10 / 5	10	2.49	1.36 / 0.29	1.34	826
simultaneous interpretation	same	0	0	0 / 0	0	0	0 / 0	0	0.16	0.26 / 0.00 / 0.00	1.10	0	0 / 0	2	4	5 / 1	9	0.50	0.65 / 0.05	1.64	675
	opposite	0	0	0 / 0	0	1	0 / 0	1	1.08	0.66 / 0.03 / 0.00	**1.74**	1	1 / 0	3	11	7 / 2	9	1.61	1.03 / 0.17	1.92	450

In table 12, the highest value in the column showing the mean rate for each indicator of difficulty (R, N1 and S) corresponding to each mode is underlined. Those underlined values show that, in all three modes, the highest mean rates for **all three indicators** were observed when the **branching direction of complement clauses** was **opposite**.

Of the underlined values in the column showing the mean rates for each indicator of difficulty, the highest value is also in a box. Those boxed values show that **reordering** and **nesting changes** were again observed most frequently in **legal translation**, where the mean rate for reordering reached nearly 9 place shifts per sentence when the branching direction of complement clauses was opposite, and the mean rate for changes in single nestings reached more than 3 changes per sentence when the branching direction of complement clauses was opposite. **Changes in semantic relations** were again characteristic of all three modes, especially **simultaneous interpretation**, where the mean rate reached nearly 2 changes per sentence when the branching direction of complement clauses was opposite.

The **mean rates** for each indicator of difficulty observed for various combinations of **mode** and **difference in the branching direction of complement clauses** are visualized in **chart 6**.

Chart 6. Mean rates for indicators of difficulty observed per sentence for combinations of mode and difference in branching direction of complement clauses



Reordering:
highest with **opposite branching direction of complement clauses**, especially in **legal translation**

Changes in single nestings:
highest with **opposite branching direction of complement clauses**, especially in **legal translation**

Changes in semantic relations:
highest with **opposite branching direction of complement clauses**, especially in **simultaneous interpretation**

This section has presented the main findings produced by analyzing the observed corpus data for this study. Based on that data, a statistical model was estimated and applied, to predict the mean response of each dependent variable to different groups of independent variables in interaction. Those predictions – which can be applied to similar texts, talks and speeches not in the corpus – are presented in the next section.

4.2.3 Predictions

In addition to producing descriptive statistics on the observed corpus data, as presented in the previous section, the statistical analysis also involved estimating and applying a model to predict the mean response of each dependent variable to the independent variables, including values not observed in the corpus. If our corpus is considered representative, the predictions produced in this way can be applied to other similar texts, talks and speeches.

The descriptive analysis presented in the previous section included two structural sub-variables: difference in the branching direction of relative clauses and difference in the branching direction of complement clauses. For the predictive analysis, those two sub-variables were combined to produce a single independent variable. That combined variable, **structural difference of the language pair**, represents the difference between English and each of the five target languages in the typical branching direction of subordinate clauses in general. The other two independent variables in the predictive analysis were the same as in the descriptive analysis: **mode** and **sentence complexity**. The three **dependent variables** were also the same: **reordering**, **nesting changes** and **changes in semantic relations**. For nesting changes, predictions for changes in double nestings are presented, but not included in the statistical comparisons because of the low values involved. The observed data was insufficient to yield any predictions for changes in triple nestings.

The first step in the predictive analysis was to check for significant interactions between our three independent variables. To do that, the p-value, or chance of randomness, was computed for the three pairwise interactions between those variables. A p-value below 0.05 is generally regarded as indicating that an interaction is significant. The figures involved in calculating p-values for interactions between our three independent variables – **mode**, **structural difference** and **sentence complexity** – are shown in **table 13**.

Table 13

p-values for interactions between mode, structural difference and sentence complexity

(R = Reordering, N1 = Changes in single nestings, S = Changes in semantic relations)

Interaction	Statistic			Degrees of freedom			p-value		
	R	N1	S	R	N1	S	R	N1	S
mode and structural difference	91.437	60.756	88.210	6	6	6	0	0	0.00
mode and sentence complexity	25.457	45.916	66.663	2	2	2	0	0	0.00
structural difference and sentence complexity	37.047	48.312	8.331	3	3	3	0	0	0.04

Table 13 shows that each of the pairwise interactions between mode, structural difference and sentence complexity yielded p-values of less than 0.05 for all three indicators of difficulty and can therefore be regarded as significant for all three indicators. In other words, each independent variable interacts significantly with the other two, with less than a 5% chance that those interactions are due to chance.

When such interactions are found to exist, statistical tests avoid investigating the effect of any single independent variable acting on its own, to find trends like which one is the strongest predictor. That's because the results of such a test would be uninformative. To understand why, let's take the example of the significant interaction found here between structural difference and mode in their effect on reordering. That interaction means that the effect of structural difference on reordering changes depending on mode. It could even be that structural difference has a positive effect on reordering in one mode and a negative effect in another mode. In that case, if we tested the effect of structural difference on reordering without considering its interaction with mode, we might obtain an average value close to 0, since the positive effect in one mode would be offset by the negative effect in another mode. By testing the simple effect of one independent variable without taking into account its interaction with the other one, we would wrongly conclude that structural difference had no impact on reordering.

As we've seen, each of our three independent variables – mode, structural difference and sentence complexity – interacts significantly with the other two. So, to produce informative results, our statistical tests investigated the interaction between each pair of those independent variables in turn, and finally all three of them acting together. The results of those four sets of tests are presented below.

Let's start with the predicted mean response of the three indicators of difficulty to interactions between **mode** and **structural difference of the language pair**. The figures are shown in **table 14**.

Table 14

Predicted mean response of indicators of difficulty

to interactions between mode and structural difference of language pair

(R = Reordering, N1/N2 = Changes in single/double nestings, S = Changes in semantic relations)

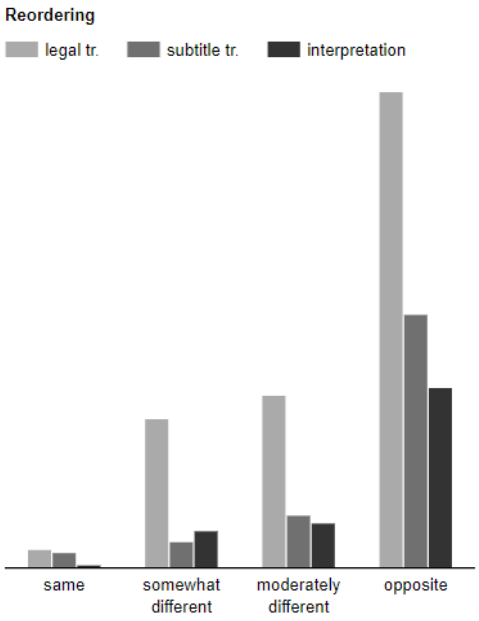
Mode	Structural difference of language pair	Response			Degrees of freedom: reordering 5660 / single nestings 5661 / double nestings 5671 / semantic relations 5660								
					Standard error			Lower confidence level			Upper confidence level		
		R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S
legal translation	same	0.121	0.122 / 0.006	0.107	0.017	0.015 / 0.004	0.016	0.092	0.096 / 0.002	0.080	0.160	0.154 / 0.020	0.142
	somewhat different	0.969	0.731 / 0.078	0.222	0.060	0.047 / 0.016	0.023	0.092	0.644 / 0.051	0.180	1.094	0.829 / 0.118	0.272
	moderately different	1.131	0.968 / 0.307	0.386	0.066	0.057 / 0.046	0.034	1.008	0.862 / 0.229	0.325	1.269	1.087 / 0.412	0.459
	opposite	3.095	1.395 / 0.270	0.529	0.130	0.069 / 0.036	0.034	2.850	1.267 / 0.207	0.467	3.361	1.537 / 0.352	0.599
subtitle translation	same	0.100	0.098 / 0.001	0.386	0.018	0.015 / 0.001	0.038	0.070	1.267 / 0.000	0.318	0.142	0.131 / 0.004	0.470
	somewhat different	0.167	0.168 / 0.016	0.290	0.024	0.020 / 0.005	0.032	0.127	0.134 / 0.009	0.233	0.220	0.212 / 0.028	0.361
	moderately different	0.344	0.346 / 0.062	0.557	0.036	0.031 / 0.016	0.048	0.281	0.290 / 0.038	0.470	0.422	0.412 / 0.103	0.660
	opposite	1.651	0.661 / 0.055	0.709	0.083	0.042 / 0.014	0.045	1.495	0.584 / 0.034	0.626	1.823	0.748 / 0.089	0.803
simultaneous interpretation	same	0.024	0.105 / 0.001	0.788	0.012	0.022 / 0.001	0.086	0.009	0.069 / 0.000	0.636	0.064	0.158 / 0.004	0.976
	somewhat different	0.235	0.198 / 0.014	1.637	0.041	0.032 / 0.005	0.141	0.167	0.144 / 0.007	1.383	0.330	0.272 / 0.029	1.938
	moderately different	0.292	0.440 / 0.055	1.168	0.047	0.053 / 0.01	0.112	0.214	0.348 / 0.028	0.968	0.400	0.557 / 0.107	1.409
	opposite	1.183	0.618 / 0.048	1.946	0.092	0.056 / 0.016	0.135	1.015	0.517 / 0.025	1.698	1.378	0.738 / 0.093	2.231

In table 14, the highest value in the column showing the mean response of each indicator of difficulty (R, N1 and S) to each mode is underlined. A comparison of each underlined value to the other values in the same column corresponding to the same mode shows that, in all three modes, the mean rates for **all three indicators** of difficulty are predicted to be lowest when the language pair has similar complex sentence structure, and to increase as the **structural difference of the language pair** increases.

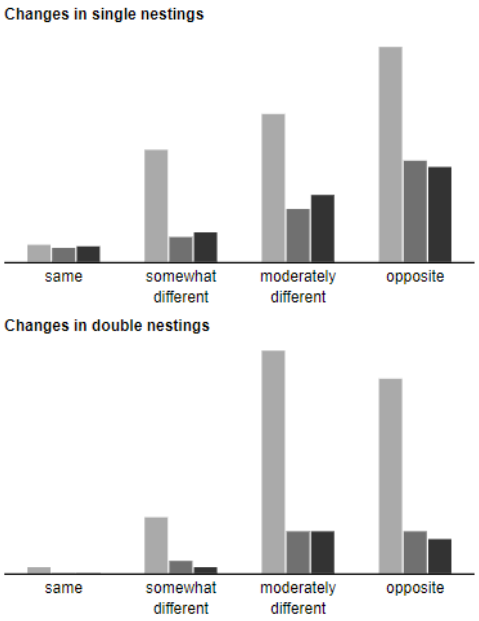
Of the underlined values in the column showing the mean rates for each indicator of difficulty, the highest value is also in a box. Those boxed values show that **reordering** and **nesting changes** are predicted to be most frequent in **legal translation**, where the mean rate for reordering is predicted to reach more than 3 place shifts per sentence when the language pair has opposite structure, and the mean rate for changes in single nestings is predicted to reach nearly 1½ changes per sentence when the language pair has opposite structure. **Changes in semantic relations** are predicted to be especially characteristic of **simultaneous interpretation**, where the mean rate is predicted to reach nearly 2 changes per sentence when the language pair has opposite structure.

The **predicted mean response** of each indicator of difficulty to interactions between **mode** and **structural difference** of the language pair are visualized in **chart 7**.

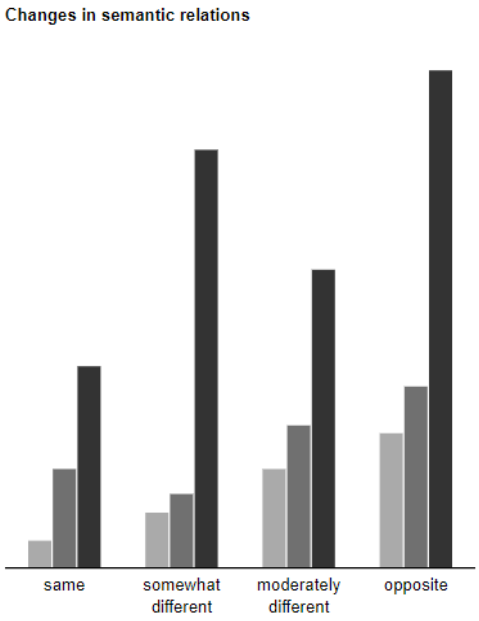
Chart 7. Predicted mean response of indicators of difficulty to interactions between mode and structural difference



Reordering: predicted to increase greatly with **structural difference**, especially in **legal translation**



Changes in single nestings: predicted to increase greatly with **structural difference**, especially in **legal translation**



Changes in semantic relations: predicted to increase with **structural difference**, especially in **simultaneous interpretation**

[As before, in the website version of this study, the reader can hover the mouse over each bar to see its exact value.]

Let's look next at the predicted mean response of the three indicators of difficulty corresponding to interactions between **mode** and **sentence complexity**, as measured by the number of functionally subordinate or reported propositions in an original English sentence. The sentence complexity variable can take any integer value. The predictive analysis considered five representative values, ranging from simple (3 subordinate or reported propositions per sentence) to extremely complex (15 subordinate or reported propositions per sentence). The figures are shown in **table 15**.

Table 15

Predicted mean response of indicators of difficulty

to interactions between mode and sentence complexity

(R = Reordering, N1/N2 = Changes in single/double nestings, S = Changes in semantic relations)

Mode	Sentence complexity	Response			Degrees of freedom: reordering 5660 / single nestings 5661 / double nestings 5671 / semantic relations 5660								
					Standard error			Lower confidence level			Upper confidence level		
		R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S
legal translation	simple	0.739	0.552 / 0.020	0.247	0.041	0.031 / 0.004	0.017	0.663	0.495 / 0.013	0.216	0.824	0.616 / 0.031	0.281
	somewhat complex	1.457	0.948 / 0.039	0.437	0.066	0.045 / 0.008	0.024	1.333	0.863 / 0.027	0.392	1.593	1.041 / 0.059	0.487
	moderately complex	2.872	1.626 / 0.079	0.775	0.154	0.098 / 0.016	0.047	2.586	1.446 / 0.054	0.688	3.191	1.829 / 0.117	0.872
	very complex	5.662	2.790 / 0.160	1.373	0.419	0.234 / 0.034	0.108	4.897	2.367 / 0.105	1.177	6.546	3.290 / 0.242	1.603
	extremely complex	11.161	4.788 / 0.322	2.434	1.109	0.538 / 0.079	0.254	9.185	3.841 / 0.198	1.985	13.562	5.969 / 0.522	2.986
subtitle translation	simple	0.280	0.223 / 0.004	0.413	0.020	0.015 / 0.001	0.024	0.243	0.195 / 0.002	0.369	0.323	0.255 / 0.007	0.463
	somewhat complex	0.703	0.541 / 0.008	1.004	0.069	0.057 / 0.002	0.089	0.580	0.440 / 0.005	0.844	0.851	0.666 / 0.014	1.194
	moderately complex	1.763	1.313 / 0.016	2.440	0.267	0.229 / 0.005	0.362	1.310	0.933 / 0.009	1.825	2.371	1.848 / 0.028	3.263
	very complex	4.421	3.186 / 0.033	5.930	0.939	0.796 / 0.010	1.270	2.915	1.953 / 0.018	3.897	6.705	5.199 / 0.059	9.024
simultaneous interpretation	simple	0.184	0.237 / 0.004	1.127	0.027	0.023 / 0.001	0.071	0.138	0.196 / 0.002	0.996	0.246	0.285 / 0.007	1.277
	somewhat complex	0.551	0.817 / 0.007	3.982	0.101	0.129 / 0.003	0.464	0.384	0.600 / 0.004	3.169	0.790	1.114 / 0.014	5.005
	moderately complex	1.646	2.822 / 0.014	14.067	0.427	0.741 / 0.005	2.776	0.990	1.687 / 0.007	9.554	2.738	4.723 / 0.029	20.711

In table 15, we don't have figures for all combinations of mode and sentence complexity. There were too few non-zero values in the data to make predictions for extremely complex sentences (15 subordinate or reported propositions per sentence) in subtitle translation, or for very or extremely complex sentences (12 or 15 subordinate or reported propositions per sentence) in simultaneous interpretation. So those rows are missing from the table.

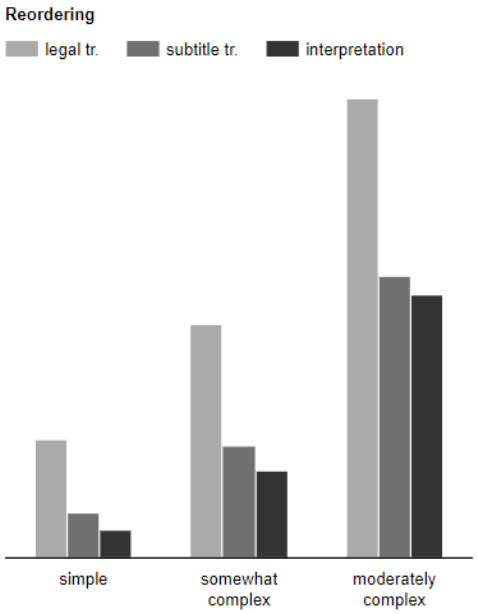
To compare like with like, we can compare the values in the column showing the mean response of each indicator of difficulty (R, N1 and S) to simple, somewhat complex and moderately complex sentences – the three degrees of complexity for which we have figures for all three modes. Of those values, the highest value in the column showing the mean rates for each indicator corresponding to each mode is underlined. A comparison of each underlined value to the other values in the same column corresponding to the same mode shows that, in all three modes, the mean rates for **all three indicators** of difficulty are predicted to increase as **sentence complexity** increases.

Of the underlined values in the column showing the mean rates for each indicator of difficulty, the highest value is also in a box. Those boxed values show that **reordering** is predicted to be most frequent in **legal translation**, where the mean rate for reordering is predicted to reach nearly 3 place shifts per sentence in moderately complex sentences (sentences with 9 subordinate or reported propositions) and more than 11 place shifts per sentence in

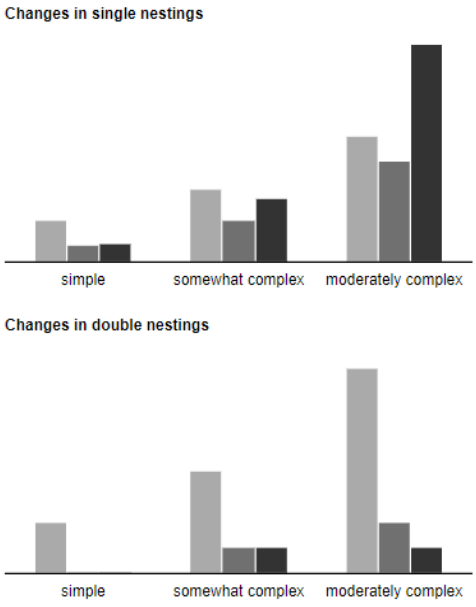
extremely complex sentences (sentences with 15 subordinate or reported propositions). **Nesting changes** and **changes in semantic relations** are predicted to be especially characteristic of **simultaneous interpretation**, where the mean rate for changes in single nestings is predicted to reach nearly 3 changes per sentence in moderately complex sentences, and the mean rate for changes in semantic relations is predicted to reach more than 14 changes per sentence in moderately complex sentences.

The **predicted mean response** of each indicator of difficulty to interactions between **mode** and **sentence complexity** are visualized in **chart 8**. No bars are shown for complex or extremely complex sentences (12 or 15 subordinate or reported propositions per sentence), since there were too few non-zero values in the data to predict comparable rates for them all.

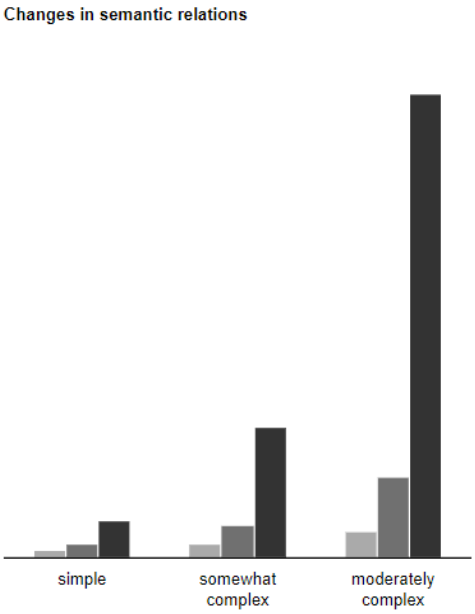
Chart 8. Predicted mean response of indicators of difficulty to interactions between mode and sentence complexity



Reordering:
predicted to increase greatly with **sentence complexity**, especially in **legal translation**



Changes in single nestings:
predicted to increase greatly with **sentence complexity**, especially in **simultaneous interpretation**



Changes in semantic relations:
predicted to increase greatly with **sentence complexity**, especially in **simultaneous interpretation**

Now let's see the predicted mean response of the three indicators of difficulty to interactions between **structural difference** and **sentence complexity**. The figures are shown in **table 16**.

Table 16

Predicted mean response of indicators of difficulty

to interactions between structural difference and sentence complexity

(R = Reordering, N1 / N2 = Changes in single/double nestings, S = Changes in semantic relations)

Structural difference of language pair	Sentence complexity	Response			Degrees of freedom: reordering 5660 / single nestings 5661 / double nestings 5671 /semantic relations 5660								
					Standard error			Lower confidence level			Upper confidence level		
		R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S
same structure	simple	0.060	0.096 / 0.001	0.287	0.011	0.009 / 0.000	0.021	0.042	0.080 / 0.000	0.248	0.086	0.117 / 0.002	0.331
	somewhat complex	0.137	0.244 / 0.001	0.717	0.026	0.026 / 0.001	0.054	0.095	0.199 / 0.000	0.619	0.199	0.300 / 0.003	0.830
	moderately complex	0.315	0.617 / 0.002	1.792	0.067	0.089 / 0.001	0.195	0.207	0.465 / 0.001	1.448	0.479	0.820 / 0.007	2.219
	very complex	0.722	1.563 / 0.004	4.483	0.186	0.310 / 0.003	0.697	0.435	1.060 / 0.001	3.305	1.197	2.306 / 0.014	6.081
	extremely complex	1.654	3.957 / 0.008	11.212	0.516	1.018 / 0.005	2.315	0.897	2.390 / 0.002	7.480	3.047	6.553 / 0.028	16.805
somewhat different structure	simple	0.303	0.265 / 0.006	0.422	0.024	0.019 / 0.002	0.026	0.260	0.230 / 0.004	0.373	0.354	0.304 / 0.010	0.476
	somewhat complex	0.726	0.575 / 0.013	1.101	0.064	0.050 / 0.003	0.074	0.611	0.486 / 0.008	0.965	0.862	0.681 / 0.020	1.255
	moderately complex	1.736	1.250 / 0.026	2.872	0.201	0.157 / 0.006	0.281	1.384	0.977 / 0.016	2.370	2.179	1.599 / 0.041	3.480
	very complex	4.154	2.717 / 0.052	7.495	0.636	0.471 / 0.014	1.037	3.076	1.934 / 0.031	5.715	5.608	3.817 / 0.087	9.829
	extremely complex	9.936	5.906 / 0.104	19.559	1.931	1.326 / 0.031	3.559	6.788	3.803 / 0.058	13.691	14.545	9.171 / 0.188	27.942
moderately different structure	simple	0.435	0.475 / 0.025	0.571	0.030	0.026 / 0.005	0.031	0.381	0.427 / 0.017	0.513	0.497	0.530 / 0.037	0.636
	somewhat complex	1.086	1.162 / 0.051	1.336	0.084	0.084 / 0.009	0.085	0.933	1.009 / 0.035	1.180	1.265	1.339 / 0.072	1.514
	moderately complex	2.713	2.841 / 0.102	3.129	0.292	0.320 / 0.019	0.303	2.197	2.277 / 0.070	2.587	3.351	3.543 / 0.147	3.783
	very complex	6.777	6.944 / 0.205	7.325	0.988	1.109 / 0.044	1.011	5.092	5.077 / 0.134	5.588	9.019	9.497 / 0.313	9.601
	extremely complex	16.926	16.973 / 0.412	17.149	3.167	3.546 / 0.107	3.118	11.729	11.270 / 0.248	12.007	24.426	25.563 / 0.685	24.492
opposite structure	simple	1.624	0.741 / 0.022	0.809	0.057	0.031 / 0.004	0.033	1.515	0.682 / 0.015	0.747	1.740	0.804 / 0.032	0.877
	somewhat complex	4.301	1.925 / 0.044	1.997	0.229	0.121 / 0.007	0.106	3.874	1.702 / 0.032	1.800	4.774	2.177 / 0.062	2.216
	moderately complex	11.390	5.003 / 0.089	4.928	1.021	0.526 / 0.016	0.424	9.554	4.072 / 0.063	4.163	13.577	6.148 / 0.127	5.834
	very complex	30.164	13.005 / 0.180	12.160	3.912	1.975 / 0.037	1.510	23.392	9.657 / 0.120	9.532	38.895	17.514 / 0.271	15.511
	extremely complex	79.884	33.803 / 0.363	30.003	13.651	6.760 / 0.092	4.916	57.144	22.840 / 0.221	21.760	111.673	50.027 / 0.595	41.370

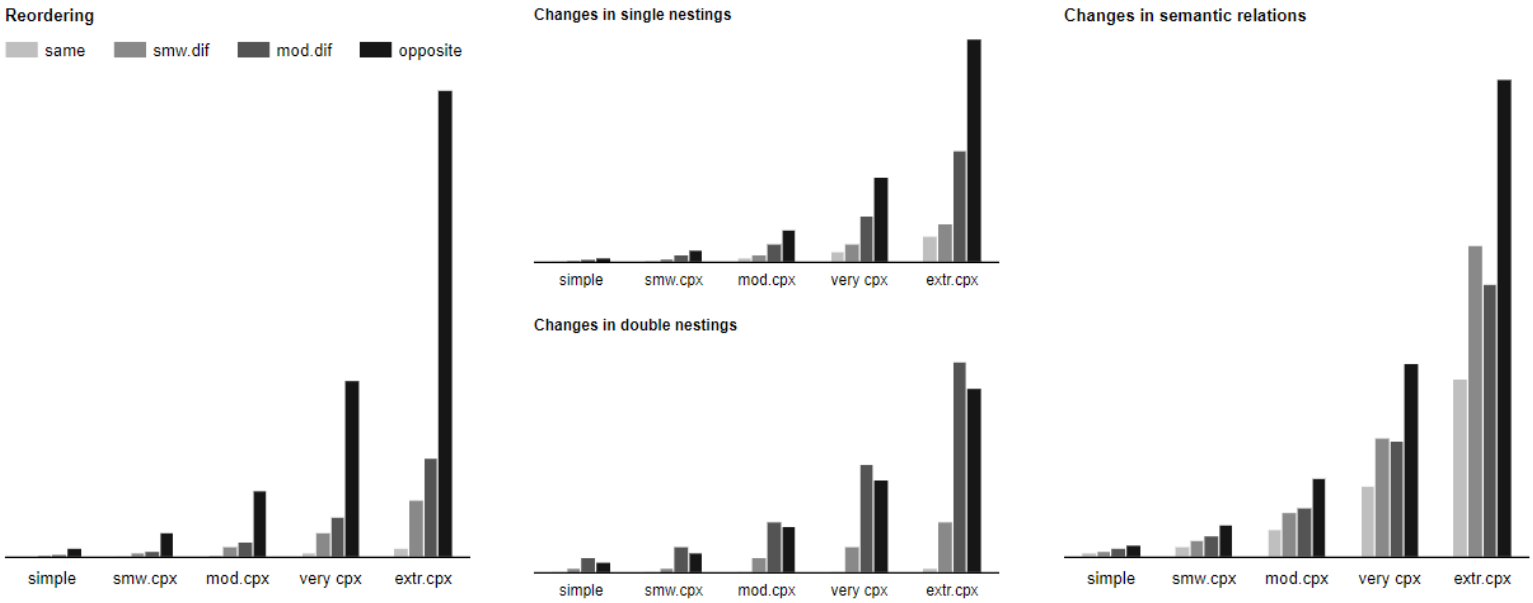
In table 16, the highest value in the column showing the mean response of each indicator of difficulty (R, N1 and S) to each degree of structural difference is underlined. A comparison of each underlined value to the other values in the same column corresponding to the same degree of structural difference shows that, for all degrees of structural difference, the mean rates for **all three indicators** of difficulty are predicted to be lowest in simple sentences, and to increase as **sentence complexity** increases.

Of the underlined values in the column showing the mean rates for each indicator of difficulty, the highest value is also in a box. Those boxed values show that the rates for all three indicators are predicted to increase greatly as **structural difference** increases. When the language pair has **opposite structure**, the mean rate for reordering is predicted to reach nearly 80 place shifts per sentence in extremely complex sentences, the mean rate for changes in single nestings is predicted to reach more than 33 changes per sentence in extremely complex sentences, and the mean rate for changes in semantic relations is

predicted to reach 30 changes per sentence in extremely complex sentences (sentences with 15 subordinate or reported propositions). All three indicators are predicted to respond especially strongly to the **combined effect** of high sentence complexity and great structural difference of the language pair.

The **predicted mean response** of each indicator of difficulty to interactions between **structural difference** and **sentence complexity** are visualized in **chart 9**.

Chart 9. Predicted mean response of indicators of difficulty to interactions between structural difference and sentence complexity



Reordering:
predicted to increase greatly
with **sentence complexity**
and **structural difference**

Changes in single nestings:
predicted to increase greatly
with **sentence complexity**
and **structural difference**

Changes in semantic relations:
predicted to increase greatly
with **sentence complexity**
and **structural difference**

Putting all the above data together, we can see the combined effect of all three independent variables. **Table 17** shows the predicted mean response of the three indicators of difficulty to interactions between **structural difference of the language pair**, **sentence complexity** and **mode**. There were too few non-zero values in the data to make predictions for extremely complex sentences in subtitle translation, or for very or extremely complex sentences in simultaneous interpretation.

Table 17

Predicted mean response of indicators of difficulty

to interactions between structural difference of language pair, sentence complexity and mode

(R = Reordering, N1/N2 = Changes in single/double nestings, S = Changes in semantic relations)

Structural difference of language pair	Sentence complexity	Mode	Response			Degrees of freedom: reordering 5660 / single nestings 5661 / double nestings 5671 / semantic relations 5660								
						Standard error			Lower confidence level			Upper confidence level		
			R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S	R	N1 / N2	S
same structure	simple	legal tr.	0.113	0.114 / 0.002	0.100	0.017	0.014 / 0.001	0.015	0.085	0.089 / 0.000	0.074	0.150	0.145 / 0.005	0.134
		subtitle tr.	0.091	0.087 / 0.000	0.348	0.016	0.013 / 0.000	0.035	0.064	0.065 / 0.000	0.286	0.129	0.117 / 0.001	0.423
		interpretation	0.021	0.090 / 0.000	0.678	0.011	0.019 / 0.000	0.073	0.008	0.059 / 0.000	0.548	0.057	0.136 / 0.001	0.838
	somewhat complex	legal tr.	0.208	0.203 / 0.003	0.179	0.024	0.020 / 0.002	0.023	0.165	0.167 / 0.001	0.139	0.261	0.247 / 0.010	0.229
		subtitle tr.	0.212	0.221 / 0.001	0.852	0.041	0.038 / 0.000	0.104	0.144	0.158 / 0.000	0.671	0.311	0.309 / 0.002	1.083
		interpretation	0.059	0.323 / 0.001	2.417	0.031	0.080 / 0.000	0.360	0.021	0.199 / 0.000	1.805	0.163	0.525 / 0.002	3.238
	moderately complex	legal tr.	0.382	0.363 / 0.006	0.320	0.045	0.038 / 0.004	0.039	0.304	0.296 / 0.002	0.251	0.461	0.444 / 0.020	0.407
		subtitle tr.	0.497	0.558 / 0.001	2.091	0.041	0.128 / 0.001	0.374	0.308	0.356 / 0.000	1.472	0.800	0.876 / 0.004	2.970
		interpretation	0.165	1.162 / 0.001	8.617	0.092	0.385 / 0.001	1.951	0.055	0.608 / 0.000	5.528	0.490	2.224 / 0.004	13.432
	very complex	legal tr.	0.703	0.648 / 0.012	0.572	0.104	0.085 / 0.007	0.079	0.527	0.501 / 0.004	0.436	0.939	0.836 / 0.040	0.750
		subtitle tr.	1.163	1.411 / 0.003	5.129	0.358	0.428 / 0.002	1.271	0.635	0.778 / 0.001	3.155	2.127	2.558 / 0.009	8.337
	extremely complex	legal tr.	1.295	1.157 / 0.025	1.023	0.251	0.197 / 0.015	0.172	0.885	0.829 / 0.008	0.736	1.894	1.615 / 0.083	1.421
somewhat different structure	simple	legal tr.	0.897	0.695 / 0.019	0.206	0.057	0.046 / 0.005	0.022	0.792	0.609 / 0.012	0.166	1.017	0.792 / 0.031	0.254
		subtitle tr.	0.150	0.154 / 0.004	0.260	0.021	0.018 / 0.001	0.029	0.114	0.122 / 0.002	0.209	0.198	0.194 / 0.007	0.324
		interpretation	0.207	0.173 / 0.003	1.402	0.036	0.028 / 0.001	0.118	0.147	0.127 / 0.002	1.189	0.290	0.237 / 0.007	1.654
	somewhat complex	legal tr.	1.724	1.065 / 0.039	0.384	0.090	0.060 / 0.008	0.035	1.557	0.955 / 0.025	0.322	1.910	1.189 / 0.059	0.459
		subtitle tr.	0.368	0.334 / 0.008	0.665	0.057	0.048 / 0.002	0.087	0.271	0.251 / 0.004	0.515	0.499	0.443 / 0.014	0.860
		interpretation	0.602	0.535 / 0.007	5.216	0.124	0.110 / 0.003	0.677	0.403	0.357 / 0.003	4.044	0.900	0.801 / 0.014	6.727
	moderately complex	legal tr.	3.314	1.634 / 0.078	0.717	0.193	0.114 / 0.016	0.063	2.956	1.426 / 0.051	0.603	3.715	1.873 / 0.118	0.852
		subtitle tr.	0.900	0.723 / 0.016	1.702	0.176	0.148 / 0.005	0.309	0.614	0.485 / 0.009	1.193	1.319	1.079 / 0.028	2.429
		interpretation	1.755	1.651 / 0.014	19.401	0.484	0.490 / 0.005	4.039	1.022	0.923 / 0.007	12.900	3.013	2.955 / 0.029	29.178
	very complex	legal tr.	6.368	2.507 / 0.156	1.339	0.499	0.245 / 0.036	0.137	5.462	2.071 / 0.100	1.096	7.426	3.035 / 0.244	1.636
		subtitle tr.	2.200	1.569 / 0.032	4.357	0.544	0.433 / 0.010	1.064	1.355	0.914 / 0.017	2.699	3.573	2.695 / 0.059	7.032
	extremely complex	legal tr.	12.238	3.846 / 0.315	2.499	1.279	0.504 / 0.082	0.319	9.971	2.974 / 0.189	1.946	15.021	4.973 / 0.524	3.210
moderately different structure	simple	legal tr.	1.042	0.908 / 0.076	0.364	0.063	0.055 / 0.014	0.033	0.925	0.805 / 0.052	0.305	1.174	1.023 / 0.110	0.434
		subtitle tr.	0.308	0.311 / 0.015	0.505	0.032	0.028 / 0.004	0.044	0.252	0.261 / 0.009	0.426	0.378	0.371 / 0.026	0.598
		interpretation	0.256	0.380 / 0.014	1.013	0.041	0.045 / 0.005	0.095	0.534	0.302 / 0.007	0.842	1.137	0.479 / 0.026	1.218
	somewhat complex	legal tr.	2.090	1.566 / 0.152	0.609	0.104	0.081 / 0.024	0.046	1.896	1.415 / 0.112	0.525	2.304	1.732 / 0.207	0.706
		subtitle tr.	0.787	0.759 / 0.031	1.159	0.097	0.091 / 0.008	0.128	0.619	0.600 / 0.019	0.933	1.001	0.961 / 0.050	1.440
		interpretation	0.779	1.320 / 0.027	3.381	0.150	0.228 / 0.009	0.466	0.188	0.941 / 0.014	2.581	0.350	1.852 / 0.052	4.429
	moderately complex	legal tr.	4.194	2.701 / 0.307	1.020	0.235	0.170 / 0.046	0.080	3.758	2.387 / 0.229	0.875	4.681	3.056 / 0.412	1.189
		subtitle tr.	2.009	1.852 / 0.062	2.661	0.339	0.341 / 0.016	0.444	1.443	1.290 / 0.038	1.919	2.797	2.659 / 0.103	3.690
		interpretation	2.371	4.582 / 0.055	11.282	0.630	1.248 / 0.019	2.418	1.408	2.686 / 0.028	7.411	3.992	7.816 / 0.107	17.174
	very complex	legal tr.	8.415	4.659 / 0.618	1.708	0.635	0.407 / 0.106	0.167	7.258	3.925 / 0.442	1.411	9.756	5.529 / 0.864	2.068
		subtitle tr.	5.128	4.518 / 0.126	6.111	1.159	1.166 / 0.035	1.421	3.293	2.725 / 0.073	3.873	7.986	7.492 / 0.218	9.641
	extremely complex	legal tr.	16.883	8.036 / 1.243	2.860	1.700	0.940 / 0.264	0.360	13.859	6.389 / 0.820	2.235	20.568	10.106 / 1.884	3.662

opposite structure	simple	legal tr.	2.831	1.299 / 0.067	0.495	0.124	0.066 / 0.012	0.033	2.599	1.175 / 0.047	0.435	3.085	1.436 / 0.094	0.563
		subtitle tr.	1.468	0.591 / 0.014	0.639	0.073	0.037 / 0.003	0.040	1.331	0.523 / 0.008	0.564	1.619	0.667 / 0.022	0.723
		interpretation	1.030	0.529 / 0.012	1.678	0.078	0.047 / 0.004	0.113	0.887	0.445 / 0.006	1.471	1.196	0.630 / 0.023	1.915
	somewhat complex	legal tr.	6.024	2.383 / 0.134	0.873	0.220	0.105 / 0.019	0.047	5.608	2.186 / 0.102	0.785	6.471	2.598 / 0.177	0.970
		subtitle tr.	3.974	1.532 / 0.027	1.546	0.325	0.154 / 0.006	0.143	3.385	1.258 / 0.017	1.290	4.665	1.866 / 0.044	1.853
		interpretation	3.323	1.954 / 0.024	5.902	0.441	0.299 / 0.008	0.701	2.562	1.448 / 0.013	4.676	4.309	2.637 / 0.045	7.450
	moderately complex	legal tr.	12.815	4.370 / 0.270	1.541	0.595	0.248 / 0.036	0.091	11.701	3.910 / 0.207	1.372	14.035	4.885 / 0.352	1.731
		subtitle tr.	10.756	3.973 / 0.055	3.741	1.500	0.676 / 0.014	0.567	8.183	2.846 / 0.034	2.779	14.139	5.546 / 0.089	5.036
		interpretation	10.718	7.214 / 0.048	20.758	2.407	1.867 / 0.016	4.129	6.902	4.343 / 0.025	14.055	16.646	11.983 / 0.093	30.659
	very complex	legal tr.	27.264	8.016 / 0.543	2.720	1.803	0.645 / 0.087	0.213	23.949	6.846 / 0.397	2.333	31.037	9.386 / 0.743	3.171
		subtitle tr.	29.116	10.305 / 0.111	9.054	5.881	2.533 / 0.030	1.971	19.596	6.365 / 0.065	5.909	43.261	16.683 / 0.189	13.872
	extremely complex	legal tr.	58.002	14.702 / 1.093	4.801	5.186	1.590 / 0.223	0.498	48.677	11.894 / 0.733	3.917	69.114	18.173 / 1.631	5.884

In table 17, we don't have figures for all combinations of sentence complexity and mode in the second and third columns. For very complex sentences, we only have figures for legal translation and subtitle translation; for extremely complex sentences, we only have figures for legal translation. To compare like with like, we can compare the values in the column showing the mean rates for each indicator of difficulty (R, N1 and S) in simple, somewhat complex and moderately complex sentences – the three degrees of complexity for which we have figures for all three modes. Of those values, the highest value in the column showing the mean response of each indicator to each combination of structural difference and sentence complexity is underlined.

A comparison of the underlined values in each column corresponding to each degree of structural difference shows that, for each degree of structural difference, the mean rates for **all three indicators** of difficulty are predicted to increase as **sentence complexity** increases. This trend is confirmed by the still higher mean rates for indicators in very complex and extremely complex sentences, for those modes for which we have figures. Moreover, a comparison of the underlined values in each column corresponding to the same degree of sentence complexity shows that, for each degree of sentence complexity, the mean rates for **all three indicators** of difficulty are predicted to increase as **structural difference** increases.

Of the underlined values in the column showing the mean rates for each indicator of difficulty, the highest value is also in a box. Those boxed values show that the mean rates for **all three indicators** of difficulty are predicted to increase greatly as **structural difference** and **sentence complexity** increase, especially when the two aggravating factors are **combined**.

The underlined values in the column for reordering (R) are all for legal translation. This shows that, for each combination of structural difference and sentence complexity, **reordering** is

predicted to be most frequent in **legal translation**, where the mean rate for reordering is predicted to reach nearly 13 place shifts per sentence in moderately complex sentences and 58 place shifts per sentence in extremely complex sentences when the language pair has opposite structure.

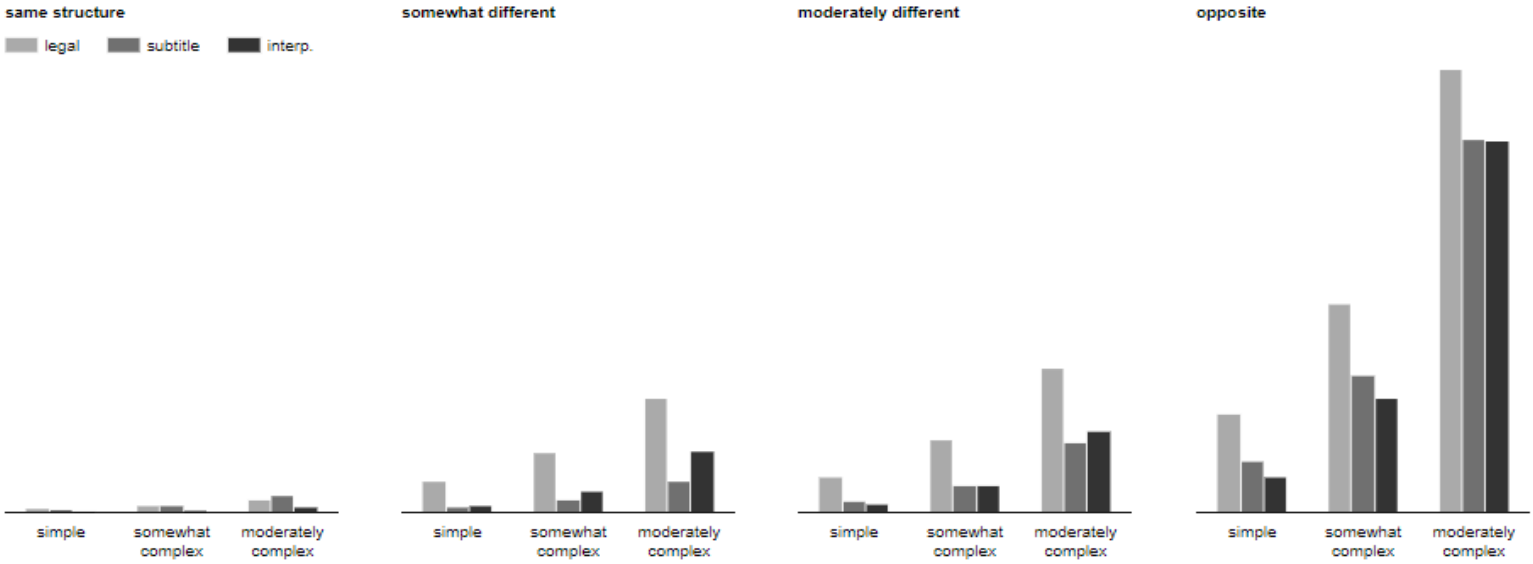
Some of the underlined values in the column for changes in single nestings (N1) are for legal translation and some – including the highest one – are for simultaneous interpretation. This shows that **nesting changes** are predicted to be more frequent in those two modes – especially in simultaneous interpretation, where the mean rate for changes in single nestings is predicted to reach more than 7 changes per sentence in moderately complex sentences when the language pair has opposite structure.

The underlined values in the column for **changes in semantic relations** (S) are all for simultaneous interpretation. This shows that, for each combination of structural difference and sentence complexity, **changes in semantic relations** are predicted to be especially characteristic of **simultaneous interpretation**, where the mean rate is predicted to reach nearly 21 changes per sentence in moderately complex sentences when the language pair has opposite structure.

The **predicted mean response** of each indicator of difficulty to interactions between **structural difference, sentence complexity** and **mode** are visualized in **chart 10**. No bars are shown for complex or extremely complex sentences, since there were too few non-zero values in the data to predict comparable rates for them all.

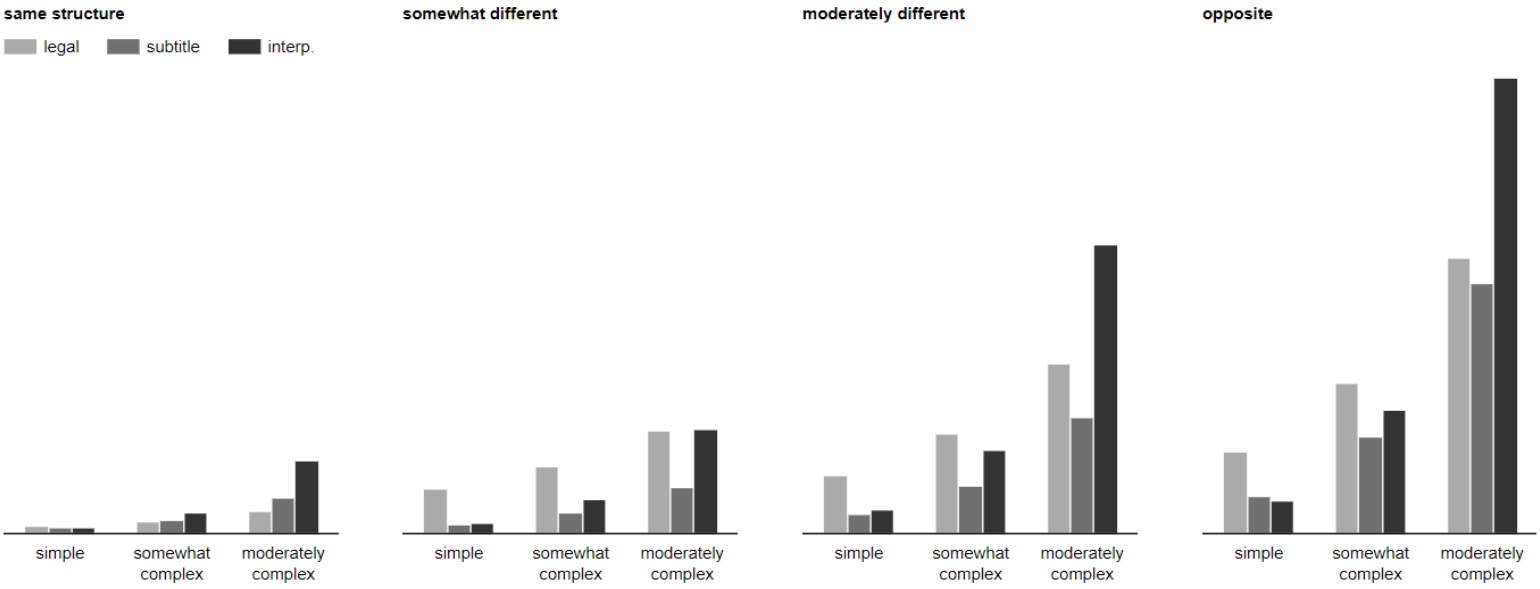
Chart 10. Predicted mean response of indicators of difficulty to interactions between structural difference, sentence complexity and mode

Reordering



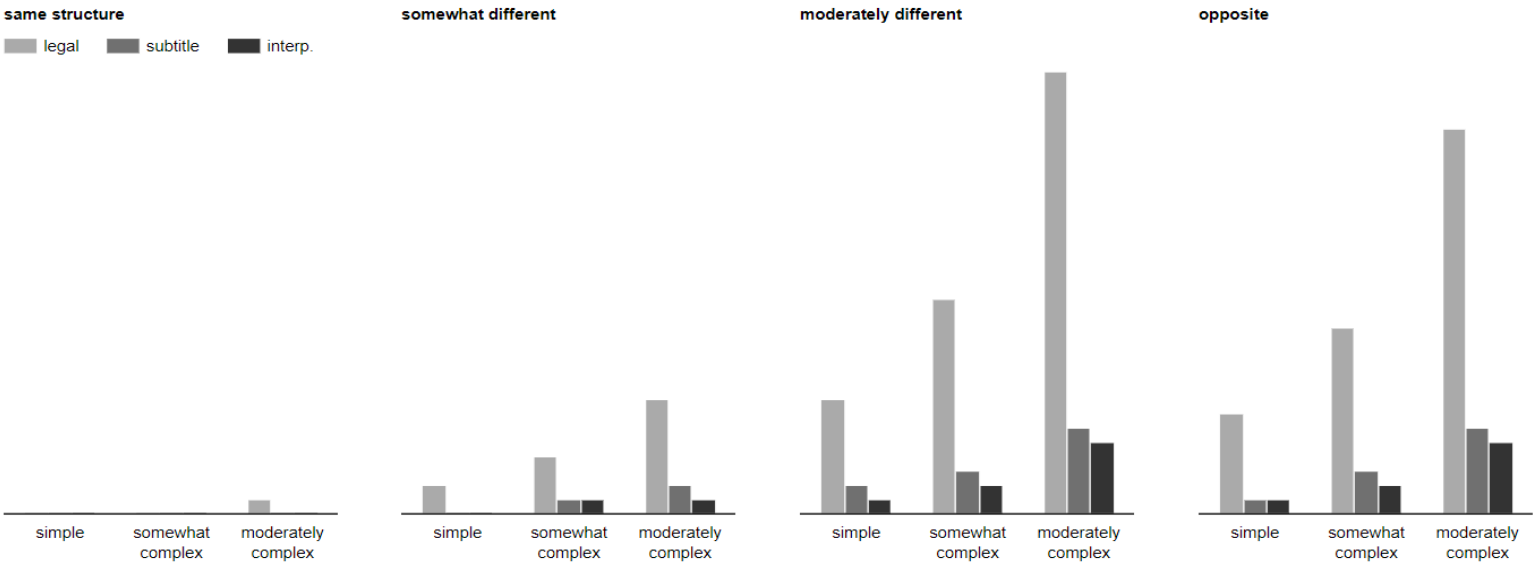
Reordering: predicted to increase greatly with **structural difference** and **sentence complexity** – a bit more in **legal translation** than in the other modes

Changes in single nestings



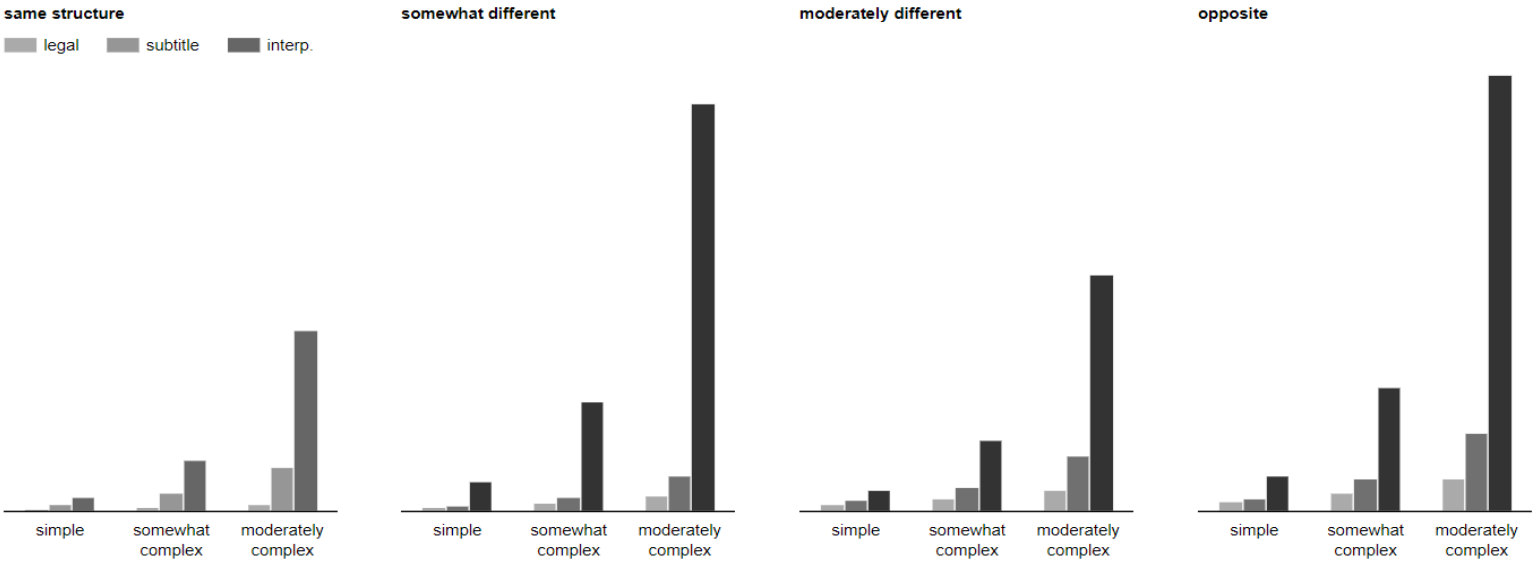
Changes in single nestings: predicted to increase greatly with **structural difference** and **sentence complexity** (no clear pattern by mode)

Changes in double nestings



Changes in double nestings: predicted to increase greatly with **structural difference** and **sentence complexity**, especially in **legal translation**

Changes in semantic relations



Changes in semantic relations: predicted to increase with **structural difference** and **sentence complexity**, especially in **simultaneous interpretation**

The last two sections have presented the main findings from our statistical analysis. In addition, a reliability check was carried out on 10% of the sentences in the corpus, to confirm the validity of the data recorded. The results of that check are presented in the next section.

4.2.4 Reliability check

The semantic parsing method summarized in section 3.1 and detailed in annex I isn't proposed here as a foolproof set of rules which can always be applied to a given sentence with the same result. Nor is its main aim to suggest a new approach to discourse analysis. The method was developed as a technical tool for assessing different language versions of a text or speech in terms of the three indicators of difficulty identified for this study. And it serves that purpose well.

Care has been taken to reduce the effect of parsing decisions in borderline cases, by parsing all language versions of a sentence the same way whenever they're judged to contain the same information. Also, the statistical analysis uses a model tailored to minimize the effects of any differences in parsing decisions between sentences, as explained in section 4.2.1 on the procedure applied for the statistical analysis. Data pages showing all segmented texts and values recorded for each sentence can be found in annex II.

In addition, a reliability check has been performed on a random sample of the data. That check consisted in reanalyzing the original English version and one other language version of every tenth sentence in the corpus. New values were recorded for all variables. The new analysis took place several months after and independently from the first analysis. The results confirmed a very high rate of agreement between the first and the new analysis. The data for the check, including a summary of various parsing issues it highlighted, can be found in annex II.

4.2.4.1 Analysis

For each of the 110 sample sentences in the reliability check, the original English version and one translated or interpreted version were analyzed again. The check involved gathering new values for one independent variable – **sentence complexity** – and three dependent variables – **reordering**, **nesting changes** (changes in **single**, **double** and **triple nestings**) and **changes in semantic relations**. Summary statistics on the agreement between values recorded in both analyses are presented below. No data on changes in triple nestings are shown, since there were no triple nestings in the English or other language version of any sentence in the sample checked.

Let's start with **percentage rates** for data agreement in the **total sample** of sentences in the data check. Summary statistics for those rates are shown in **table 18**.

Table 18

Percentage rates for data agreement in total sample

(C = Complexity, R = Reordering, N1/N2 = Changes in single/double nestings, S = Changes in semantic relations)

	Number of sentences	Same value in both analyses				Agreement rate (%)			
		C	R	N1 / N2	S	**C**	**R**	**N1 / N2**	**S**
Total sample	110	101	109	107 / 110	106	**92**	**99**	**97 / 100**	**96**

Another useful measure for the consistency of data recorded twice is **Cohen's kappa coefficient** (***κ***). Kappa values are considered to be more robust than percentage rates like the ones in table 18, as they take into account the possibility of agreement occurring by chance. Kappa values range from 0 (no agreement) to 1 (perfect agreement). To measure the consistency of data for numerical variables with a small range of values, such as those recorded in this study, **weighted kappas** are generally used.

Weighted kappas for data agreement were first calculated for the **total sample** of sentences. Summary statistics for those calculations are shown in **table 19**.

Table 19

Weighted kappas for data agreement in total sample

(C = Complexity, R = Reordering, N1/N2 = Changes in single/double nestings, S = Changes in semantic relations)

	Weighted kappa				95% asymptotic confidence interval							
					lower bound				upper bound			
	C	**R**	**N1 / N2**	**S**	C	R	N1 / N2	S	C	R	N1 / N2	S
Total sample	**0.97**	**1.00**	**0.98 / 1.00**	**0.97**	0.95	0.99	0.96 / 1.00	0.93	0.99	1.00	1.00 / 1.00	1.00

The bolded values from tables 18 and 19 are visualized in **charts 11 and 12**.

Chart 11. Percentage rates for data agreement in total sample

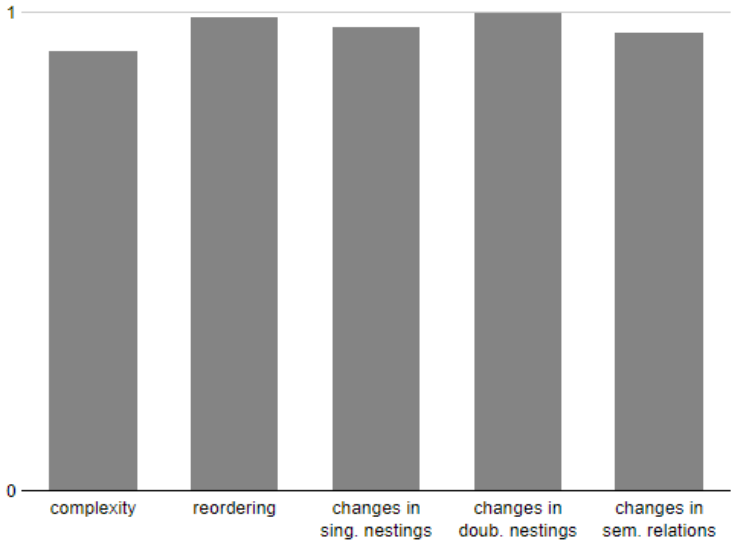
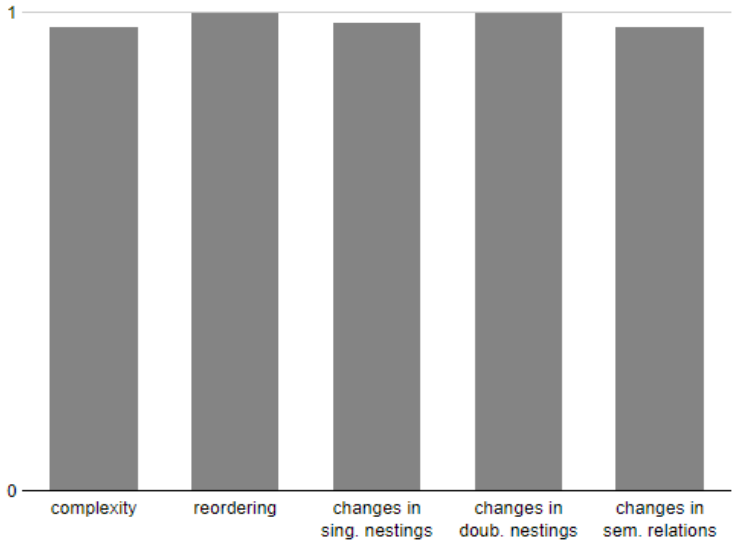


Chart 12. Weighted kappas for data agreement in total sample



Landis and Koch (1977) suggest the following scale for interpreting weighted kappa values:

Kappa	Interpretation
< 0.00	Poor
0.00-0.20	Slight
0.21-0.40	Fair
0.41-0.60	Moderate
0.61-0.80	Substantial
0.81-1.00	Almost perfect

According to the above scale, there was almost perfect agreement between the first analysis and the new one in data recorded for the total sample of sentences. There was slightly less agreement in data for sentence complexity than for the other variables.

In addition to these overall results, we can try to get an idea of areas where there may be greater inconsistency than in others. We can do this by comparing data recorded for sentences in different modes, in different target languages and with different degrees of complexity. For smaller sample sizes like these, percentage rates are considered to be more robust than kappa values.

Let's look first at **percentage rates** for data agreement **by mode**. Summary statistics for those rates are shown in **table 20**.

Table 20

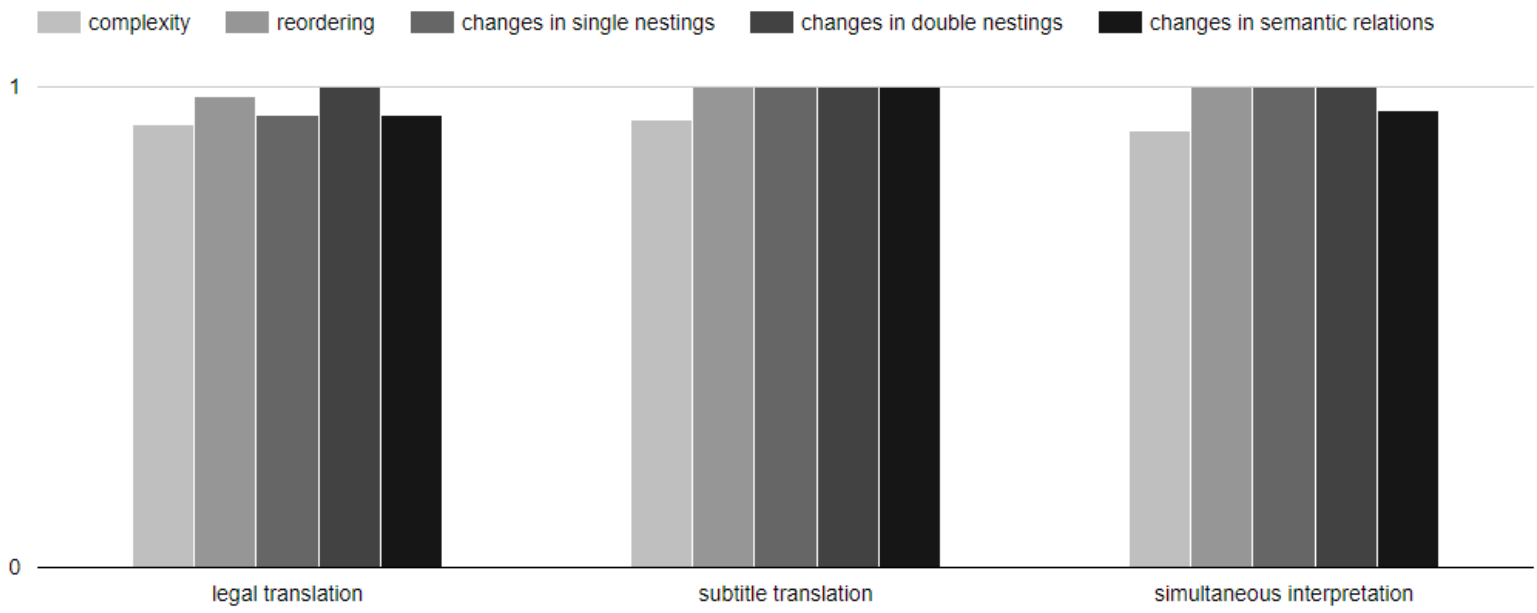
Data agreement by mode

(C = Complexity, R = Reordering, N1/N2 = Changes in single/double nestings, S = Changes in semantic relations)

Mode	Number of sentences	Same value in both analyses				**Agreement rate (%)**			
		C	R	N1 / N2	S	**C**	**R**	**N1 / N2**	**S**
Legal translation	48	44	47	45 / 48	45	**92**	**98**	**94 / 100**	**94**
Subtitle translation	40	37	40	40 / 40	40	**93**	**100**	**100 / 100**	**100**
Simultaneous interpretation	22	20	22	22 / 22	21	**91**	**100**	**100 / 100**	**95**

The bolded columns in table 20 indicate that there was almost perfect agreement between the first analysis and the new one in data recorded for each mode. There was slightly less agreement in data for legal translation than for the other two modes. These results are visualized in **chart 13**.

Chart 13. Data agreement by mode



Let's look next at **percentage rates** for data agreement **by target language**. Summary statistics for those rates are shown in **table 21**.

Table 21

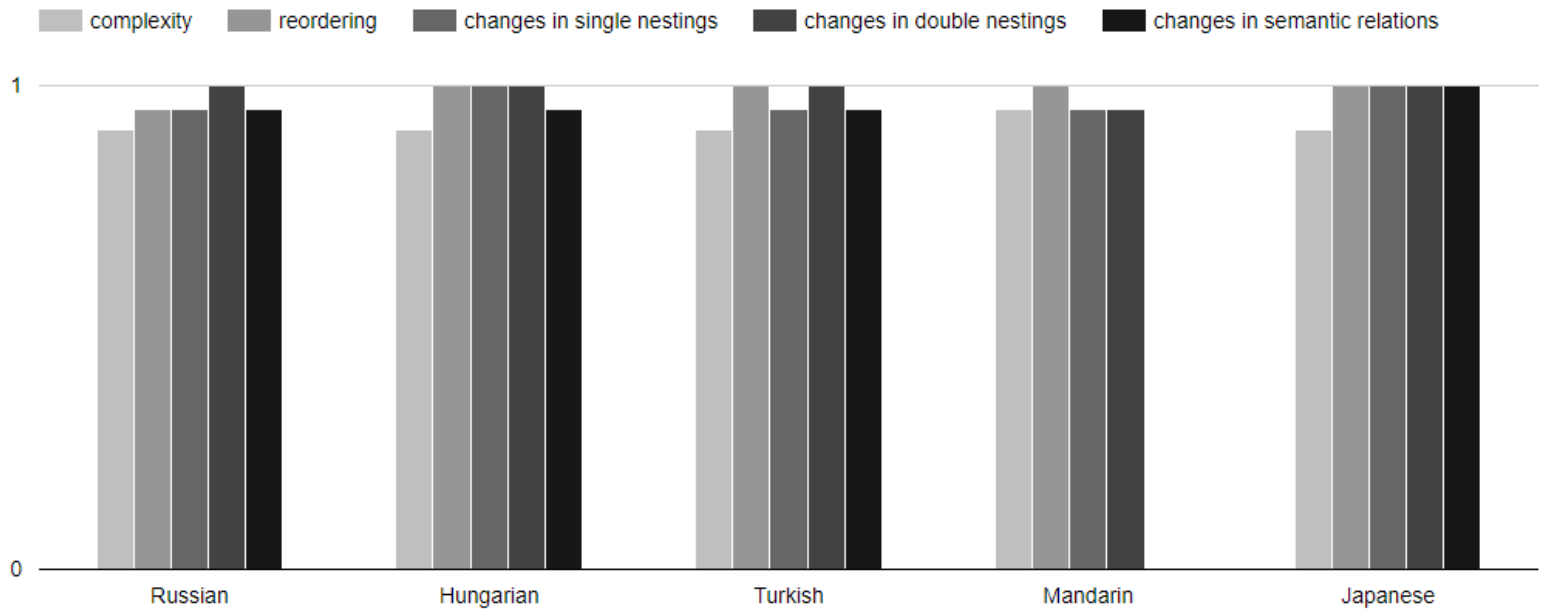
Data agreement by target language

(C = Complexity, R = Reordering, N1/N2 = Changes in single/double nestings, S = Changes in semantic relations)

Target language	Number of sentences	Same value in both analyses				Agreement rate (%)			
		C	R	N1 / N2	S	C	R	N1 / N2	S
Russian	22	20	21	21 / 22	21	**91**	**95**	**95 / 100**	**95**
Hungarian	22	20	22	22 / 22	21	**91**	**100**	**100 / 100**	**95**
Turkish	22	20	22	21 / 22	21	**91**	**100**	**95 / 100**	**95**
Mandarin	22	21	22	21 / 22	21	**95**	**100**	**95 / 100**	**95**
Japanese	22	20	22	22 / 22	22	**91**	**100**	**100 / 100**	**100**

The bolded columns in table 21 indicate that there was almost perfect agreement between the first analysis and the new one in data recorded for each target language. There were no major differences in data for different target languages. These results are visualized in **chart 14**.

Chart 14. Data agreement by target language



Finally, let's look at **percentage rates** for data agreement **by degree of sentence complexity**, as measured by the number of functionally subordinate propositions in the original English version of a sentence. Sentence complexity as recorded in the first analysis was used as an input variable for this part of the check. That input variable consisted in three representative ranges for subordinate proposition counts per sentence (0-2, 3-5 and 6+). Agreement between the first analysis and the new one in the exact value recorded for sentence complexity was one of the four output variables, as in the other parts described above. Summary statistics for this part of the check are shown in **table 22**.

Table 22

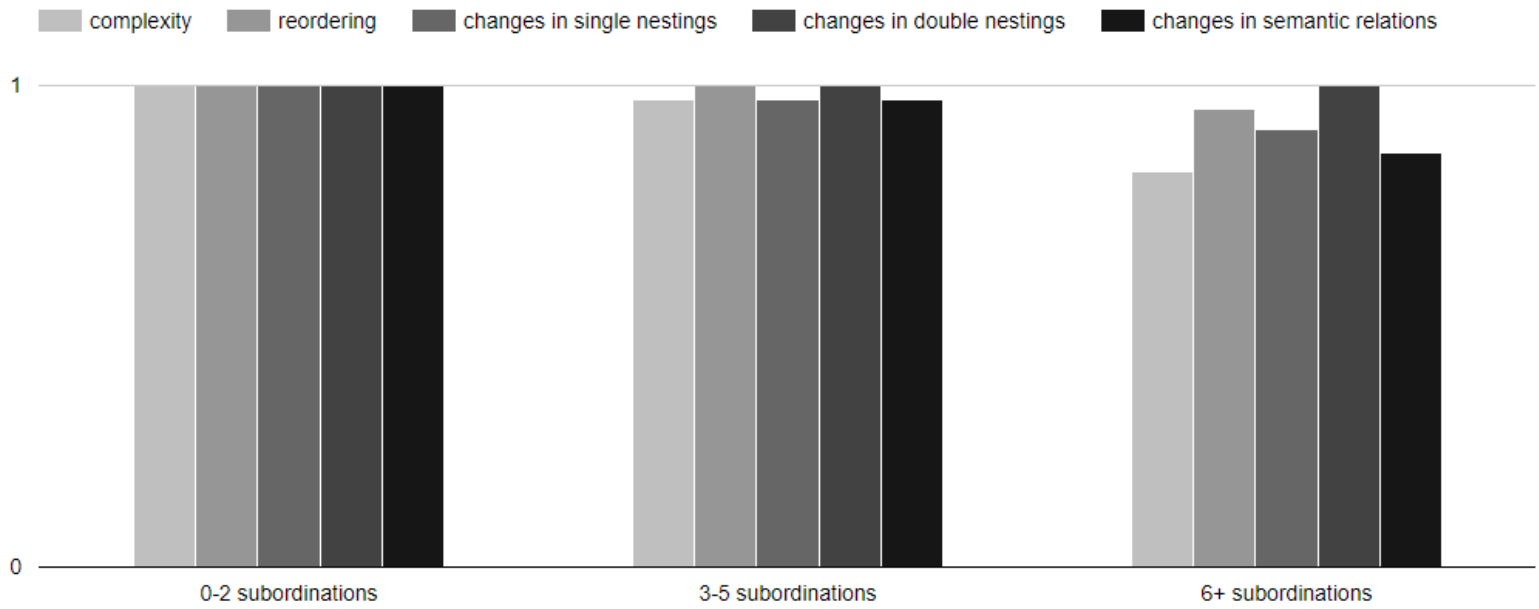
Data agreement by degree of sentence complexity

(C = Complexity, R = Reordering, N1/N2 = Changes in single/double nestings, S = Changes in semantic relations)

Degree of complexity	Number of sentences	Same value in both analyses				Agreement rate (%)			
		C	R	N1 / N2	S	C	R	N1 / N2	S
0-2 subordinations	57	57	57	57 / 57	57	**100**	**100**	**100 / 100**	**100**
3-5 subordinations	31	30	31	30 / 31	30	**97**	**100**	**97 / 100**	**97**
6+ subordinations	22	18	21	20 / 22	19	**82**	**95**	**91 / 100**	**86**

The bolded columns in table 22 indicate that there was almost perfect agreement between the first analysis and the new one in data recorded for sentences with different degrees of complexity. The rates of data agreement decreased somewhat as sentence complexity increased. These results are visualized in **chart 15**.

Chart 15. Data agreement by degree of sentence complexity



4.2.4.2 Summary of results

The reliability check presented in this section was carried out on a random 10% sample of sentences in the corpus, on one random target language of the five for each sentence. Of the three independent and three dependent variables recorded for each sentence, there was a possibility of variation in five variables: sentence complexity, reordering, changes in single and double nestings, and changes in semantic relations. With values for those five variables recorded twice each in 110 sample sentences, the data check included a total of 1,100 values, representing 2% of the overall data. If we discount the data for changes in double nestings because of the low numbers involved, a total of 880 significant values were recorded and compared.

Both in percentage rates and in weighted kappas, there was almost perfect agreement between the first analysis and the new one in values recorded for variables across the board. Breaking the results down, there were: (a) slightly more differences in data for sentence complexity than for the three indicators of difficulty, (b) slightly more differences in data for legal translation than for the other two modes, and (c) more differences in data for complex sentences than for simple ones. There were no major differences in data recorded for different target languages.

These results show that a random representative sample of the data in this study is almost perfectly replicable, as recorded independently by the author after an interval of several

months. Although the sample represents just 2% of the total data, the large number of values checked and the very high levels of agreement found suggest that similar levels apply to the corpus overall. This confirms that the findings of the study can be regarded as robust.

The reliability check also involved an analysis of issues behind various parsing decisions. Those parsing issues are presented in section 2 of annex I. They reveal many gray areas where distinctions were borderline. It might be possible to clear up some of those gray areas with a more rigorous version of the semantic parsing method developed for this study. Some other areas may just be intrinsically gray, because human language doesn't always allow for clear-cut distinctions in certain areas – like whether a proposition is functionally independent or subordinate, which of two linked propositions is more salient, or whether a speaker or writer identifies with the content of a subordinate clause.

Still, those gray areas are unlikely to affect the findings of the study significantly. That conviction is confirmed by the very high level of consistency found in the data check. It's further strengthened – as explained in section 4.2.1 on the procedure applied for the statistical analysis – by a statistical model that isolates any parsing inconsistencies that do occur as extraneous effects not involving the independent variables being tested.

Of all the parsing issues highlighted in section 2 of annex I, the one that stands out most in terms of product quality is reformulation and non-standard syntax in simultaneous interpretation between languages with very different structure. Though such interpretation solutions can be useful, they can sound awkward. And they can change meaning. This study has focused on difficulty in production. It hasn't considered the way the result of that production is perceived or understood. It could be interesting to ask listeners of similar content interpreted simultaneously into typologically different languages to assess how natural that interpretation sounds and how easy it is to understand, and to answer questions on its content. The findings could help shed light on another important effect of structural difference between languages on interpretation, from the perspective of the listener.

This chapter has presented the method and main findings of the statistical analysis, including a reliability check on data recorded. Those findings involve descriptions of associations between variables observed in our corpus data, as well as predictions for more general associations that could be found in the corpus, as well as in similar texts, talks and speeches. Those associations are discussed and conclusions drawn in the next and final chapter. That chapter also considers some coping strategies for simultaneous interpretation between languages with very different structure.

5. Discussion

5.1 Summary of findings

A statistical analysis of our corpus data involving English and five target languages from different families has shown that recorded rates for all three features identified as indicators of difficulty in translation or interpretation are closely associated with structural difference in the language pair involved. In the sentences analyzed, the highest rates for each indicator were observed in Turkish and Japanese. Of the languages considered, those were the ones with the greatest structural difference from English. Reordering and nesting changes were much more frequent in legal translation than in the other two modes. Changes in semantic relations were especially characteristic of simultaneous interpretation.

Based on the corpus data, the models chosen for our statistical analysis also predicted a number of associations which may be generalized to similar texts, talks and speeches. The rates for each indicator of difficulty were predicted to increase greatly with increasing structural difference in the language pair and with increasing sentence complexity. In legal translation, this was especially true for reordering and nesting changes, and in simultaneous interpretation for changes in semantic relations.

The associations found between structural difference in the language pair of translation or interpretation and rates recorded for the three indicators of difficulty have some general implications which apply to all three modes of language transfer considered in this study. Those associations suggest that, the more a language pair differs in structure: (a) the more the linear order of propositions is likely to change in translation or interpretation of a complex sentence in that pair, (b) the more nested structures are likely to be created or eliminated in translation or interpretation of a complex sentence in that pair, and (c) the more the semantic relations between propositions are likely to be changed in translation or interpretation of a complex sentence in that pair. Taken together, these findings suggest that, across all three modes of transfer, the more a language pair differs in structure, the more difficult it's likely to be to translate or interpret a complex sentence in that pair, and the more the original meaning is likely to be changed.

Determining the precise causes for these associations is beyond the scope of this study. Below are some speculative explanations as to why structural difference in a language pair may make it more difficult to translate or interpret complex sentences in that pair, along with some related observations.

5.1.1 Structural difference and reordering

It's been shown (Hawkins 2014) that having to keep several logical processing windows open at a time – as a translator or interpreter needs to do if juggling propositions around in different order – is more difficult than opening one logical processing window at a time, closing it, then moving on to the next one – as a translator or interpreter can do if transferring propositions in parallel order. It's also been shown (Donolato, Giofrè and Mammarella 2017) that recalling verbal information in reverse order is harder than recalling it in the order it was received.

Studies by Hartsuiker et al. (2004, 2016) and others provide evidence that bilingual people have a single mental representation of structures which are similarly ordered in their two languages. This suggests that, besides problems involving the order of recalled information, a translator or interpreter working between languages where subordinate clauses branch in opposite directions has to deal with the added challenge of managing two different mental constructs when processing relations between propositions. In contrast, a translator or interpreter working between structurally similar languages can process those relations using a single mental construct.

Reordering is also worth recording to quantify it in its own right. It's informative to see, for each language pair, how far away the average proposition needs to be shifted in different modes of language transfer. In legal translation of a complex sentence between languages with very different structure, like English-Turkish and English-Japanese, the total number of place shifts recorded in this study sometimes reached triple digits for a given sentence, while the same sentence had been translated with little or no reordering between structurally similar languages.

5.1.2 Structural difference and nesting changes

The findings of this study suggest that translation or interpretation of a complex sentence from a right-branching language like English into a left-branching language like Turkish, Japanese or to some extent Mandarin is likely to lead to many more nestings in the translated or interpreted version of the sentence than in the original version, and therefore to be more difficult to produce and to process. This may be partly due to a basic asymmetry between the two directions in which a subordinate proposition can branch from its parent.

Left-branching languages tend to be “head-final,” with a phrase head typically coming at the end of its phrase in most phrase types. So a syntactic phrase expressing a proposition in such a language will generally have its predicate at the end of the phrase, preceded by any other constituents. One of those constituents is likely to be the subject of the predicate, which, even in a left-branching language, tends to be near the beginning of the phrase. This can make for lots of long-distance attachments, with several constituents sandwiched between the subject and predicate of a long proposition. One or more of those intervening constituents can themselves be propositions. And any of those nested propositions can in turn be split, leading to multiple layers of nesting.

In my experience, a long, complex sentence in a left-branching language tends to have many more nestings than a comparable sentence in a right-branching language. A Turkish or Japanese legal text, for example, is likely to have sentences with many more nestings and long-distance attachments than a comparable text drafted in English, German or Russian. This makes the phrasal combination domains in those sentences more difficult to establish and to process.

Also in my experience, this nesting tendency of left-branching languages is liable to be compounded in translation from a right-branching language. A sentence in a European language can be long and complex, but have few or no nestings, consisting of a series of unbroken propositions, with each subordinate proposition linked to the end of its parent. But transferred with structural accuracy into a language like Turkish or Japanese, that same sentence can often end up with multiple nestings. This typically happens in written translation, in a genre characterized by long, complex sentences – unless the translator makes a special effort to change the hierarchical structure of the original so as to avoid nested structures in translation. They may be reluctant to do that, especially in a text which has legal consequences, or even in an article they wish to translate faithfully. Changing the hierarchical structure of an original sentence in translation also risks distorting its meaning.

I submit that these two tendencies – the inherent nesting tendency of left-branching languages, compounded by the extra nesting effect of translation from a right-branching language into a left-branching one – may go a long way towards explaining the strong preliminary association found between structural difference and recorded values for nesting changes in the language pairs considered in this study.

5.1.3 Structural difference and changes in semantic relations

A change in semantic relations in a written translation of a complex sentence compared to the original version of that sentence presumably means that the translator has: (a) had trouble understanding the structure of the source language, (b) had trouble reproducing that structure in the target language, or (c) chosen to depart from the original structure for some reason. Such a change can also result from any combination of the above factors. As explained in section 3.3.4 on changes in semantic relations, this study doesn't attempt to determine whether difficulty as reflected in such changes results from necessity or from choice.

A translator working between languages with largely parallel structure, like two European languages, can generally reformulate the propositions of a complex sentence one by one and in order. This includes the subordinating links between propositions – like subordinating conjunctions, relative pronouns and prepositions – which they can transfer directly from one language to the other, without having to take apart and reconstruct the logical relation established by each one.

On the other hand, if a translator working in a language pair with very different structure chooses or needs to change the hierarchical relations between propositions in the translation of a complex sentence compared to the original version, that may be because faithfully reproducing those relations would result in a translation that's hard to process or that sounds awkward. Such restructuring is likely to involve extra effort. Changing the hierarchical relations between propositions also creates a greater risk of distorting the original meaning.

In simultaneous interpretation between languages with very different structure, a change in semantic relations in an interpreted version of a sentence compared to the original version of that sentence can be due to any of the reasons described above for written translation. It's also likely to be due to the fact that too great a burden has been placed on the interpreter's working memory.

For these reasons, I speculate that changes in semantic relations between propositions, whether deliberate or not, are a sign of extra effort expended by the translator or interpreter in processing those relations, reproducing them or both. This may help explain the associations found in this study between structural difference in a language pair and recorded rates for changes in semantic relations.

5.1.4 Differences between modes

This study has established preliminary associations between structural difference in a language pair and recorded rates for indicators of difficulty in translating or interpreting complex sentences in that pair, with some differences according to the mode of language transfer. The higher rates observed and predicted for reordering and nesting changes in language pairs with very different structure appear to be especially characteristic of legal translation. This may be due to the greater sentence complexity typical of legal texts, and to the fact that standard written translation is largely free from the time, space or working memory constraints inherent to the other two modes. On the other hand, higher rates for changes in semantic relations appear to be especially characteristic of simultaneous interpretation.

Among the language pairs considered, the observed and predicted rates for reordering and for nesting changes in language pairs with very different structure are relatively low in subtitle translation and simultaneous interpretation, and appear less strongly associated with structural difference in those modes than in legal translation. For subtitle translation, this more parallel order with respect to the original may be partly due to the need or desire for subtitle segments to run parallel to the video image. For simultaneous interpretation, it may well be partly due to the constraint on interpreters' working memory.

On the other hand, the observed and predicted rates for changes in semantic relations in language pairs with very different structure are particularly high in subtitle translation and in simultaneous interpretation, and appear more strongly associated with structural difference in those modes than in legal translation. This may be for similar reasons to those suggested for reordering and nesting changes. In subtitle translation, the timing constraint can lead a translator to prefer a more parallel order to the original than would be the case in a standard written translation, thereby distorting the relations between propositions. In simultaneous interpretation, the working memory constraint can have a similar effect.

These findings suggest that there may be a trade-off between ease of production and preservation of meaning in translation or interpretation of complex sentences between languages with very different structure. Subtitle translation and simultaneous interpretation in such pairs seem to be characterized by more parallel order to the original and more manageable structure in the output than legal translation. But that comparative ease may come at the price of greater changes to the hierarchical relations between propositions, meaning greater potential distortion of the original message.

This study has achieved what it set out to do. It has established preliminary associations between structural difference in a language pair and recorded rates for indicators of difficulty in translation or interpretation of complex sentences in that pair. And it has given an initial indication of particular types of difficulty associated with translation or interpretation between languages with very different structure, which seem less likely to characterize transfer between languages with similar structure.

For written translation, the main take-away from these findings is awareness – awareness of the difficulty, its reasons, its magnitude, the problems it can create, and therefore the need for professionals working between languages with very different structure to take extra time and care in production.

All this applies to simultaneous interpretation as well, plus the great added challenge of the natural constraint on working memory. Though not much can be done to reduce that added challenge, interpreters working in language pairs with very different structure can get better at coping with it. They can do so through practice and by applying various strategies when interpreting complex sentences. Those strategies are discussed in the next section.

5.2 Strategies for interpretation between languages with very different structure

This study has found preliminary evidence of associations between structural difference in a language pair and recorded rates for indicators of difficulty in translating or interpreting complex sentences in that pair. A natural question is: *"What can be done about it?"* In one sense, the unsatisfying answer is: *"Not much."* Translating and interpreting complex sentences between languages with very different structure can just be objectively very hard. The main purpose of this study is to confirm and raise awareness of that difficulty, not to suggest that it can be mitigated in any substantial way.

Especially under the working memory constraints of simultaneous interpretation, the difficulty of transferring coherent content between languages with very different structure can become enormous. That can make it impossible to render a complex speech with anything approaching the completeness and accuracy of interpretation between structurally similar languages. The best thing an interpreter in this situation can hope for is to get a written copy of the speech or speaking notes beforehand, if there is one. Simultaneous interpretation in any language pair can be easier with a written text than without one, because the interpreter can do a partial sight translation while interpreting. But sight translation is often much trickier in a language pair with very different structure than in a structurally similar pair. That makes it all the more important for an interpreter working in such a language pair to try to get a copy of any text long enough beforehand to prepare it.

Of course, despite our best efforts, it's often not possible to get a copy of a text. In that case, it's all the more crucial for the interpreter to be equipped with strategies to make the best of what can seem like an impossible task. Some of the main strategies interpreters working between languages with very different structure can use in trying to cope with that task are discussed below. But first, a word about working memory and different proposed approaches to interpretation.

5.2.1 Working memory and interpretation

If reordering and nesting changes are a headache for translators, they can be a nightmare for simultaneous interpreters. In a proper written translation between languages with very different structure, the propositions of a complex sentence may need to be rearranged in inverse or scrambled order, and multiple nestings may need to be constructed or taken apart.

For a simultaneous interpreter trying to interpret a complex sentence in such a language pair, doing that to the same extent can be impossible because of the natural limits to working memory.

When transferring a complex sentence between structurally similar languages, an interpreter can start to process and reformulate the first proposition as soon as they've heard it, or even part of it. That frees up working memory, so they can go on to the next proposition. Each new proposition is linked to the one before it, parallelling their order in the original version of the sentence. That means a good interpreter working between, say, two European languages may be able to produce a result that sounds more or less like a written translation and that accurately reflects the content and coherence of the original speech. The most structural work they'll need to do will be to retain or anticipate the odd element (like a clause-final verb in German) over a short distance here or there.

But that can be impossible in simultaneous interpretation between languages with very different structure. An interpreter trying to interpret complex sentences between a right-branching and a left-branching language can face a huge cognitive challenge. In many cases, producing a structurally accurate rendition would require the interpreter to hear an entire original sentence, before starting to rearrange its propositions and recast the links between them. Just understanding a sentence with multiple nestings in real time can be hard, as we've seen, especially without a written copy of what's being said. Doing that, plus retaining the entire sentence, rearranging its content, then producing an intelligible and accurate interpretation, all while trying to retain and process the next incoming complex sentence, can be a task beyond the working memory capacity of the normal human brain.

Gile (2009) proposes an often-cited model dividing the task of simultaneous interpretation into three **efforts** – **listening**, **remembering** and **speaking**. Interpreting complex sentences between structurally different languages can require devoting such a huge amount of brainpower to **structural management** that this could possibly be seen as a fourth effort, seriously affecting the cognitive capacity that an interpreter has available to devote to the other three tasks.

Seleskovitch and Lederer's (1989) *"théorie du sens"* or "interpretive theory" claims that a good interpreter "deverbalizes" incoming meaning and then reformulates it as a whole in the target language. Similarly, Dam (2001: 27) describes "meaning-based" interpretation as relying on a "non-verbal" representation of meaning. In practice, this means that an interpreter can generally achieve more natural wording and coherent structure in the target language by processing the incoming message in larger chunks, as single units of meaning in

a larger context, rather than interpreting words and shorter phrases separately. Put that way, it's hard to find fault with the interpretive theory and meaning-based interpretation as a guideline. But restating meaning-based interpretation in terms of the size of speech chunks processed before reformulation also helps reveal its limits.

I can process a whole speech chunk before reformulating it, if I can retain it. The more information that chunk contains, the harder it will be to retain. If I hear a long sentence with many propositions and am asked to retain its content, I may be able to retain the overall message, but I probably won't remember each element of each proposition. We can generally retain only a certain number of items – Miller (1956) says around seven – in working memory. That limit can be taken as applying to items in a list, elements of propositions, or general notions of events or situations described.

That's where meaning-based interpretation, as good as it is as a guideline, may break down, and form-based interpretation, necessitated by structural constraints, may need to take over. Because the ordinary human brain can't retain every element in a long, complex sentence. If we go for the big picture, we're likely to lose some of the detail. And an interpreter needs to try to reproduce both – the big picture and the detail.

For interpreting between structurally similar languages, like two European languages, where propositions follow each other in the same order, the more an interpreter succeeds in keeping a manageable gap from the speaker, the more flowing, natural and meaning-based their interpretation is likely to be. But that may not work for interpreting a long, complex sentence between languages with very different structure, where propositions often appear in reverse or jumbled order. In such conditions, an interpreter may choose to listen to the entire sentence before starting to reformulate it, in which case they're liable to leave out some detail. Or, more likely, they'll listen to one or two propositions and then start to interpret. In that case, they'll have to manage the structural problems created by the fact that an accurate interpretation would have to start with the last proposition in the original version, which they won't have heard before starting to produce their rendition of the sentence.

This study is about demonstrating comparative difficulty in translation or interpretation, not about proposing solutions. Still, given the limits of working memory and of meaning-based interpretation, the challenges of simultaneously interpreting complex sentences between languages with very different structure are so specific and so acute that it's worth mentioning some strategies interpreters can use to cope with the challenges of complex sentence structure. Some of the most important such strategies are **sentence division**, **anticipation** and **syntactic transformation**. These strategies are discussed briefly below.

5.2.2 Sentence division

One strategy interpreters can use to reduce the need for reordering propositions and to maintain a manageable burden on working memory is to divide longer sentences into shorter ones. For example, figure 41 shows two sentences from the 2006 Nobel Literature Prize Lecture by author Orhan Pamuk, as spoken in Turkish, along with a nice English translation by Maureen Freely. Propositions are grouped separately, with lines connecting the corresponding propositions in the original and translated versions. Syntactically split propositions are shown in separate groups with separate lines.

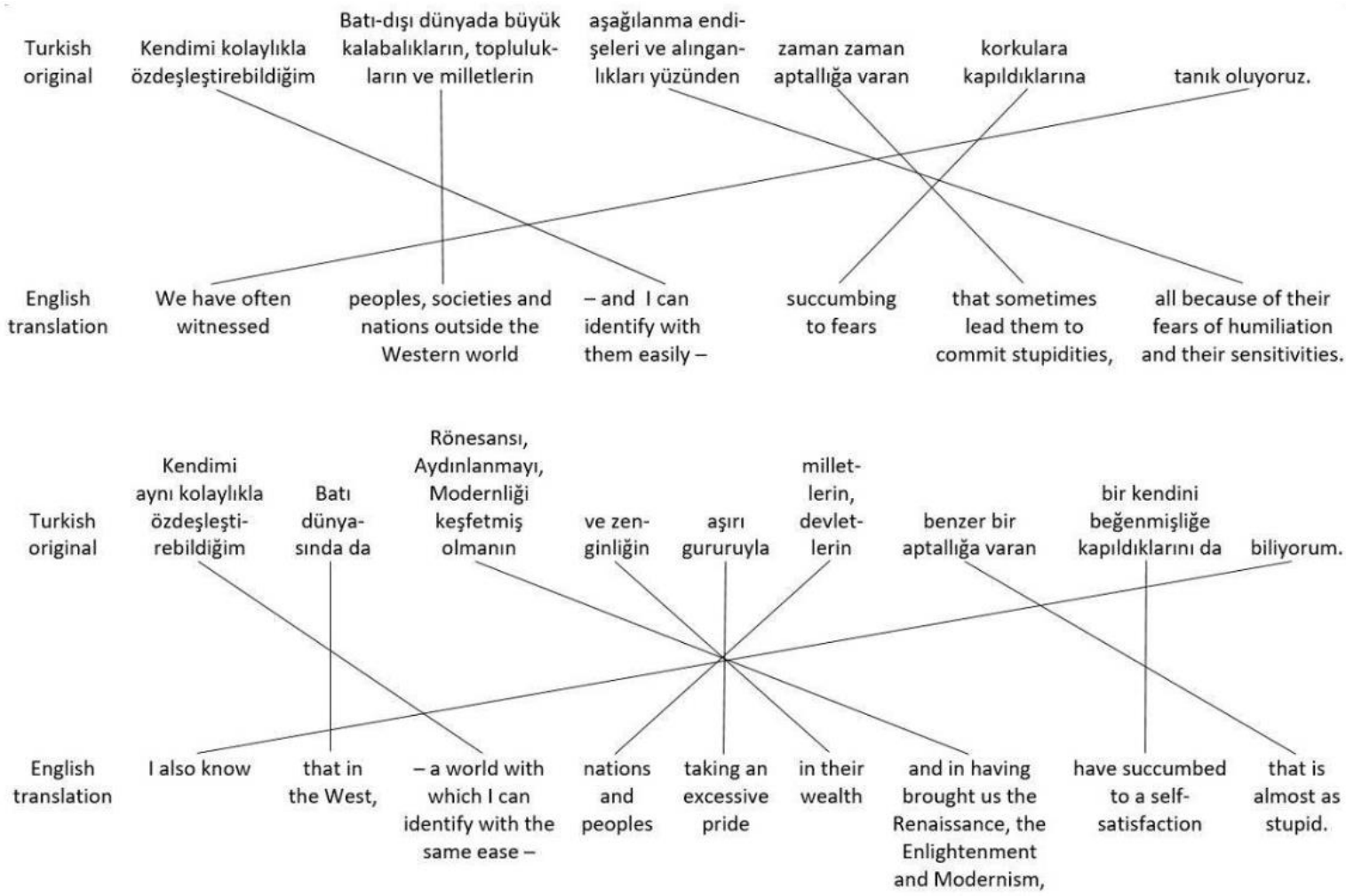


Figure 41
Original Turkish sentences and English translations

Compared to the original Turkish sentences, the order of propositions in the English translations is completely jumbled. Unless an interpreter had a written copy of the speech to prepare beforehand, it's unlikely that they could produce an interpretation anything like the nice written translation in real time, with the main propositions – which come at the end of the Turkish sentences – in the right places at the beginning of the English sentences, and with all the other pieces in the right places too. Instead, the interpreter might try dividing the original Turkish sentences shown in figure 41 into shorter ones. With luck, they might produce something like the hypothetical English interpretation of the two sentences shown in figure 42.

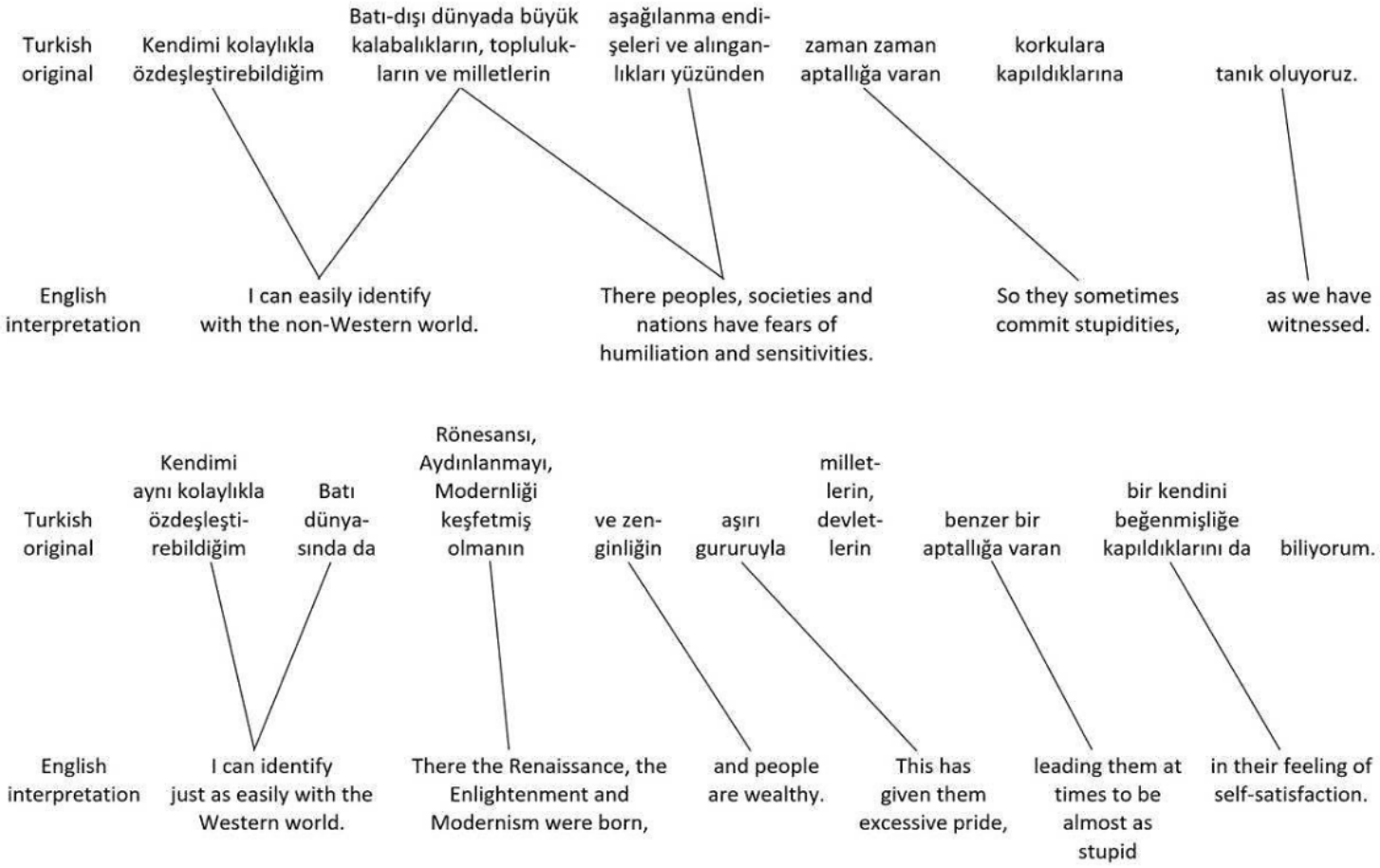


Figure 42
Original Turkish sentences and hypothetical English interpretation

Figure 42 illustrates how the two sentences from the original Turkish speech shown in figure 41 could been divided into six separate sentences in a hypothetical English interpretation. The advantage of doing this is that the propositions end up in more or less parallel order in interpretation to their order in the original version. One disadvantage is that this can lead to lower register, because of flatter structure. Another disadvantage is that some detail may be left out.

5.2.3 Anticipation

Another strategy that can be used in interpreting complex sentences between languages with very different structure is **anticipation** – guessing and interpreting parts of a sentence before hearing them. This can be useful in interpreting from a left-branching language like Turkish or Japanese into a right-branching one like English. That's because the functional information necessary to begin formulating a sentence in a right-branching language may come only at the end of the sentence in a left-branching one.

For example, figure 43 shows a parse tree with a hypothetical opening sentence from a Turkish speech. The numbers show the order the branches need to be read in to make sense in English.

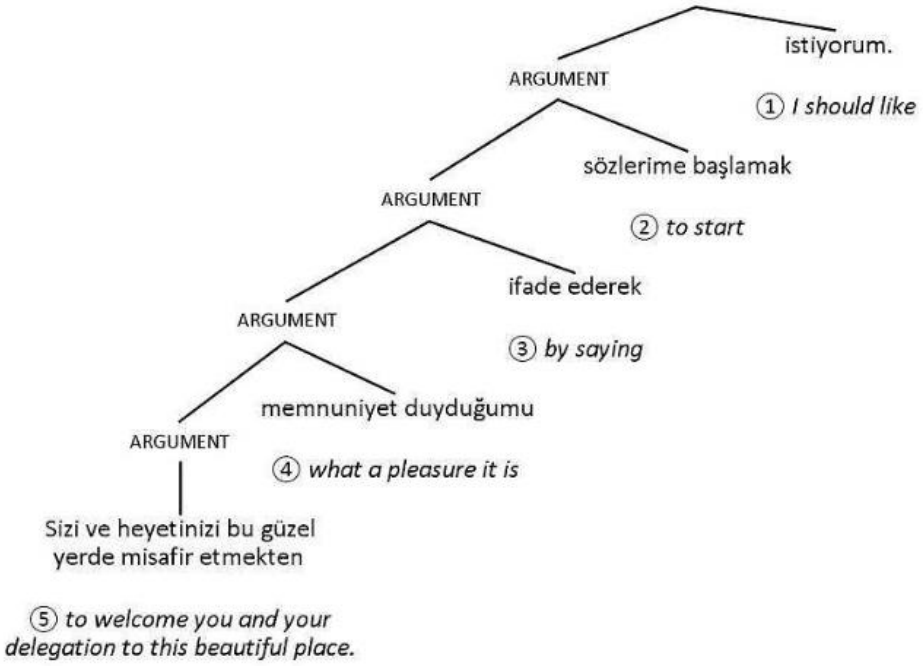


Figure 43
Hypothetical original Turkish sentence

An interpreter wishing to reproduce the Turkish sentence in figure 43 in English might decide to begin speaking after hearing the first clause (branch number 5 in the tree). They might anticipate the main subject with something non-committal, like the hypothetical beginning in figure 44.

Figure 44
Hypothetical interpretation, anticipating first words

The interpreter would then have to accommodate the rest of the sentence, with appropriate subordinate or coordinate structures. The advantage of anticipating elements like this is that the interpretation ends up in more or less parallel order to the original version – similarly to sentence division. The disadvantage is the risk of guessing wrong and having to correct oneself.

5.2.4 Syntactic transformation

Perhaps the most sophisticated strategy for interpreting complex sentences between languages with very different structure is **syntactic transformation**. This involves changing the relations among propositions so that they come out in interpretation in more or less parallel order to the original.

To see how this can work, let's look at an example of a complex sentence for interpretation. Figure 45 shows a parse tree with the beginning of a speech given in Turkish by the Vice President of the Scientific and Technological Research Council of Turkey, at a conference in 2008. The numbers show the order the branches need to be read in to make sense in English.

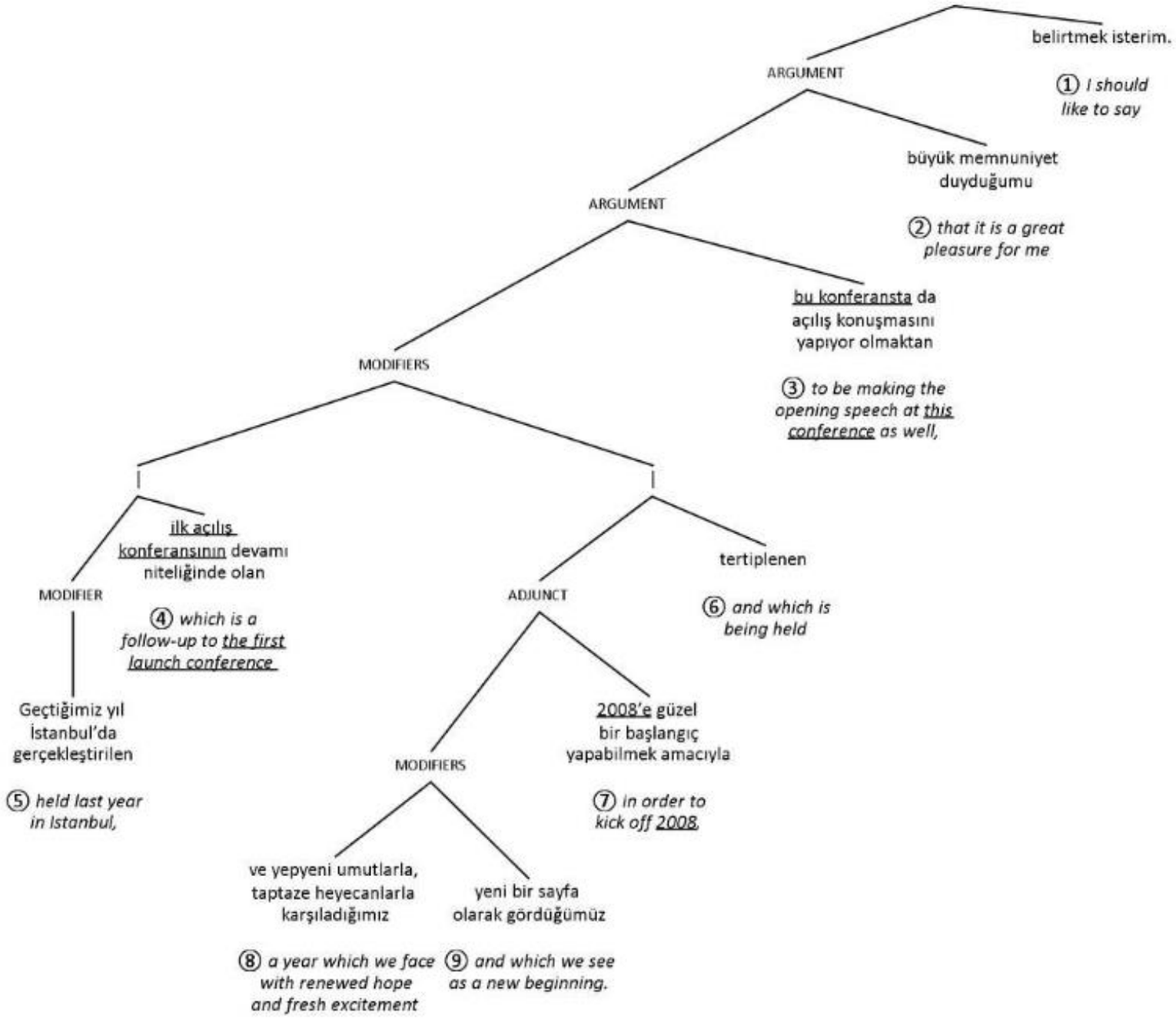


Figure 45
Original Turkish sentence

A structurally accurate English version of the Turkish sentence in figure 45 is shown on the parse tree in figure 46.

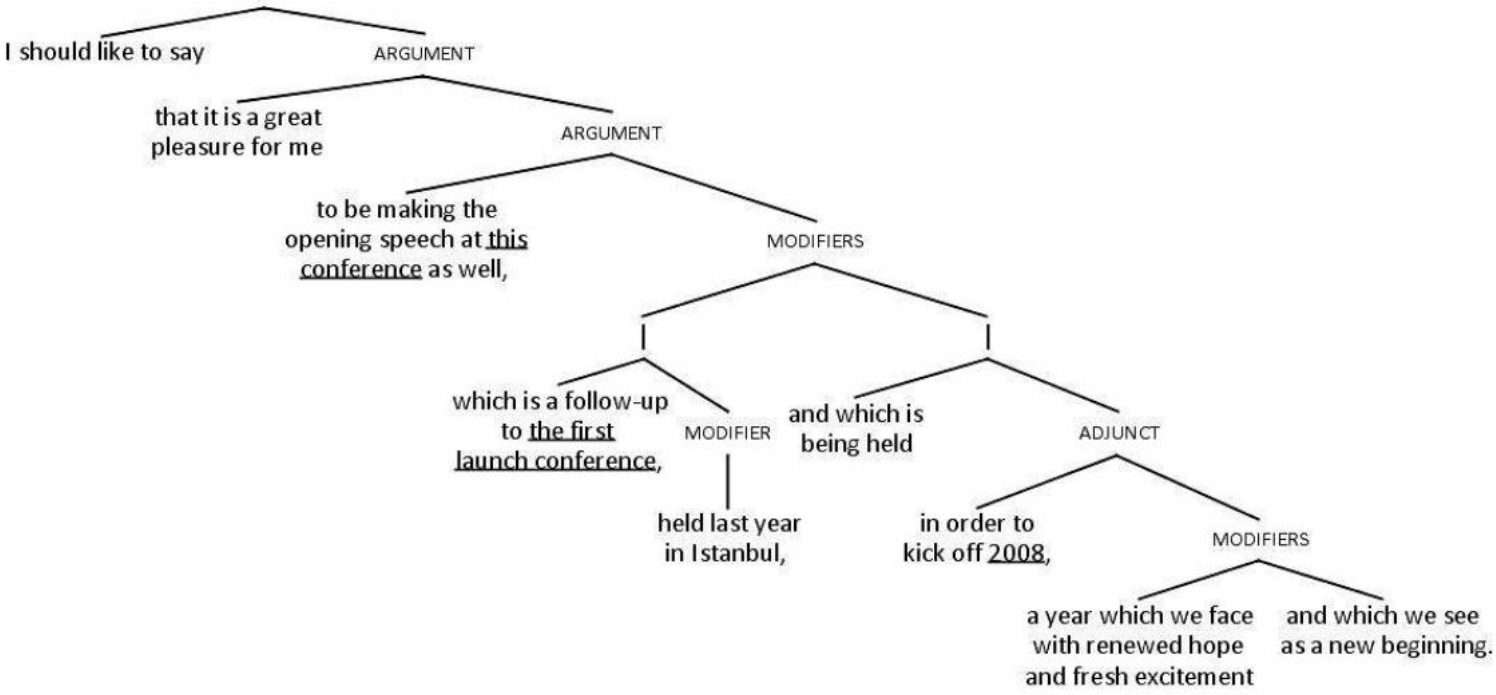


Figure 46
Structurally accurate English version of sentence

An interpreter wishing to interpret a Turkish sentence like the one in figure 45 into English might try starting with the same approach as illustrated in figure 44 – anticipating the main subject. The problem is that the main subject of the sentence in figure 45 comes at the end of a long Turkish sentence, after lots of subordinate clauses which don't lead the listener towards the speaker's main point. This makes anticipation much harder and calls for an alternative strategy.

How about sentence division? Because of limited working memory, an interpreter interpreting a Turkish sentence like the one in figure 45 into English might try dividing it into smaller sentences. The result could be similar to the hypothetical interpretation shown in figure 47.

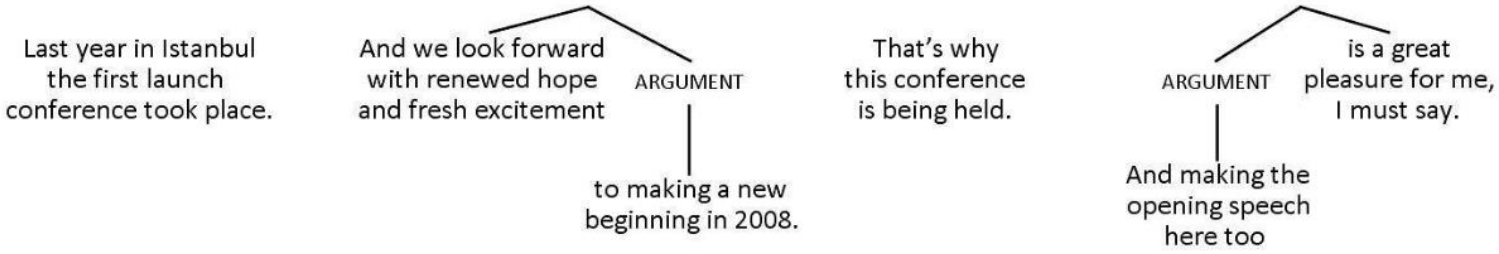


Figure 47
Hypothetical English interpretation with sentence division

The hypothetical interpretation based on sentence division, shown in figure 47, is easier to produce in real time than a structurally accurate interpretation would be. But it sounds a lot choppier and flatter than the original. And it's missing a lot of the detail.

Alternatively, a skilled interpreter might try to change the structure of the original version of the sentence. Ideally, they might manage to construct a sentence similar to the original version in formality and complexity, without changing the linear order more than limited working memory allows. They could do this through a series of clever structural transformations, producing something like the hypothetical English interpretation shown in figure 48. The original Turkish sentence is shown under the tree, segmented and glossed. Nearly every proposition in the hypothetical English interpretation corresponds to the one directly below it in the Turkish original.

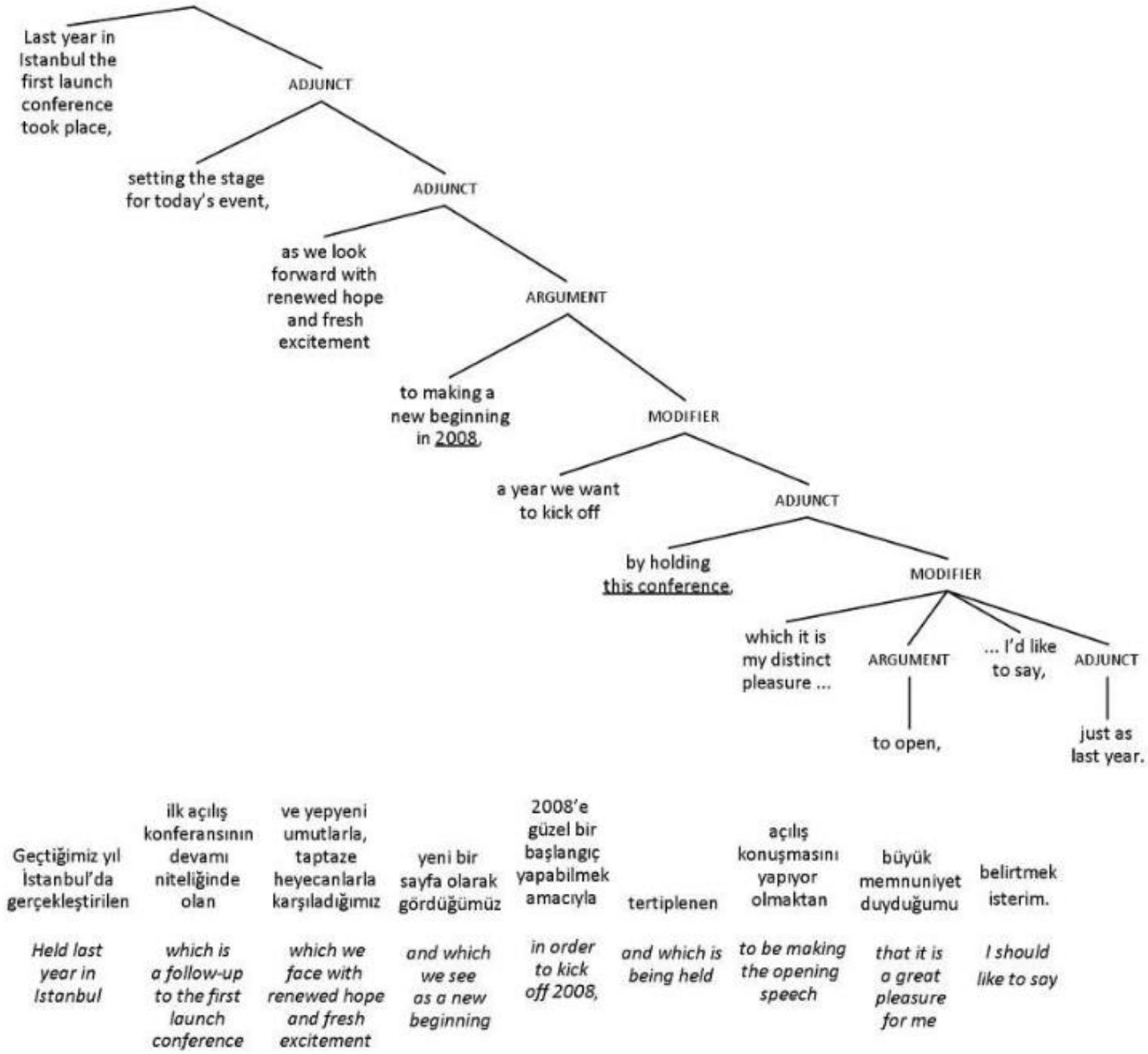


Figure 48
Hypothetical clever English interpretation of sentence, parallelling original Turkish version

The linear order of propositions in the hypothetical English interpretation in figure 48 is nearly parallel to the order of propositions in the original Turkish version of the sentence. The result isn't choppy or flat, and more or less manages to reflect the rhetorical style of the original speech. But … all the syntactic relations between clauses have been inverted. The syntactically lowest clause in the original sentence has become the syntactically highest clause in the interpreted version, and vice versa.

Figure 49 shows parse trees comparing a structurally accurate English version and the restructured English version produced by our hypothetical clever interpreter. The arrowed lines connect corresponding propositions in the two versions, showing the changes in syntactic relations between them.

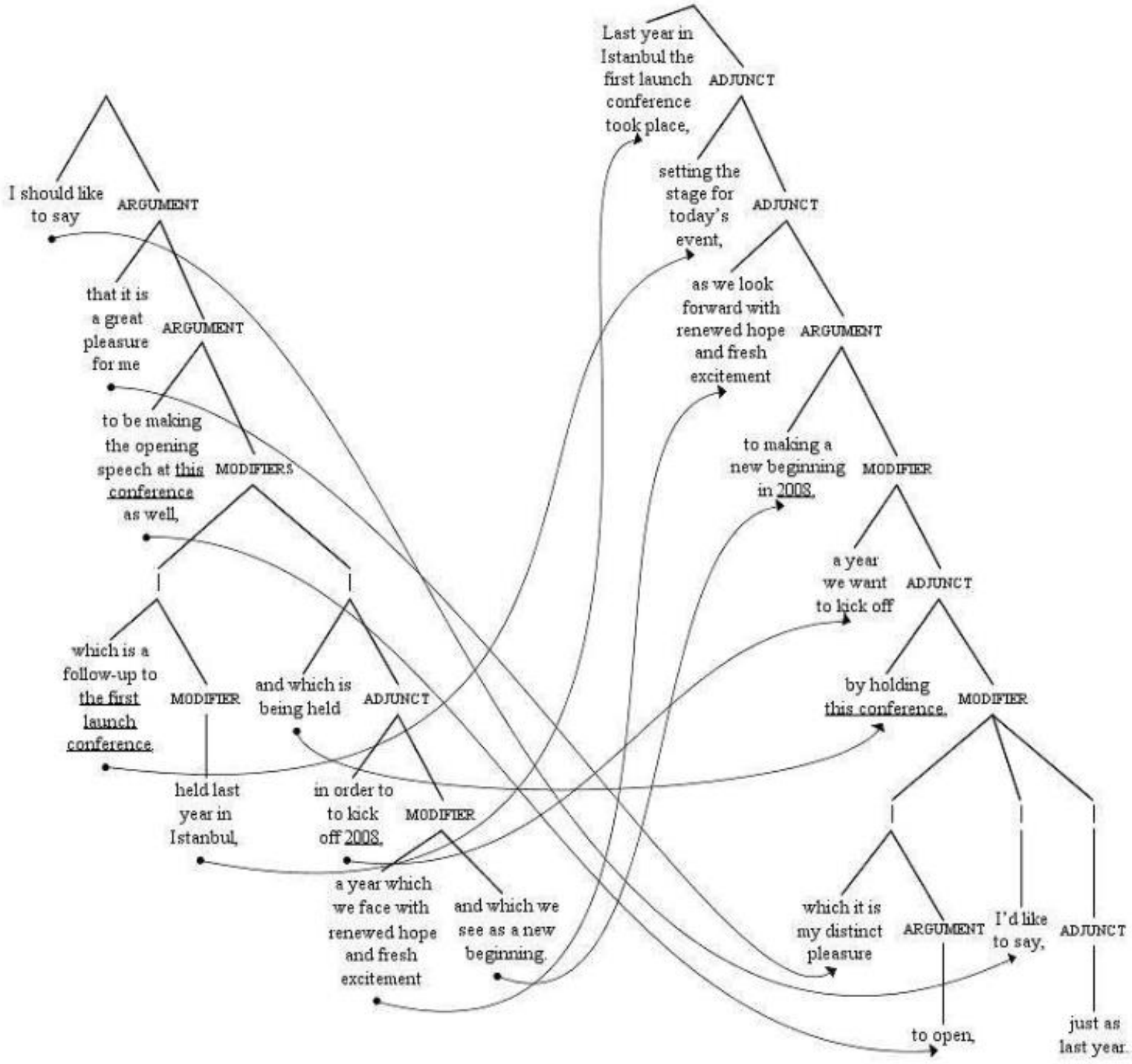


Figure 49

Structurally accurate English version

Cleverly reconstructed interpretation

As with the structural changes we saw before from sentence division and anticipation, the sort of structural distortion due to syntactic transformation that's illustrated on the right-hand side of figure 49 may be acceptable in interpretation, but would be less acceptable in written translation. And of course this hypothetical interpretation is an idealized case. A real interpreter would be unlikely to execute such fancy syntactic footwork so elegantly in practice. Plus, such mental gymnastics, even if possible, could only be as neat as shown here if the original propositions were each in one piece syntactically, as they happen to be in this case. In a different complex sentence in a left-branching language like Turkish, some of the original propositions could well be split by long nested propositions, which could themselves be split by other propositions. In that case, anything approaching an accurate or elegant interpretation in real time could be next to impossible.

This section has briefly presented some strategies which simultaneous interpreters can use when interpreting complex sentences between languages with very different structure. These strategies can be hard to apply, and the result is often less than ideal in terms of content or style. But that effort and that compromise can pay off, by reducing the burden on an interpreter's working memory.

This brief discussion of interpreting strategies brings us to the end of this study. The main conclusions are summarized in the next section.

5.3 Conclusion

Is structural difference in a language pair associated with difficulty in translating or interpreting complex sentences in that pair? The tentative answer given here to that question is: *Yes.* This study has established preliminary associations between structural difference in a language pair and recorded rates for indicators of difficulty in translating or interpreting complex sentences in that pair, with some differences according to the mode of language transfer.

Can anything be done to reduce that difficulty? In my opinion, the short answer is: *Not much.* Various strategies can be practiced and applied for coping with the working memory constraint in simultaneous interpretation, as described in the previous section. But the main take-away from this study is that translating or interpreting complex sentences can be much more difficult between languages with very different structure than between structurally similar languages – so much so, particularly in simultaneous interpretation, that the challenge can seem insurmountable. Even if not much can be done about it, it can still be useful to be aware of that difficulty – its nature, its causes, how intractable it can be, as well as its potential effects.

This study is now complete. It's proposed a semantic parsing method for segmenting complex sentences in a way that allows for better cross-linguistic comparison than a syntactic approach. It's used that method to count and record rates for indicators of difficulty in translation or interpretation into five languages from typologically different families. And it's associated those rates with structural difference in the language pair, sentence complexity and mode of language transfer.

When we say "languages with very different structure," what languages are we talking about besides the ones considered here, especially among languages likely to be used in professional translation or interpretation? Based on typological classifications by Dryer (2013a) and Schmidtke-Bode and Diessel (2017), languages with the **same complex sentence structure** as English (relative and complement clauses which both typically branch to the right) include most Indo-European languages, as well as languages like Arabic, Hebrew, Indonesian, Swahili, Thai and Vietnamese. Languages with **somewhat different structure** from English (relative clauses which typically branch either way and complement clauses which typically branch to the right) include Armenian, Finnish and Hungarian. Languages with **moderately different structure** from English (relative clauses which typically branch to the left and complement clauses which typically branch to the right) include Sino-Tibetan languages, Basque and Georgian. Languages with **opposite structure** from English (relative and

complement clauses which both typically branch to the left) include Turkish, Japanese and Korean.

The findings of this study may help confirm the impressions of many professionals, who feel from experience that translating or interpreting complex sentences can be much more difficult between languages with very different structure than between structurally similar languages. The findings also confirm that structural difficulties manifest themselves differently in different modes of language transfer. Because of space and time constraints in subtitle translation and the working memory constraint in simultaneous interpretation, those two modes appear to be associated with more parallel transfer and easier-to-process output structure than legal translation. But that greater ease in production and processing seems to come at the price of more changes in hierarchical structure and therefore potentially in meaning.

Impressions of the comparative difficulty of transferring complex sentences between languages with major differences in structure can seem obvious to professional translators or interpreters with relevant experience. Still, stating such impressions explicitly can be somewhat taboo. This is true for a number of reasons, including good ones like professional solidarity. This study hopes to go some way towards dispelling that taboo, by helping to highlight structural difference in a language pair as a major potential factor of difficulty – in addition to other linguistic and cultural factors which can complicate the task of translating or interpreting between languages from different families and different parts of the world.

Particularly for simultaneous interpretation, the natural constraint on working memory can make it nearly impossible to interpret complex sentences between structurally very different languages with anything approaching the completeness, accuracy, emphasis and style of a good written translation.

To draw an analogy, a translator can be likened to a swimmer in a pool. They first survey a sentence, then dive in and start swimming forward. The greater their expertise, the more skillful they are in technique, elegance and speed. And they're in control, as the water of the text is still, allowing them to proceed as quickly or as slowly as they like.

Continuing the analogy, a simultaneous interpreter can be likened to a swimmer in a river with a current. They have less control as they swim than the translator does in the pool. Where the current isn't too fast, they have time to maneuver around obstacles. They can speed up or slow down relative to the flow. But ultimately it's the speed of the current which

determines their pace. And if they're swimming downstream, the direction of flow helps immensely by propelling them in the right direction.

This propelling effect is so essential and so constant that interpreters take it for granted when swimming downstream – working between languages where propositions follow each other in similar order. It's only if an interpreter has to swim upstream – working between languages where propositions come at them in reverse order – that they realize how tough it can be to fight the flow. If the current isn't too strong, they can manage, though with considerably more effort than swimming downstream, and less gracefully. But if the speaker's propositions come rushing at the interpreter in a very different order from an order in which they can process and reformulate them coherently, the task can become overwhelming.

When professional simultaneous interpretation was first developing, some experts claimed that interpretation between languages with very different structure was simply not possible: "Some languages, such as Japanese, do not permit simultaneous interpreting, due to the complexity of their grammatical structure" (Bower 1959, cited in Davidson 1992: 1). "That's impossible," said Sen Nishiyama, one of the pioneer consecutive interpreters in Japan, in 1945. "The word order of English and Japanese is exactly opposite. It just can't be done" (Torikai 2009: 92).

This study suggests that there may be some truth to those early impressions. Major structural difference in some language pairs (like between a European language and Turkish, Mandarin or Japanese) may well mean that it simply isn't possible to interpret complex sentences in such a pair with the same degree of accuracy, detail and coherence as between two European languages. For different reasons and perhaps to a different extent, the same may also apply to subtitle translation in a structurally very different pair. As for legal translation between languages with very different structure, the difficulty may be felt mostly by the translator and reflected less in the output than for the other two modes – although that output may also be harder to read than the output of translation in a structurally similar pair.

The semantic parsing method proposed in this study is fit for its purpose, as confirmed by the high degree of consistency found in the reliability check. But there's room for improving it. In particular, an attempt could be made to define more complete and objective criteria for deciding if a given proposition is an assertion and is therefore functionally independent. An attempt could also be made to define criteria for confirming whether syntactically nested or grammatically deranked propositions, which are characteristic of some languages, have less assertive force and are therefore more functionally subordinate than corresponding structures in other languages.

An approach like the one taken in this study could be applied to different genres. A more rigorous version, or a partially automated version, of the proposed semantic parsing method could be developed. Some issues raised here could be investigated in more depth, such as comparing the cognitive difficulty of processing different numbers and levels of nested structures, measuring the cognitive difficulty of reordering propositions, or making a typology of changes in semantic relations or other changes characteristic of translating or interpreting between languages with very different structure. Other related issues could be explored further, such as the importance of preserving logical order or rhetorical effect in translation or interpretation between languages with very different structure. Two issues of output quality in simultaneous interpretation of complex sentences highlighted in the reliability check are the tendency to restate and reformulate information and the tendency to use non-standard syntax. It could be interesting to compare simultaneous interpretation of speeches with complex sentences into typologically different languages, in terms of how natural and clear the interpretation is perceived to be, and how well it's understood.

I hope the findings of this study will prove interesting and useful to linguists, students, teachers, and professional translators and interpreters. It may help confirm impressions from experience, inform individual or policy decisions, or provide a basis for targeted training or future research. If so, it will have achieved its aim.

Epilogue – Other challenges

This study has established preliminary associations between structural difference in a language pair and recorded rates for three indicators of difficulty in translating or interpreting complex sentences in that pair. But reordering, nesting changes and changes in semantic relations aren't the only problems associated with translating or interpreting complex sentences between languages with very different structure. There are other challenges, which aren't measured or recorded for statistical analysis in this study, but which translators and interpreters working between languages with very different structure need to be aware of. Two of those challenges – disruption of logical order and weakening of rhetorical effect – are discussed in this epilogue.

Logical order

Logical order in interpretation

Translation or interpretation between languages with very different structure can involve disrupting the logical order of propositions as presented in the original message. For an example of this problem in simultaneous interpretation, let's have another look at the long sentence from a Turkish speech shown at the end of section 5.2 on strategies for interpretation between languages with very different structure. The original Turkish sentence is reproduced in figure 50. The numbers again show the order the branches need to be read in to make sense in English.

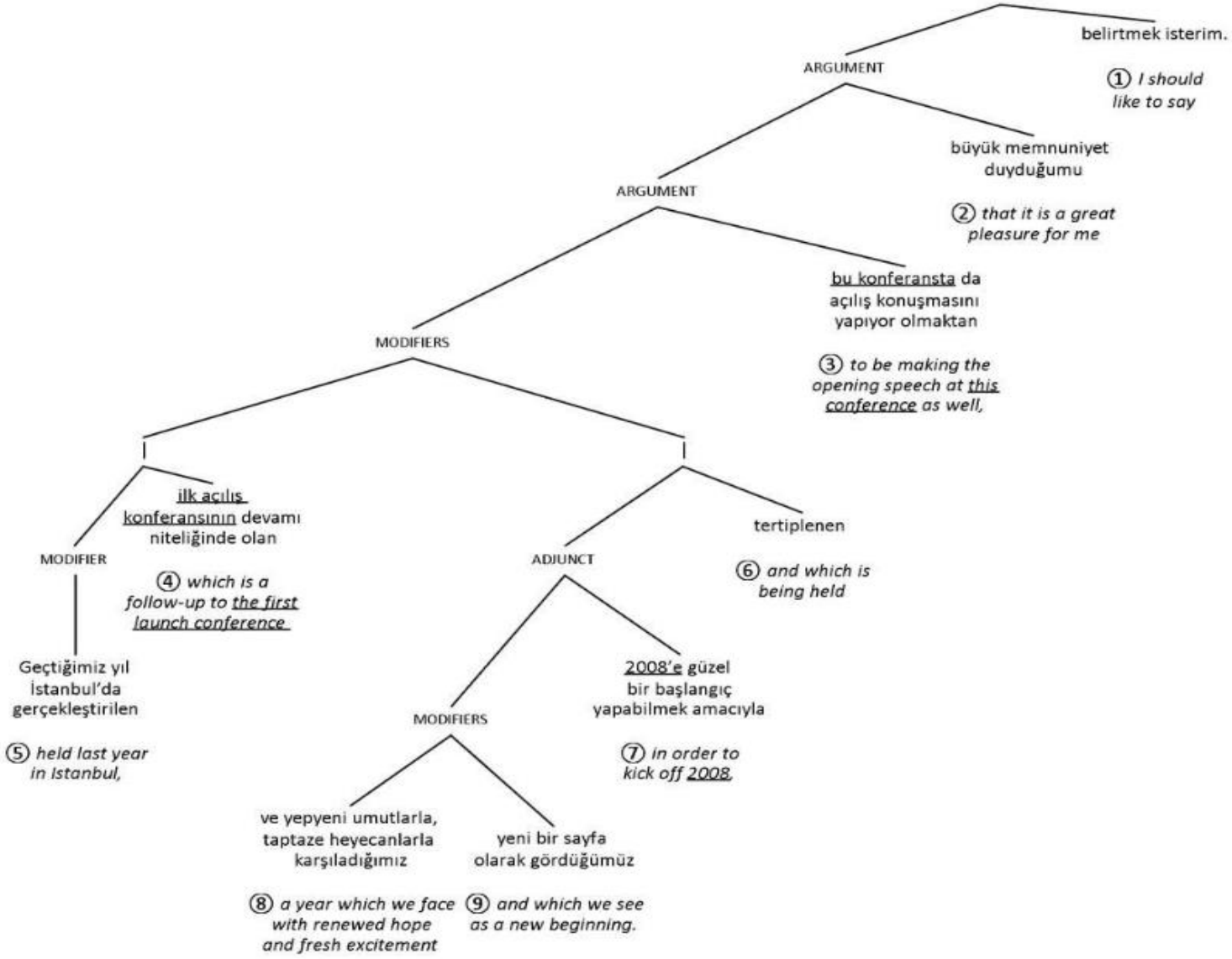


Figure 50
Original Turkish sentence

We also saw earlier a hypothetical, structurally accurate interpretation into English of the Turkish sentence shown in figure 50. That hypothetical English interpretation is reproduced in figure 51.

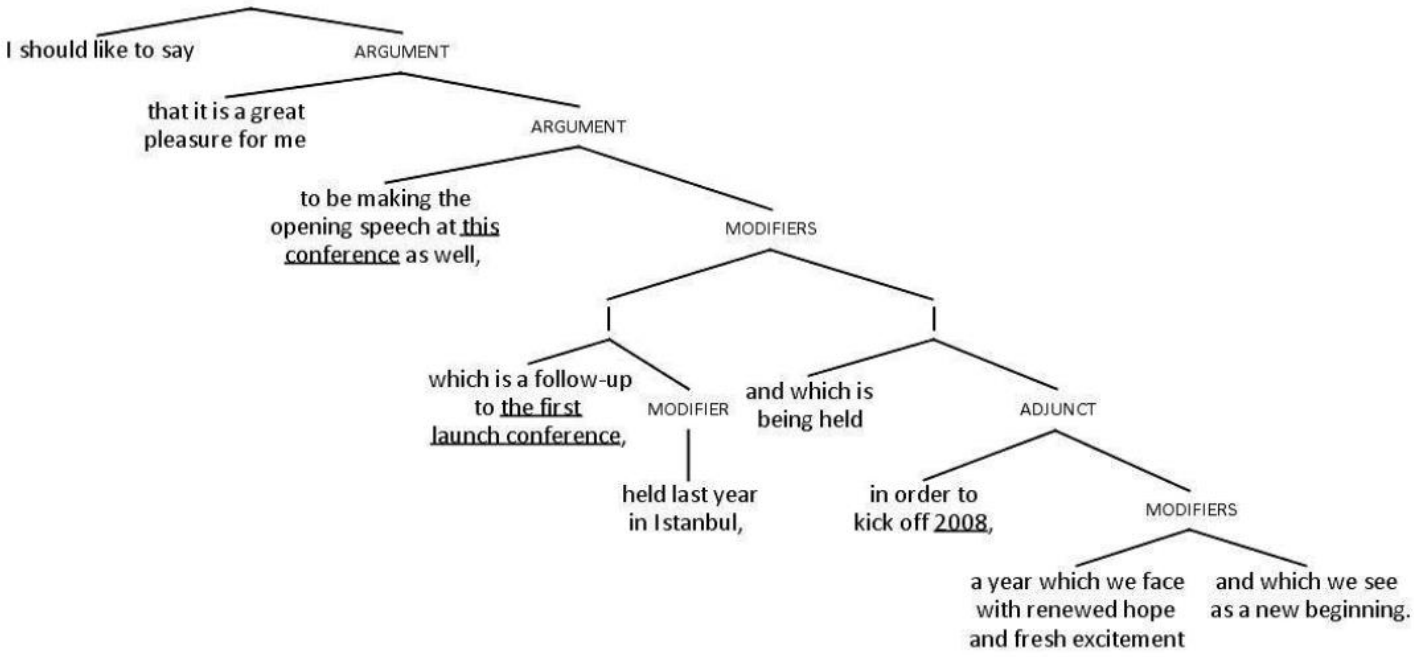


Figure 51
Hypothetical, structurally accurate English interpretation of sentence

We've already mentioned the difficulty of beginning to interpret such a sentence, because of the difficulty of anticipating where the speaker is going. And we've seen the problems that can arise through coping strategies like sentence division or syntactic restructuring. But there's another problem with the hypothetical, structurally accurate English interpretation of the sentence shown in figure 51. That problem has to do with the logical order in which events are described.

In the original Turkish version of the sentence, the description *"held last year in Istanbul"* comes before *"to be making the opening speech at this conference as well."* So the linear sequence of event descriptions in the original Turkish version reflects the chronological order of the events described. Likewise, *"to be making the opening speech at this conference as well"* comes before *"that it is a great pleasure for me,"* which comes before *"I should like to say."* Here again, linear sequence reflects chronological order. First the speaker got the chance to speak, that made him happy, and now he's telling us about it.

But an audience listening to a structurally accurate English interpretation of the same sentence, like the one in figure 51, would hear first about this year's conference, then about last year's. And they'd hear first that the speaker wants to say something now, then that what he wants to talk about is a feeling he's had for a while, and finally what made him feel that way. Figure 52 shows the original Turkish version of the sentence, with numbers indicating the chronological order of the events in question.

Geçtiğimiz yıl İstanbul'da gerçekleştirilen	ilk açılış konferansının devamı niteliğinde olan	ve yepyeni umutlarla, taptaze heyecanlarla karşıladığımız	yeni bir sayfa olarak gördüğümüz	2008'e güzel bir başlangıç yapabilmek amacıyla	tertiplenen	bu konferansta da açılış konuşmasını yapıyor olmaktan	büyük memnuniyet duyduğumu	belirtmek	isterim.
①						②	③		④
held last year in Istanbul,	*which is a follow-up to the first launch conference*	*a year which we face with renewed hope and fresh excitement*	*and which we see as a new beginning.*	*in order to kick off 2008,*	*and which is being held*	*to be making the opening speech at this conference as well,*	*that it is a great pleasure for me*	*to say*	*I should like*

Figure 52
Turkish original
Events described in chronological order

Figure 53 shows the hypothetical, structurally accurate English interpretation of the sentence. Again, the numbers show the chronological order of the events in question.

I should like	to say	that it is a great pleasure for me	to be making the opening speech at this conference as well,	which is a follow-up to the first conference	held last year in Istanbul,	and which is being held	in order to kick off 2008,	a year which we face with renewed hope and fresh excitement	and which we see as a new beginning.
④		③	②		①				

Figure 53
Structurally accurate English interpretation
Events described in reverse chronological order

Because of the structural difference between Turkish and European languages, this mismatch between syntactic sequence and chronological order of events is inevitable if the relations among propositions are accurately retained in interpretation. If the person giving the original speech had been speaking a European language, they might have produced a sentence describing the events in a sequence closer to their chronological order than the hypothetical English interpretation in figure 53. They might have started by saying, *"After speaking at last*

year's successful conference, …" We can only speculate. The point is that translating or interpretating complex sentences between languages with very different structure can involve yet another trade-off – between the structural accuracy of a sentence and the logical order of the events it describes.

In interpretation into a European language of a sentence like the Turkish one in figure 50, describing the events in clear, chronological order might be considered more important than preserving the hierarchical relations between propositions. The choice between these options can often be less than obvious, and the output can accordingly be easier or harder to follow.

Logical order in translation

Preserving logical order can be hard in simultaneous interpretation, because of the constraint on working memory. The task can be easier in written translation, as long as the translator is aware of the problem. To see how, let's consider (22), a hypothetical run-on sentence about a speaker's wife learning Japanese. (The same sentence is also given as an example in section 3 of annex I.)

> (22) My wife's learning Japanese, because she loves Japan, which has always been her favorite place to visit, although she's always felt she could get more out of it if she spoke the language, which, as she's finding out, is a never-ending journey of discovery into a culture that holds endless fascination and startling beauty for the learner.

Figure 54 shows a parse tree with a hypothetical Turkish translation of the sentence in (22) based on a syntactic rather than a semantic analysis of structure. The numbers show the order the branches need to be read in to make sense in English.

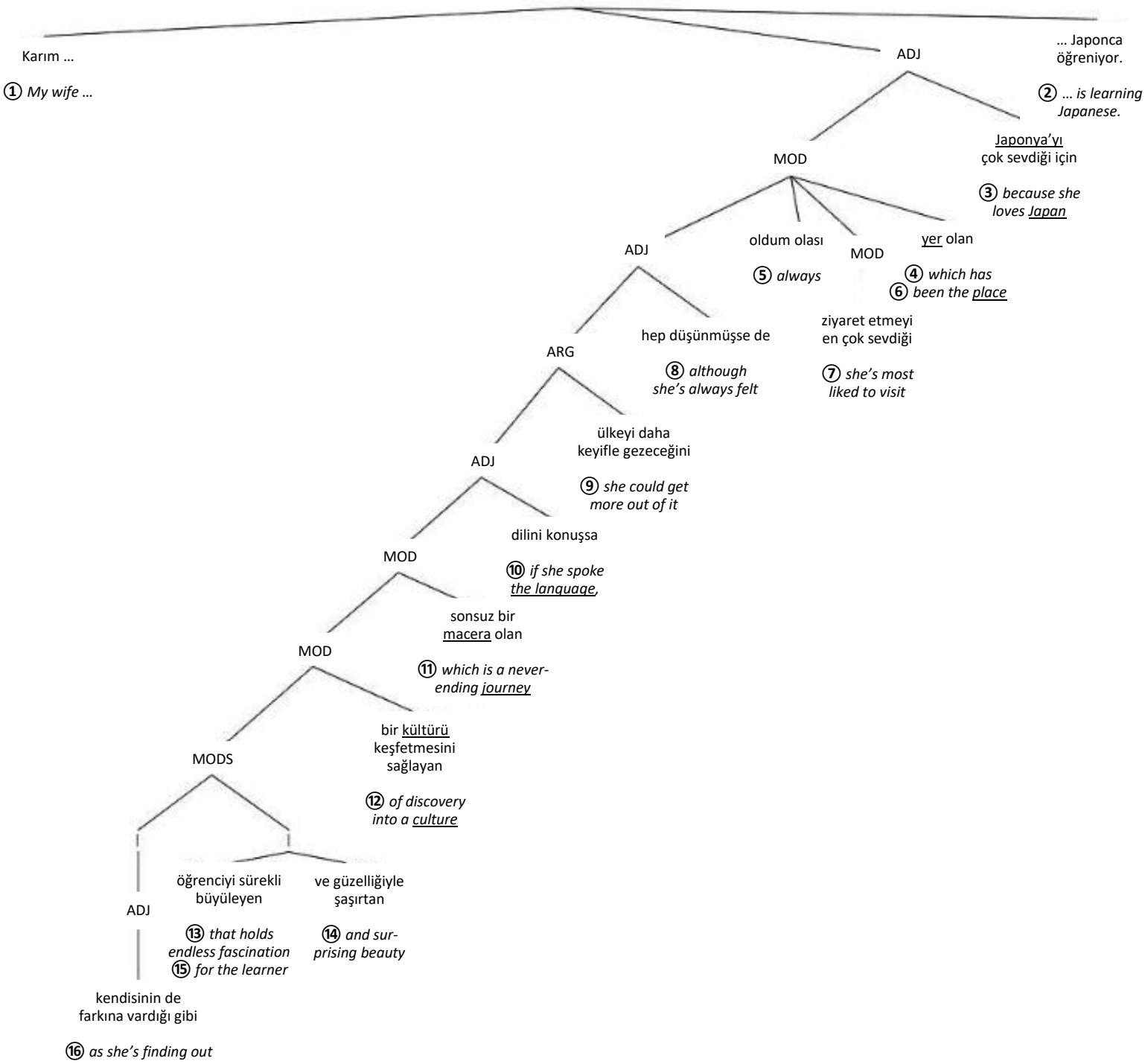


Figure 54
Turkish translation of complex sentence based on syntactic analysis of structure

There are a couple of problems with the hypothetical Turkish translation shown in figure 54. One problem is the long gap in the main clause at the top of the tree. Another problem is the potential weakening of assertive force in the subordinate clauses through grammatical deranking and syntactic nesting. (These two problems are discussed in section 3 of annex I.) A third problem with this translation is the difficulty of understanding information in the order it's presented in.

Translating a complex sentence from a language like English into a language like Turkish based on a syntactic analysis of structure can result in an output sentence where the assertions are not only weakened through grammatical deranking and nesting, but also appear in reverse or mixed-up order. The original English sentence in (22) includes several assertions. Those assertions are made in the order shown in (23).

(23) My wife's learning Japanese.
She loves Japan.
Japan's always been her favorite place to visit.
She's always felt she could get more out of it if she spoke the language.
She's finding out what I'm about to say.
Learning Japanese is a never-ending journey of discovery into a culture.
That culture holds endless fascination for the learner.
It also startles the learner with its beauty.

Each sentence in (23) can be seen as an assertion, with its own place in an overall sequentially formed message. Mixing up the order the assertions are presented in can distort the logical coherence of that message. The hypothetical translation in figure 54 presents the assertions in a confusing order. That order is shown in (24).

(24) My wife's involved in something [we'll know what when we get to the rest of the main clause] …
She's finding out what I'm about to say.
Something holds endless fascination for the learner.
That something also startles the learner with its beauty.
That something is a culture and something else is a never-ending journey of discovery into it.
She's always felt she could get more out of it if she spoke the language.
Japan's always been her favorite place to visit.
She loves Japan.
… The thing my wife's involved in is that she's learning Japanese.

In a good translation based on a semantic analysis of structure, a complex sentence with multiple assertions in a European language can be rendered in a language like Turkish as a series of shorter sentences. Each of those shorter sentences can contain one functionally independent proposition corresponding to the main clause, and one or two other functionally independent propositions corresponding to subordinate clauses. An example, produced by

expert translator and interpreter Aksel Vannus, is shown in figure 55. The numbers show the order the branches need to be read in to make sense in English.

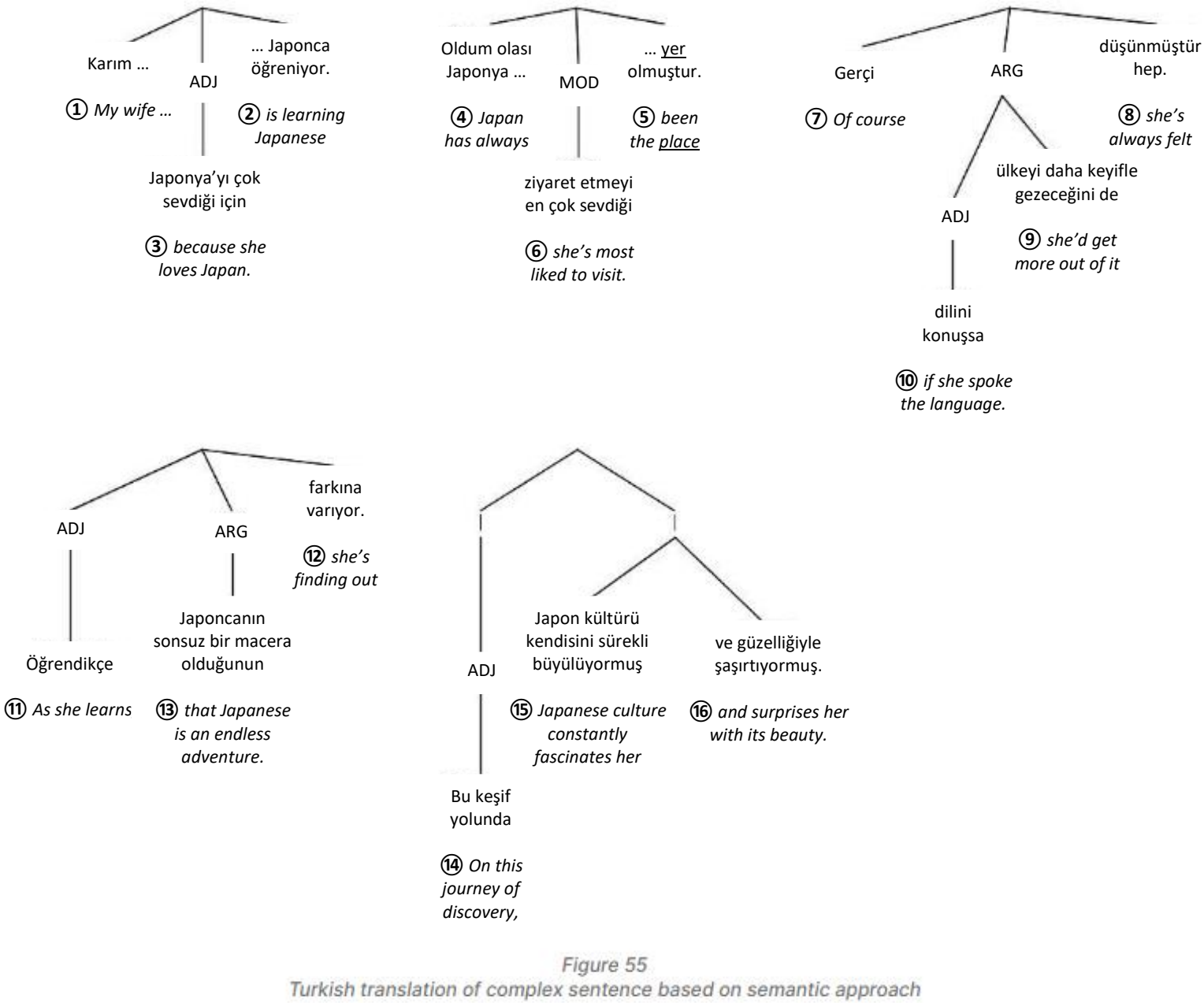


Figure 55
Turkish translation of complex sentence based on semantic approach

A nice Turkish translation like the one in figure 55 sounds more natural and is much easier to understand than the one in figure 54 based on a syntactic analysis of the original sentence. One reason is that the nice translation doesn't contain any long-distance attachments and doesn't make the listener or reader wait for verbs. Research by Ueno and Polinsky (2009) shows that languages like Japanese and Turkish prefer structures that provide early access to

the verb, even though the syntax of those languages requires a verb to be placed at the end of its clause. The other reason the nice translation sounds better than a syntactically accurate one is that the assertive force of the functionally independent propositions is maintained and moves forward from one assertion to the next, in the same order as in the original.

This section has shown how translating or interpreting complex sentences between languages with very different structure based on a syntactic analysis of structure can disrupt the logical order of a sentence. The next subsection discusses another way a syntactic approach can disrupt the flow of a text or speech.

Rhetorical effect

In the previous section, we saw how translating or interpreting a complex sentence based on a syntactic analysis of structure can disrupt the logical order in which information is presented. Another way a syntactic analysis can disrupt the flow of a text or speech is by weakening its rhetorical effect. To see how, consider the last sentence of Dr. Martin Luther King's historic 1963 speech, "Freedom's Ring," known for its refrain-like line, *"I have a dream."* The sentence is shown in figure 56, grouped into functional propositions.

When we let free-dom ring,	when we let it ring from every village and hamlet, from every state and every city	we will be able to speed up that day	when all of God's children,	{ black men and white men, Jews and Gentiles, Protestants and Catholics, }	will be able to join hands	and sing	{ in the words of the old Negro spiritual, }	"Free at last!	Free at last!	Thank God Almighty, we are free at last!"
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪

Figure 56
Last sentence of King speech – Original English

Each number in figure 56 corresponds to what would be a leaf on one of our semantic parse trees – a proposition or part of a split proposition. Numbers 5 and 8 are nested propositions, enclosed in brackets. Number 4 contains a syntactically isolated joint argument of the propositions whose predicates are in numbers 6 and 7. Number 8 is segmented as a separate proposition, because it contains information other than semantically typical information (see explanation in section 2.1 of annex I) and can be rephrased as a clause ("as the old Negro spiritual goes").

A hypothetical, structurally accurate Japanese version of the sentence in figure 56 is shown in figure 57. The numbers show the order the parts need to be read in to make sense in English.

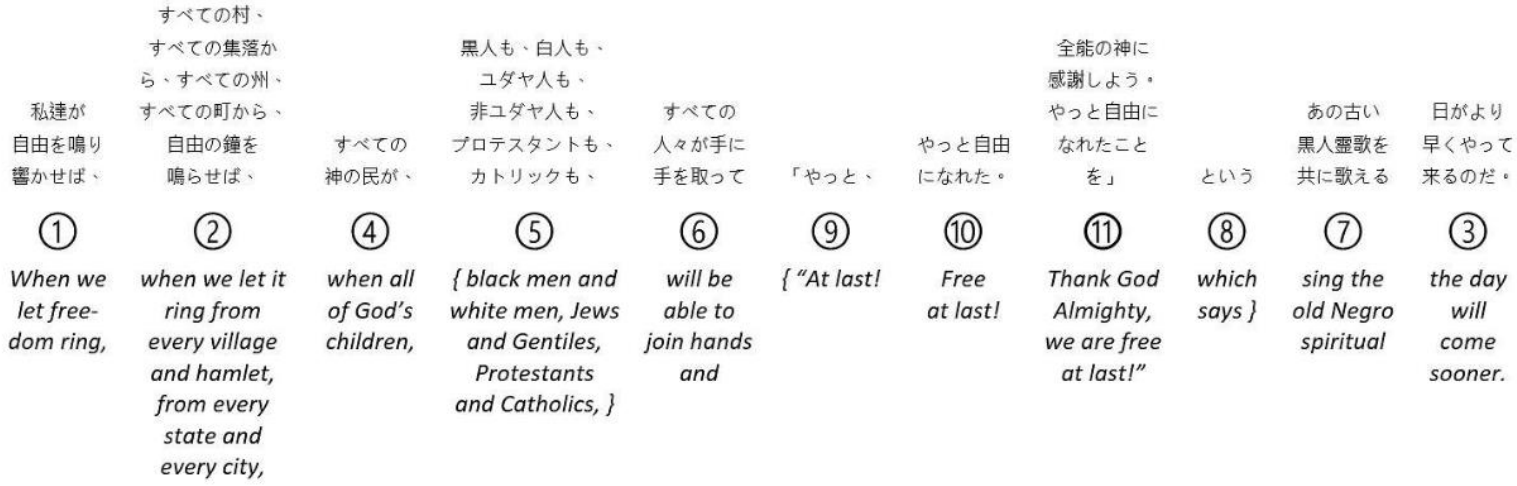


Figure 57
Hypothetical, structurally accurate Japanese translation of sentence

There are several problems with the hypothetical, structurally accurate Japanese translation shown in figure 57. One problem is that it's hard to process, because of the many nested propositions. And again there's the problem of the logical order the events are described in. In the original English version, *"we will speed up the day"* comes before *"when all of God's children … will join hands and sing,"* which is followed by the words of the song. This reflects the logical order of events hoped for: first the great day will come, then everyone will join hands and sing, then the words of the song will ring out.

This logical order is disrupted in the hypothetical, structurally accurate Japanese translation in figure 57, because of the difference in branching direction between English and Japanese. The Japanese translation first says everyone will join hands, then gives the words of the song, then says everyone will sing, and finally says the great day will come. The result may be confusing, since the events are described out of order. The relevant parts of the original English version and of the structurally accurate Japanese translation are compared in figures 58 and 59. The numbers there show the chronological order of the events in question.

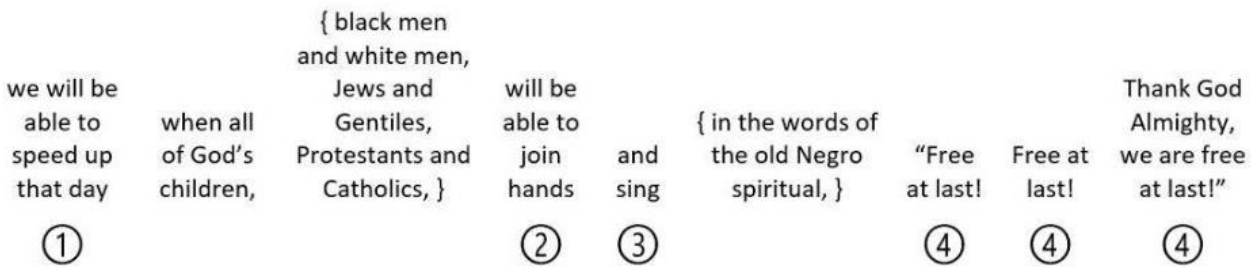


Figure 58
Original English version
Events described in chronological order

すべての神の民が、	黒人も、白人も、ユダヤ人も、非ユダヤ人も、プロテスタントも、カトリックも、	すべての人々が手に手を取って	「やっと、	やっと自由になれた。	全能の神に感謝しよう。やっと自由になれたことを」	という	あの古い黒人霊歌を共に歌える	日がより早くやって来るのだ。
		②	④	④	④		③	①
when all of God's children,	*{ black men and white men, Jews and Gentiles, Protestants and Catholics, }*	*will be able to join hands and*	*{ "At last!*	*Free at last!*	*Thank God Almighty, we are free at last!"*	*which says }*	*sing the old Negro spiritual*	*the day will come sooner.*

Figure 59
Hypothetical, structurally accurate Japanese translation
Events described in mixed-up order

But logical order isn't the only problem. Another problem with the hypothetical, structurally accurate Japanese translation in figure 57 is the rhetorical effect of the order the events are described in. The original English version of the speech crescendos to the final words, *"Free at last!"* Those words are powerful for several reasons: the use of direct speech; their elliptical syntax; their repetition; their religious invocation; the sonorous way they're declaimed; and the fact that they're at the end of the speech, reverberating among the cheers of hundreds of thousands of people present at the event, and in the heads of listeners everywhere then and since. But this rhetorical effect may be diminished in the hypothetical, structurally accurate Japanese translation. Because complex sentence structure is head-final in Japanese, the structurally accurate Japanese translation places the inspiring words of the spiritual in the lowest level of a multiple nesting, followed by the last part of a syntactically split proposition, which is followed by a time description (*"the day will come sooner"*).

This illustrates another dilemma facing translators and interpreters working between languages with very different structure: the trade-off between ensuring structural accuracy, which can mean a lot of reordering, and preserving rhetorical effect, which can mean leaving information in its original order. Not only can changing the sequence of information in a sentence disrupt the logical order of events described. It can also weaken the rhetorical effect of describing events in a certain order.

A nice Japanese translation of Dr. King's famous speech is published on the website MLK online. That translation, shown in figure 60, reflects the trade-off described above. Some structural accuracy is sacrificed, in exchange for greater ease of understanding, clearer logical order and more powerful rhetorical effect. This time the numbers indicate the order the phrases need to be read in to make sense in English.

Figure 60
Actual Japanese translation

The translator who produced the nice translation shown in figure 60 was apparently aware of the problems that would have been created by a structurally accurate translation. So they've chosen instead to move the words of the spiritual to a separate final sentence. One advantage of doing that is that it makes the first sentence easier to understand, creating fewer nestings than there would be in a structurally accurate translation. The other advantages are clearer logical order and greater rhetorical effect, as the inspiring words of the spiritual are now closer to the end of the speech. Given the various trade-offs described, the translator has taken a sound middle road, sacrificing some structural accuracy in exchange for improving other features of the translation.

As with any trade-off, the result isn't perfect in every way. The event of the great day coming is still described after the event of everyone joining hands and singing. The words of the song still aren't at the very end of the speech. And the main clause in the final sentence is elliptical, consisting only of the word "day" with a subject marker, to indicate what position that word – with all the propositions under it, including the words of the song – should be interpreted as having occupied in the previous sentence. Again, we see a number of trade-offs between structural accuracy and other features – ease of processing, logical order and rhetorical effect – in translating or interpreting complex sentences between languages with very different structure. As before, there's no ideal solution.

Of course, translators or interpreters working in language pairs with very different structure aren't always beset by such problems. If the sentences in the original text or speech are short and simple, structural issues like the ones described in this epilogue are less likely to arise. Even with longer, complex sentences, it's sometimes possible to reorder propositions in translation or interpretation without creating a result that's more confusing or less compelling than the original.

But where the original sentences are long and complex and involve successive event descriptions, lines of reasoning or passionate rhetoric, translating or interpreting complex sentences between languages with very different structure can produce a result that's less than ideal – by splitting propositions, disrupting logical order, weakening rhetorical effect, or (in interpretation) placing too great a burden on working memory.

This epilogue on other challenges for translating and interpreting complex sentences between languages with very different structure winds up this study. All that's left is for me to wish colleagues success in facing these challenges, hoping that I've managed to help them in some way.

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Annex I
Semantic parsing

Annex I describes a method for parsing complex sentences into component propositions and indicating the functional relations between those propositions. That method is applied to each sentence in the corpus, to record values for the variables fed into the statistical analysis. The semantic parsing method is described briefly in section 3.1. The details of the method are presented in annex I, the document version of which is printed separately.

The annex can also be seen online at:
structural-difficulty-in-translation-and-interpretation.com/annexes/semantic-parsing

Annex II
Data

Data for all sentences in the corpus can be seen online at:
structural-difficulty-in-translation-and-interpretation.com/annexes/data

Data for the reliability check can be seen online at:
structural-difficulty-in-translation-and-interpretation.com/annexes/data-check