Iconicity of sequence: A corpus-based analysis of the positioning of temporal adverbial clauses in English

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Abstract

Recent work in functional and cognitive linguistics has argued and presented evidence that the positioning of adverbial clauses is motivated by competing pressures from syntactic parsing, discourse pragmatics, and semantics. Continuing this line of research, the current paper investigates the effect of the iconicity principle on the positioning of temporal adverbial clauses. The iconicity principle predicts that the linear ordering of main and subordinate clauses mirrors the sequential ordering of the events they describe. Drawing on corpus data from spoken and written English, the paper shows that, although temporal clauses exhibit a general tendency to follow the main clause, there is a clear correlation between clause order and iconicity: temporal clauses denoting a prior event precede the main clause more often than temporal clauses of posteriority. In addition to the iconicity principle, there are other factors such as length, complexity, and pragmatic import that may affect the positioning of temporal adverbial clauses. Using logistic regression analysis, the paper investigates the effects of the various factors on the linear structuring of complex sentences.

Keywords: *iconicity; temporal adverbial clauses; constituent order; competing motivations; logistic regression.*

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1. Introduction

Adverbial clauses are subordinate clauses that are combined with a main clause in complex sentences. As can be seen in examples (1) to (4), in English the adverbial clause may precede or follow the associated main clause. This raises the interesting question of what motivates the sequential ordering of main and subordinate clauses. When does the adverbial clause precede the main clause and when does it follow it?

(1) *If* it's a really nice day, we could walk.
(2) I'd quite like to go to Richmond Park *because* I was reading about it in this novel.
(3) *When* you get a tax rebate, you get the money back after about a year, don't you?
(4) Weigh up all these factors carefully *before* you commit yourself to the manoeuvre.

1.1. *Competing motivations for the positioning of adverbial clauses*

In a recent paper, Diessel (2005) argued that the ordering of main and adverbial clauses is motivated by functional and cognitive pressures from three sources: (1) syntactic parsing, (2) discourse pragmatics, and (3) semantics. Drawing on Hawkins' (1994, 2004) processing theory of constituent order and complexity, he shows that adverbial clauses are easier to process, and thus more highly preferred, if they follow the main clause. According to Hawkins, the human processor prefers linear structures that allow for fast and easy access to the recognition domain. The recognition domain is defined as the string of linguistic elements that must be processed and kept in working memory until the parser has accessed all immediate constituents of a phrase once the mother node of the phrase has been recognized.

Complex sentences consist of two clauses functioning as the immediate constituents of a bi-clausal structure, which is organized by the subordinate conjunction creating the mother node $S_{complex}$ that dominates the complex sentence construction (cf. Hawkins 1994: 360). If the adverbial clause follows the main clause, the subordinate conjunction establishes the $S_{complex}$-node right after the main clauses has been processed and before the adverbial clause is accessed, which means that the two immediate constituents of the complex sentence can be attached to their mother node (i.e., $S_{complex}$) as soon as this node is constructed. In contrast, if the adverbial clause precedes the main clause, the subordinate conjunction establishes the $S_{complex}$-node right at the beginning of the bi-clausal structure, which means that the human parser first has to process the adverbial

clause before the second immediate constituent, i.e., the main clause, can be attached to $S_{complex}$. Complex sentences with an initial adverbial clause thus have a longer recognition domain (5a) than complex sentences with final adverbial clauses (cf. 5b and cf. Diessel 2005). If the human processor prefers complex sentences with final adverbial clauses, one has to ask what motivates the occurrence of initial adverbial clauses. Why do speakers prepose adverbial clauses if complex sentences with final adverbial clauses are easier to parse?

(5) a. [When . . . . .]$_{SUB}$ [. . . . .]$_{Main}$ recognition domain

b. [. . . . .]$_{Main}$ [when . . . . .]$_{SUB}$ recognition domain

One factor that motivates the preposing of adverbial clauses is their pragmatic function. A number of studies have argued and presented evidence that the discourse function of an adverbial clause varies with its position relative to the main clause (cf. Chafe 1984; Diessel 2005; Ford 1993; Givón 1990: 846–847; Ramsay 1987; Thompson and Longacre 1985; Thompson 1985, 1987; Verstraete 2004). If the adverbial clause follows the main clause it tends to provide new information, or else functions as an afterthought; but if the adverbial clause precedes the main clause, it serves to organize the information flow in the ongoing discourse. As Chafe (1984), Givón (1990: 846–847), and others have argued, initial adverbial clauses provide a guidepost for the interpretation of subsequent clauses; they are often used at the beginning of a new paragraph or a new turn to organize the transition between discourse topics. In other words, the occurrence of initial adverbial clauses is motivated by particular discourse-pragmatic functions. Complex sentences containing initial adverbial clauses can be seen as particular constructions that speakers use to stage information, i.e., to lay a thematic foundation for the following discourse (cf. Ford 1993: Ch 3; Givón 1990: 846–847; Thompson 1987; Verstraete 2004).

However, this general orientation function of initial adverbial clauses does not explain why certain semantic types of adverbial clauses occur in initial position more readily than others. In addition to syntactic parsing and discourse pragmatics, we thus have to consider the meaning of complex sentences to account for the sequential ordering of main and subordinate clauses. In the literature, the following major semantic types of adverbial clauses are usually distinguished: temporal clauses, indicating a temporal relationship between two events; conditional clauses, expressing a condition or prerequisite for the realisation of the main clause event;

causal clauses, providing a cause or reason for the proposition expressed in the main clause; result clauses, referring to the result or consequence of the main clause event; and purpose clauses, denoting the goal or purpose of the activity expressed in the main clause (see Quirk et al. 1985: Ch 12 for a detailed discussion of the various semantic types of adverbial clauses).

Using corpus data from both spoken and written genres, a number of studies have demonstrated that temporal, conditional, causal, result, and purpose clauses tend to occur in different positions relative to the main clause (cf. Altenberg 1984; Biber et al. 1999: 820–825; Diessel 1996, 2005; Ford 1993; Quirk et al. 1985: Ch 12; Ramsay 1987). To simplify, conditional clauses usually precede the main clause, temporal clauses are commonly used both before and after the main clause, and causal, result, and purpose clauses predominantly follow the associated main clause.

Interestingly, the same positional patterns have also been observed in many other languages across the world. Investigating the distribution of adverbial clauses in a representative sample of the world's languages, Diessel (2001) identified two common cross-linguistic patterns. There are languages in which all adverbial clauses precede the main clause, unless they are extraposed (e.g., Japanese), and there are languages in which the positioning of adverbial clauses varies with their meaning (e.g., Punjabi). In the latter language type, conditional clauses usually precede the main clause, temporal clauses exhibit a mixed pattern of pre- and postposing, and causal, result, and purpose clauses commonly follow the associated clause (see also Hetterle 2007).

1.2. *Iconicity of sequence*

Another factor that seems to influence clause order is iconicity. The notion of iconicity comprises two basic types, diagrammatic iconicity, which is concerned with structural (or relational) similarities between the sign and the referent, and imagic iconicity, which is concerned with substantial similarities between the sign and the referent (e.g., sound symbolism). The notion of diagrammatic iconicity has been used in various functional and cognitive explanation of linguistic structure (cf. Croft 2003: Ch 4.2; Dressler 1995; Fenk-Oczlon 1991; Givón 1985, 1991; Haiman 1980, 1983, 1985, 1994, 2006; Haspelmath forthc.; Itkonen 2004; Jakobson 1965[1971]; Plank 1979; Tabakowska et al. 2007; Taylor 2002: 45–48). The general idea "behind [diagrammatic] iconicity is that the structure of language reflects in some way the structure of experience" (Croft 2003: 102); but this general notion of iconicity subsumes a wide variety of dif-

ferent meanings.[1] In this paper, I concentrate on a particular subtype of diagrammatic iconicity, iconicity of sequence, which refers to the sequential ordering of linguistic elements in discourse and complex sentences. Note that this kind of iconic motivation cannot be explained by frequency of occurrence (cf. Haspelmath 2008) or effort reduction (cf. Haiman 2006) as other types of iconicity.

There are a number of studies suggesting that clause order in complex sentences is usually iconic. For instance, Lehmann (1974) and Haiman (1978, 1983) argued that conditional clauses tend to precede the main clause because conditional clauses refer to an event that is conceptually prior to the one expressed in the main clause; Greenberg (1963 [1966]) proposed that purpose clauses follow the main clause because they denote the intended endpoint or result of the activity expressed in the associated clause (cf. Schmidtke in press); and Clark (1971) argued that *after*-clauses precede the main clause more often than *before*-clauses, because *after*-clauses refer to an event that occurs prior to the one in the main clause, whereas *before*-clauses refer to a posterior event (cf. Diessel 2005).

While all of these studies suggest that iconicity of sequence is an important determinant of the linear structuring of complex sentences, it must be emphasized that the distributional properties of certain semantic types of adverbial clauses are not consistent with the iconicity principle. In particular, the positioning of causal clauses violates the iconicity of sequence. Although causes and reasons are conceptually prior to the effect expressed in the main clause, causal clauses tend to occur sentence-finally (cf. Altenberg 1984; Diessel 2001, 2005; Ford 1993: Chs 3–4; Hetterle 2007). Across languages, causes and reasons are commonly expressed in constructions that follow the semantically associated clause, suggesting that iconicity of sequence is not relevant for the positioning of causal clauses. Diessel (2006) argues that the tendency of causal clauses to follow the main clause is motivated by the fact that causal clauses are primarily

1. In a recent review of the literature, Haspelmath (2008) identified eight different subtypes of (diagrammatic) iconicity: (1) iconicity of quantity (greater quantities are expressed by more linguistic structure), (2) iconicity of complexity (more complex meanings are expressed by more complex forms), (3) iconicity of cohesion (semantic cohesion is reflected in structural cohesion), (4) iconicity of paradigmatic isomorphism (one meaning, one form in the system), (5) iconicity of syntagmatic isomorphism (one form, one meaning in the clause), (6) iconicity of sequence (sequences of form match sequences of experiences), (7) iconicity of contiguity (semantically associated elements occur adjacent to each other), and (8) iconicity of repetition (repetition in linguistic form reflects repeated experiences).

used to back up a previous statement that the hearer may not accept or may not find convincing.

Moreover, while the positioning of conditional clauses is consistent with the iconicity of sequence, there is an alternative explanation for their distribution. Conditional clauses precede the main clause because they denote a hypothetical situation, providing a conceptual framework (or mental space) for the interpretation of subsequent clauses (cf. Dancygier 1998; Dancygier and Sweetser 2000; Lehmann 1974). If the conditional clause follows the main clause, the hearer may at first misinterpret the preceding main clause as a factual statement. Since the revision of a previous utterance increases the processing load, there is a strong motivation to place conditional clauses before the main clause (cf. Diessel 2005). Thus, it seems that the iconicity principle is not immediately relevant for the positioning of causal and conditional clauses.

Moreover, one might hypothesize that iconicity of sequence, which denotes the temporal dimension of experience, primarily concerns the ordering of temporally related clauses. Previous studies suggest that temporal clauses denoting a prior event precede the main clause more often than temporal clauses of posteriority (cf. Clark 1971; Diessel 2005). But although iconicity of sequence has been widely discussed in the literature, it has never been systematically investigated. It is the purpose of this study to fill this gap. Using corpus data from spoken and written English, the paper presents the first quantitative analysis of the positioning of temporal adverbial clauses to systematically investigate the effect of the iconicity principle on clause order.

2. Analysis

The analysis concentrates on five types of temporal clauses marked by the subordinating conjunctions *when, after, before, once*, and *until*. The five conjunctions have been chosen for two reasons: first, they are among the most frequent temporal conjunctions in English, and second, they are semantically especially interesting for the purpose of this study.

When-clauses are interesting because *when* is the only temporal conjunction in English that does not specify the temporal sequence between main and adverbial clauses. As can be seen in examples (6) to (8), *when*-clauses denote situations that can occur prior, posterior, or simultaneously to the one expressed in the main clause.

(6) We shall make up our mind *when* the IMF has reported. [prior]
(7) They had already made breaches in the defensive wall of sand [...] *when* the order came. [posterior]
(8) I did cook occasionally, *when* they were out. [simultaneous]

The four other conjunctions are interesting because they form semantic pairs: *after* and *before* describe a temporal sequence of two events from reverse perspectives (cf. 9–10). *After*-clauses refer to an event that precedes the one expressed in the main clause, whereas *before*-clauses refer to a posterior event. The iconicity principle would thus predict that *after*-clauses precede the main clause more frequently than *before*-clauses.

(9) a. *After* her father died, of course, Isabel's trust fund included quite a substantial holding in the company. [prior]
b. I put Emily back in her own bed, *after* she'd fallen asleep. [prior]

(10) a. *Before* the debt crisis set in, Brazil was enjoying growth rates of 7 percent per year. [posterior]
b. The heat [...] from the sun is retained by the earth for a while, *before* it's radiated away. [posterior]

Quirk et al. (1985: 1082) point out that *after*- and *before*-clauses are not generally converses of one another. Both clause types have special uses in which the two constructions have different meanings. For instance, a complex sentence with a *before*-clause referring to a non-factual (or counterfactual) situation does not have the same meaning as the corresponding complex sentence with an *after*-clause (cf. 11–12); but constructions of this type are rare (examples 11–12 are the only counterfactual *before*-clauses in the entire database).

(11) a. An Asian man [...] triggered the alarm *before* I could stop him.
≠ I could stop an Asian man, *after* he triggered the alarm.

(12) a. *Before* he could move in for the tackle, Hughes had driven the ball high past Grobbelaar from 25 yards.
≠ He could move in for the tackle, *after* Hughes had driven the ball high past Grobbelaar from 25 yards.

Once and *until* parallel *after* and *before*: an adverbial clause introduced by *once* refers to a prior event, whereas an adverbial clause marked by *until* denotes a posterior situation. However, *once* and *until* differ from *after* and *before* in that they introduce adverbial clauses that are telic: *once* indicates a designated starting point of the situation expressed in the main clause and *until* marks its endpoint (cf. 13–14).

(13) a. *Once* the problem became clear, policy was tightened. [prior]
b. We'll be pretty busy *once* our course gets back into full swing. [prior]

(14) a. *Until* I'd spoken to William Davis I'd no idea that the monarchy was the only bright spot on our horizon. [posterior]

b. There should be no further cuts in interest rates, *until* the underlying rate of inflation begins to tumble. [posterior]

Note that all five conjunctions can have non-temporal meanings (cf. Quirk et al. 1985: 1078–1086). *When*-clauses may have a conditional interpretation, *after*-clauses are sometimes interpreted with a causal connotation, *before*-clauses can express a purpose or goal, *once*-clauses are often conditional, and *until*-clauses may express a combination of time, purpose, and result. However, these non-temporal semantic features are not or only weakly grammaticalized; they usually emerge as conversational implicatures from the interpretation of temporal clauses in the discourse context.[2]

2.1. *Study 1*

2.1.1. *Methods.* The analysis is based on data from the British Component of the International Corpus of English (ICE-GB). The ICE-GB corpus consists of 1 million words compiled from a wide variety of spoken and written genres. The corpus is tagged and includes detailed information about syntactic structure. For this study, I randomly selected 200 *when*-clauses, 200 *after*- and *before*-clauses (100 *after* and 100 *before*), and 200 *once*- and *until*-clauses (100 *once* and 100 *until*). Half of the data come from spoken discourse, the other half come from written genres. The study is restricted to finite adverbial clauses and disregards participle constructions and gerunds. After the initial search, I excluded all adverbial clauses that were not relevant for the purpose of the current investigation. Specifically, I excluded adverbial clauses that are inserted into the main clause (cf. 15) and adverbial clauses that do not occur with an associated main clause (cf. 16).

(15) And the reason for that before you ask me was that uhm everybody was confusing my brain.
(16) Uhm half an hour after I leave probably.

Moreover, I excluded adverbial clauses that are related to the main clause at the speech act level (cf. Hengeveld 1989). There were, for instance, several *before*-clauses that speakers used as independent speech acts to coordinate the interaction between the speech participants (cf. 17–18).

2. In some uses, the non-temporal meanings have been conventionalized as in *I would vote for Kennedy before I vote for Bush*; but constructions of this type are rare.

Table 1. *Raw frequencies*

	Spoken	Written	Total
when	94	95	189
after	47	50	97
before	41	46	87
once	48	50	98
until	49	50	99
Total	279	291	570

(17) Now before you ... uhm ... break into groups and look at the results of the two analyses and try and see what's going on ... any sort of questions?

(18) Uhm well before we get into the detailed discussion of all of this have you got something else Mary?

Since adverbial clauses of this type do not describe a sequence of two related events, they were disregarded. Table 1 shows the frequency of the five conjunctions after the irrelevant items were excluded.

All sentences were manually coded for two features: (1) the position of the adverbial clause relative to the main clause (initial ADV-clause vs. final ADV-clause), and (2) the conceptual order of main and adverbial clauses (prior ADV-clause vs. posterior ADV-clause vs. simultaneous ADV-clause). The data were separately coded by the author and a student assistant; intercoder reliability was very high, with almost 100 percent.

2.1.2. *Results.* The majority of temporal clauses follow the main clause. Overall, there are 166 initial and 404 final adverbial clauses in the data, i.e., 70.9 percent of the temporal clauses follow the main clause and only 29.1 percent precede it. Figure 1 shows the proportions of initial and final adverbial clauses expressing a prior, posterior, or simultaneously occurring event. As can be seen in the graph, 53.9 percent (N = 119) of the prior adverbial clauses precede the main clause, 22.2 percent (N = 36) of the simultaneous adverbial clauses are preposed, and only 5.9 percent (N = 11) of the posterior temporal clauses are placed before the associated main clause. There is thus a clear correlation between conceptual order and linear structure: temporal clauses denoting a prior event precede the main clause more often than temporal clauses denoting a simultaneously occurring event, which in turn are more frequently preposed to the main clause than temporal clauses of posteriority. A 2×3 χ^2-analysis

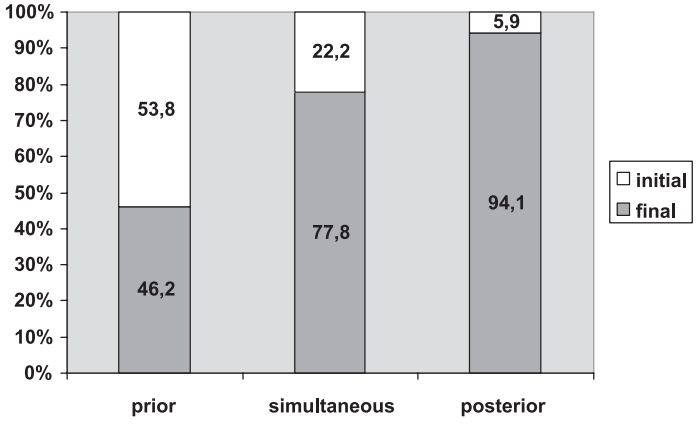

Figure 1. *Conceptual order and linear structure*

revealed that the association between conceptual order and linear structure is significant ($\chi^2 = 185.13$, $df = 2$, $p < 0.001$).

While there is a preference for an iconic clause order, it must be emphasized that a significant number of complex sentences violate the iconicity of sequence. If we disregard adverbial clauses referring to a simultaneously occurring event, there are 295 complex sentences with iconic and 113 complex sentences with non-iconic clause orders, i.e., 27.7 percent of the temporal clauses examined in this study violate the iconicity principle. Interestingly, complex sentences containing initial adverbial clauses are more consistent with the iconicity principle than complex sentences containing final adverbial clauses. As can be seen in Figure 2, if the adverbial clause precedes the main clause, 91.5 percent (N = 119) of all sentences are iconic, but if the adverbial clause follows the main clause, only 63.3 percent (N = 176) exhibit an iconic ordering ($\chi^2 = 35.25$, $df = 1$, $p < 0.001$).

Since the positioning of temporal adverbial clauses varies with the subordinate conjunction, I also examined the positional patterns of individual types of temporal clauses. As can be seen in Table 2, *when*-clauses tend to follow the main clause: 51 *when*-clauses precede the main clause and 138 *when*-clauses occur after it. The majority of the *when*-clauses denote a situation that occurs simultaneously to the one expressed in the main clause. As can be seen in this table, there are 26 prior *when*-clauses, 162 simultaneous *when*-clauses, and only 1 posterior *when*-clause.

The positioning of the *when*-clause correlates with the conceptual order: 57.7 percent of the prior *when*-clauses precede the main clause, but

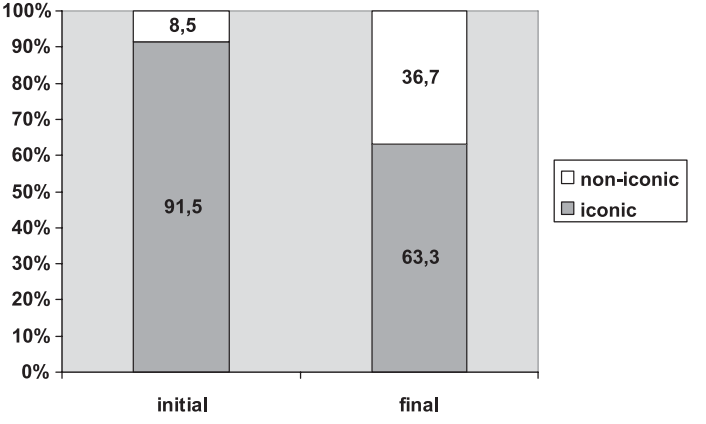

Figure 2. *Clause order and iconicity*

Table 2. When-*clauses—conceptual order and linear structure*

Linear order	Prior	Simultaneous	Posterior	Total
Initial	15	36	0	51
Final	11	126	1	138
Total	26	162	1	189

Table 3. After- *and* before-*clauses—conceptual order and linear structure*

Linear order	*after*	*before*	Total
initial	27	6	33
final	70	81	151
Total	97	87	184

only 22.3 percent of the simultaneously occurring *when*-clauses are preposed. Leaving aside the one posterior *when*-clause, a 2×2 χ^2-analysis revealed a significant association between linear structure and conceptual order ($\chi^2 = 14.26$, $df = 1$, $p < 0.001$), confirming the hypothesis that clause order is iconic.

Like *when*-clauses, *after*- and *before*-clauses tend to occur at the end of a complex sentence. As can be seen in Table 3, there are 151 final and only 33 initial *after*- and *before*-clauses in the data. Of the initial subordinate clauses, 27 are introduced by *after* and only 6 are introduced by *before*. A 2×2 χ^2-analysis revealed a significant association between clause

order and clause type ($\chi^2 = 13.66$, $df = 1$, $p < 0.001$), suggesting that the conceptual order expressed by *after* and *before* influences the ordering of main and the subordinate clauses. Note, however, that complex sentences with initial adverbial clauses are more often iconic than complex sentences with final adverbial clauses: 81.8 percent (N = 27) of the sentences with initial *after*- and *before*-clauses are iconic, but only 53.6 percent (N = 81) of the sentences with final adverbial clauses are consistent with the iconicity of sequence ($\chi^2 = 8.868$, $df = 1$, $p < 0.003$).

Interestingly, *before*-clauses functioning as independent speech acts (see examples 18–19 above) always precede the main clause: there are five *before*-clauses of this type in the data and all five clauses occur before the main clause. However, even if we include speech act *before*-clauses into the analysis, adverbial clauses marked by *after* precede the main clause significantly more often than adverbial clauses marked by *before* ($\chi^2 = 7.411$, $df = 1$, $p < 0.006$).

Finally, *once* and *until* parallel *after* and *before* in that they indicate a temporal sequence between two situations: *once*-clauses are conceptually prior to the event in the main clause, while *until*-clauses denote a posterior situation. However, the distributional contrast between *once* and *until* is much more pronounced than the distributional contrast between *after* and *before*. As can be seen in Table 4, 77 *once*-clauses precede the main clause but only 5 *until*-clauses are preposed. A 2×2 χ^2-analysis revealed that the distributional difference between *once* and *until* is highly significant ($\chi^2 = 109.56$, $df = 1$, $p < 0.001$). Once again, the iconicity principle is more consistent with complex sentences containing initial adverbial clauses than with complex sentences containing final adverbial clauses: 93.9 percent (N = 77) of the initial adverbial clauses occur in complex sentences that are iconic, but only 81.7 percent (N = 94) of the final adverbial clauses are embedded in an iconically structured sentence ($\chi^2 = 6.182$, $df = 1$, $p < 0.013$).

To summarize, we have seen that the positioning of temporal adverbial clauses varies with conceptual order: temporal clauses denoting a prior event precede the main clause significantly more often than temporal clauses denoting a simultaneous event, which in turn are more frequently

Table 4. Once- *and* until-*clauses—conceptual order and linear structure*

Linear order	*once*	*until*	Total
initial	77	5	82
final	21	94	115
Total	98	99	197

preposed to the main clause than temporal clauses of posteriority. The analysis suggests that iconicity of sequence has a significant effect on the positioning of temporal adverbial clauses in English. However, the data also reveal that the iconicity principle cannot be the sole determinant of the sequential structuring of complex sentences because 27.3 percent of the sentences examined in this study do not have an iconic clause order; that is, more than a quarter of all sentences violate the iconicity of sequence. Moreover, the iconicity principle does not explain why complex sentences with initial adverbial clauses are more often iconic than complex sentences with final adverbial clauses (cf. Figure 2), and why the positioning of the temporal adverbial clause varies with the subordinate conjunction. For instance, although both *after* and *once* introduce prior adverbial clauses, *once*-clauses precede the main clause more often than *after*-clauses (cf. Tables 2 and 3). In order to account for these findings, we have to include additional factors into the analysis. The second study was designed to investigate the combined effect of the iconicity principle and other factors influencing clause order in English.

2.2. *Study 2*

Based on the previous research (see Section 1.1.), we may hypothesize that in addition to iconicity of sequence the following factors are relevant for the positioning of temporal adverbial clauses:

1. The semantic relationship between main and adverbial clauses. Complex sentences containing temporal adverbial clauses often imply a conditional, causal, or purposive relationship (see above). Since conditional clauses tend to precede the main clause, while causal and purpose clauses usually follow it, it is a plausible hypothesis that the positioning of temporal adverbial clauses is affected by their implicit meanings. This may account for the distributional differences between *once*-clauses, which are often conditional, and *after*-clauses, which can be causal.
2. The length of the adverbial clause. It is well-known that heavy constituents tend to occur sentence-finally (Behaghel 1932). There are two explanations for this: information structure and syntactic parsing (see Wasow 2002 for a review of the literature). In the discourse-pragmatic literature it is commonly assumed that given information tends to precede new information because new information needs to be grounded in information that is already known to the hearer. Since new information needs more explicit coding than given information, long constituents tend to occur at the end of a sentence (cf. Dik 1989: 351). Alternatively, Hawkins (2004: 104–108) argued that

right-branching languages like English tend to place long constituents at the end of the sentence because the order short-before-long is easier to parse than the reverse ordering (see above). Since adverbial clauses are heavy constituents it is a plausible hypothesis that the predominance of final temporal clauses results from the weight of these constructions. Moreover, we may assume that temporal clauses preceding the main clause tend to be shorter than temporal clauses that follow it (cf. Diessel 2005).

3. The complexity of adverbial clauses. Hawkins (1994, 2004) argued that constituent order is crucially affected by the structural complexity of linguistic elements. Specifically, he claimed that in right-branching languages like English, syntactically complex structures tend to occur sentence-finally because in final position they are easier to parse. Since adverbial clauses can vary in terms of their complexity, we may assume that initial temporal clauses are structurally less complex than final adverbial clauses.

2.2.1. *Methods.* In order to test these hypotheses, I conducted a binary logistic regression analysis, in which all of the above mentioned factors are taken into account. Logistic regression analysis is an extension of ordinary regression analysis, in which the dependent variable is categorical (rather than continuous as in ordinary regression analysis) (cf. Tabachnik and Fidell 2004: Ch 12; Backhaus et al. 2006: Ch 7). The goal of binary logistic regression analysis is to predict the value of the dichotomous dependent variable from one or more predictor variables that can be continuous, discrete, dichotomous, or a mix of them (cf. Tabachnik and Fidell 2004: 517; Backhaus et al. 2006: 428).[3] In the current study, logistic re-

3. Logistic regression analysis involves the same formula as ordinary regression analysis except that the dependent variable is expressed by the natural logarithm of the odds, i.e., $\ln(p/1-p) = a + bx$. The odds provide a probability measure that is defined as the ratio of the probability that an event A will occur and the probability that the event A will not occur, i.e., odds $= P(A)/1 - P(A)$. The odds must be distinguished from simple probabilities. For instance, in a corpus of a 100 complex sentences with 40 initial adverbial clauses and 60 final adverbial clauses, the odds of randomly selecting an initial adverbial clause are $40/60 = 0.666$, and the odds of randomly selecting a final adverbial clause are $60/40 = 1.5$. By contrast, the probability of selecting an initial adverbial clause is 0.4 and the probability of selecting a final adverbial clause is 0.6. Probability values increase linearly, but the odds increase exponentially (cf. $10/90 = 0.11$, $20/80 = 0.25$, $30/70 = 0.43$, $40/60 = 0.66$, $50/50 = 1$, $60/40 = 1.5$, $70/30 = 2.3$, $80/20 = 4$, $90/10 = 9$, $95/5 = 19$, $99/1 = 99$). The natural logarithm of the odds transfers the exponential curve into a symmetrical S-curve which defines the two outcomes of a binary logistic regression analysis (cf. Tabachnik and Fidell 2004: Ch 7; Backhaus et al. 2006: Ch 7).

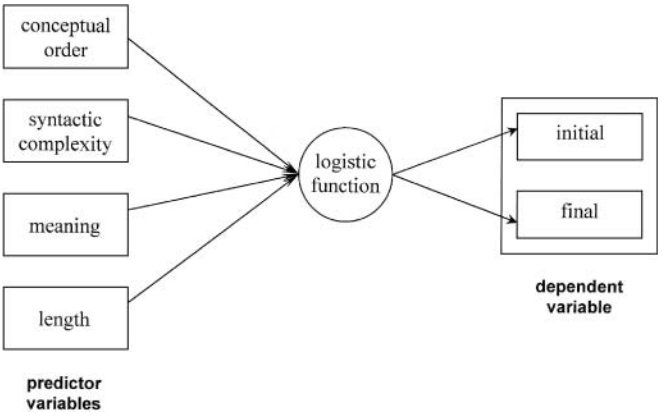

Figure 3. *Research design*

gression analysis was used to predict the position of the adverbial clause (i.e., initial or final) from the following set of predictors: conceptual order (i.e., iconicity), meaning, length, and syntactic complexity. Figure 3 shows the research design.

Conceptual order and syntactic complexity were coded as dichotomous variables: adverbial clauses denoting a prior event were distinguished from adverbial clauses denoting a posterior or simultaneously occurring event, and simple adverbial clauses consisting of a single clause were distinguished from complex adverbial clauses containing another subordinate clause. Meaning was coded as a discrete variable with three levels: (i) purely temporal, (ii) temporal with an implicit conditional meaning, and (iii) temporal with an implicit causal or purposive meaning. Finally, length was coded as a continuous variable, measured by dividing the number of words in the adverbial clause by the total number of words in the complex sentence.[4] For all features, intercoder reliability was at least 95 percent.

2.2.2. *Results.* Table 5 shows the raw frequencies of the categorical predictors, i.e., conceptual order, complexity, and meaning, and Figure 4 shows the histograms of the continuous predictor, relative length (i.e., the ratio of adverbial clause/complex sentence), for final and initial temporal clauses.

4. For instance, if the adverbial clause consists of 6 words and the complex sentence of 13 words, the relative length of the adverbial clause is $6/13 = 0.4615384$, i.e., 46.15 percent.

Table 5. *Frequencies of the categorical predictor variables*

VARIABLE	LEVEL	INITIAL	FINAL	TOTAL
Conceptual order	1. posterior/simultaneous	47	302	349
	2. prior	119	102	221
Complexity	1. simple	138	309	447
	2. complex	28	95	123
Meaning	1. purely temporal	89	299	388
	2. conditional	76	52	128
	3. causal/purposive	1	53	54

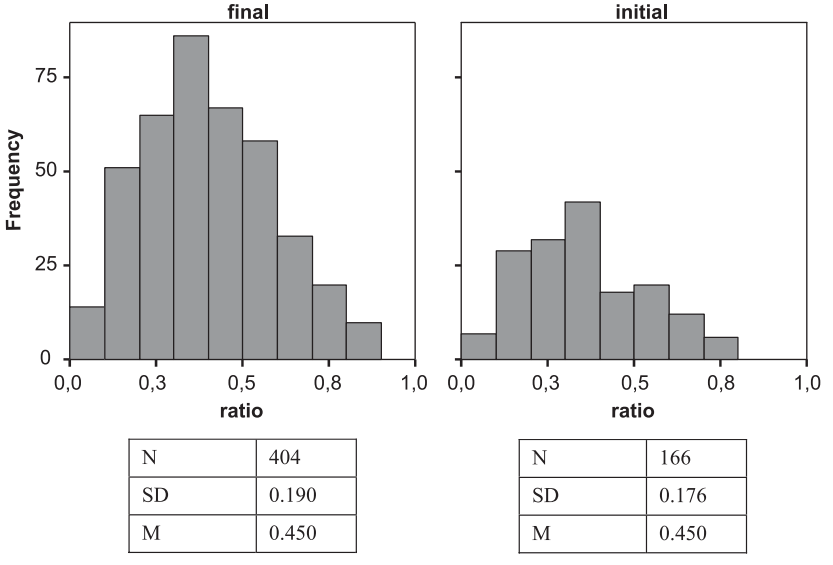

Figure 4. *Frequency of the relative length of initial and final temporal clauses*

Note that the frequency distributions are consistent with the proposed hypotheses: prior temporal clauses precede the main clause on average more often than posterior and simultaneous temporal clauses. In addition, Table 5 shows that simple adverbial clauses are more often preposed to the main clause than complex adverbial clauses (i.e., adverbial clauses including another subordinate clause), and that temporal clauses with an implicit conditional meaning tend to precede the main clause, whereas temporal clauses with an implicit causal or purposive meaning almost always follow it. The histograms show that the average relative length of final temporal clauses is greater than the average relative length of initial adverbial clauses, but the difference is small: if the adverbial clause fol-

lows the main clause the mean relative length of the adverbial clause is 45 percent, and if the adverbial clause precedes the main clause the mean relative length of the adverbial clause is 40.5 percent of the entire sentence. In order to test if and to what extent these asymmetries are relevant for the positioning of temporal adverbial clauses, I conducted a stepwise logistic regression analysis starting with the maximal model in which all predictor variables and their interactions are included in the regression. This model is compared to the null (or empty) model in which none of the predictor variables is included (cf. Tabachnik and Fidell 2004: Ch 12; Backhaus et al. 2006: Ch 7). In the current study, the maximal model was significantly different from the null model, indicating that the predictors as a group reliably distinguish between initial and final position. However, since the interactions between the various predictor variables were not significant, they were excluded from the model (cf. Crawley 2005: 104). In the next step, I computed a regression model including only the predictor variables without their interactions. In this model, three of the predictor variables turned out to be significantly related to the dependent variable, i.e., conceptual order, meaning, and length. Since syntactic complexity was not significantly related to clause order, it was removed from the regression model. The resulting minimally adequate model fit the data significantly better than the null model ($\chi^2 = 174.69$, $df = 4$, $p < 0.001$) and had almost the same explanatory power (Nagelkerke's $R^2 = 0.38$) as the maximal model (Nagelkerke's $R^2 = 0.39$). The overall prediction accuracy increased from 70.9 percent in the null model to 80 percent in the minimally adequate model, which is a reasonable improvement given that prediction accuracy can only increase if the model correctly predicts some of the initial adverbial clauses (which account for only 29.1 percent of the data).

As in ordinary multiple regression analysis, regression coefficients indicate the effect of the individual predictor variables on the outcome; but since the regression coefficients of logistic regression analysis are difficult to interpret, they are commonly transformed into odds ratios, which is a measure of effect size that indicates the likelihood of a particular outcome to occur.[5] Table 6 provides a summary of the analysis of the predictor variables in the minimally adequate model.

5. Odds ratios are calculated by dividing the odds of an event occurring by the odds of another event occurring. For instance, if 65 percent of the days during one year are sunny and 35 percent are rainy, the odds of a sunny day are 1.86 and the odds of a rainy day are 0.54 and the odds ratio (sunny/rainy) is 3.43, which means that a sunny day is 3.43 times more likely to occur than a rainy day.

Table 6. *Results of the logistic regression analysis*

Factor	reg. coef. B	Wald χ^2	df	p	odds ratio	lower CI	upper CI
Conceptual order	1.902	73.69	1	0.001	6.70	4.34	10.35
Meaning		41.07	2	0.001			
a. causal/purpose	−2.775	7.27	1	0.007	0.06	0.01	0.469
b. conditional	1.364	31.20	1	0.001	3.91	2.42	6.31
Length	−1.343	7.39	1	0.001	0.19	0.06	0.63

The regression coefficients indicate the direction of change induced by a particular predictor: positive values (which correspond to odds ratios larger than 1.0) indicate that the predictor variable increases the likelihood of the adverbial clause to precede the main clause; negative values (which correspond to odds ratios smaller than 1.0) indicate that the predictor variable decreases the likelihood of the adverbial clause to precede the main clause. The Wald χ^2-values and the associated levels of significance indicate that the predictor variables (conceptual order, meaning, and length) are significant. The odds ratios show the change in odds for an adverbial clause to be placed in initial position. For instance, the odds ratio for conceptual order indicates that for adverbial clauses denoting a prior event the odds of preceding the main clause are 6.7 times larger than the odds for adverbial clauses denoting a posterior or simultaneous event. The two final columns show the lower and upper boundaries of the confidence intervals for the odds ratios (cf. Backhaus et al. 2005: 475–476).

Note that conceptual order and conditional meaning increase the likelihood of the adverbial clause to precede the main clause (compared to posterior/simultaneous temporal clauses with purely temporal meaning), whereas a causal/purposive meaning and an increase in length decrease the likelihood of the adverbial clause to precede the main clause (compared to purely temporal clauses that are shorter). Note also that conceptual order, i.e., the encoding of a prior event, is the strongest predictor for the initial occurrence of a temporal adverbial clause.

Since the positioning of temporal adverbial clauses varies with the subordinate conjunction (see above), I also computed regression models for individual types of temporal clauses. Specifically, I developed three separate logistic regression models for *when*-clauses, *after*- and *before*-clauses, and *once*- and *until*-clauses using the same stepwise procedure as in the model described above (Table 7 in the Appendix provides a summary of the frequency data). Interestingly, while conceptual order had a significant effect on the positioning of all temporal clauses (*when*: $\chi^2 = 12.149$,

$df = 1$, $p < 0.001$; *after/before*: $\chi^2 = 14.504$, $df = 1$, $p < 0.001$; *once/until*: $\chi^2 = 32.285$, $df = 1$; $p < 0.001$), meaning and length were only significant for certain types of temporal clauses, suggesting that the effect of conceptual order is more consistent across clause types than the effect of the other predictor variables. Meaning was significant for the positioning of conditional *once*- and *until*-clauses ($\chi^2 = 6.491$, $df = 1$; $p < 0.011$) and marginally significant for the positioning of causal/purposive *after*- and *before*-clauses ($\chi^2 = 3.601$, $df = 1$; $p < 0.061$); but although *when*-clauses were often used with an implicit conditional meaning, conditionality did not affect their position ($\chi^2 = 9.546$, $df = 1$; $p < 0.010$). Length was only significant for *once*- and *until*-clauses ($\chi^2 = 6.491$, $df = 1$; $p < 0.011$), but not for *when-, after-*, and *before*-clauses (*when*: $\chi^2 = 2.000$, $df = 1$, $p > 0.157$; *after/before*: $\chi^2 = 0.398$, $df = 1$, $p > 0.528$).

3. Discussion

The analysis suggests that iconicity of sequence has a strong and consistent effect on the linear structuring of complex sentences with temporal adverbial clauses. Temporal clauses referring to a prior event precede the main clause more often than temporal clauses expressing a simultaneously occurring event, which in turn precede the main clause more often than temporal clauses of posteriority. The iconicity of sequence is in accordance with both complex sentences in which the conceptual order of main and adverbial clauses is encoded by the subordinate conjunction (i.e., *after-, before-, once-*, and *until*-clauses) and complex sentences in which the conceptual order is inferred from the meaning of the whole sentence because the conjunction itself does not express a particular order (i.e., *when*-clauses). In both types of sentences, clause order correlates with conceptual structure: *after*- and *once*-clauses, referring to a prior event, precede the main clause significantly more often than *before*- and *until*-clauses, denoting a posterior situation, and *when*-clauses referring to a prior event are more frequently preposed to the main clause than *when*-clauses denoting a posterior or simultaneously occurring event. The analysis also revealed that complex sentences including initial adverbial clauses are more consistent with the iconicity principle than complex sentences including final adverbial clauses: while complex sentences with initial adverbial clauses are almost always iconic, more than one third of all complex sentences with final adverbial clauses violate the iconicity of sequence.

Another factor that correlates with the positioning of temporal adverbial clauses is their implicit meaning. About one third of all adverbial clauses examined in this study imply a conditional, causal, or purposive

relationship between the events expressed by main and subordinate clauses. Like ordinary conditional clauses, temporal clauses with an implicit conditional meaning tend to precede the main clauses, and like ordinary causal and purposive clauses, temporal clauses with an implicit causal or purposive meaning almost always follow it. This may explain why *once*- and *after*-clauses differ in their distribution: although both types of adverbial clauses denote a prior event, *once*-clauses, which are often conditional, precede the main clause more often than *after*-clauses, which are frequently used with an implicit causal meaning. Note that in the logistic regression analysis the meaning of the adverbial clause had less predictive power than iconicity of sequence. Moreover, the analysis showed that while the iconicity principle influenced all temporal clauses, the implicit meaning was only relevant for certain types of temporal clauses.

Apart from conceptual order and implicit meaning, the length ratio of main and adverbial clauses was a significant predictor of clause order. The analysis revealed that initial temporal clauses account for a smaller proportion of the overall length of the complex sentence than final adverbial clauses, i.e., adverbial clauses that precede the main clause are shorter than adverbial clauses that follow it; but since the difference was relatively small, length had only a small effect on the positioning of the adverbial clause. In the conjunction-specific analyses, *once*- and *until*-clauses were the only adverbial clauses for which the length ratio was a significant predictor.

Why do these factors influence the positioning of temporal adverbial clauses? I suggest that all of the factors examined in this study are relevant for clause order because they influence the processing of complex sentences. Specifically, I claim that iconicity of sequence, which is commonly characterized as a semantic principle, can be interpreted as a processing principle that contributes to the overall processing load of a complex sentence construction because a non-iconic clause order is difficult to plan and to interpret. As Givón (1985: 189) put it: "All other things being equal, a coded experience is easier to *store, retrieve* and *communicate* if the code is maximally isomorphic to the experience" (emphasis is the original). There are several experimental studies supporting this view. For instance, Ohtsuka and Brewer (1992) found that iconic sentences combined by *next* are easier to understand and to remember than non-iconic sentences combined by *before*, and Clark (1971) found that English-speaking children have fewer difficulties to understand *before*- and *after*-clauses if clause order is iconic (see also Carni and French 1984; Clark 1973; Coker 1978; Diessel 2004; Ferreiro and Sinclair 1971; Trosborg 1982). Assuming that non-iconic orders are difficult to plan

and to interpret, it is a plausible hypothesis that complex sentences tend to be iconic because speakers prefer linguistic structures that are easy to process.

Like iconicity, the meaning of the adverbial clause is relevant for the processing of the complex sentence. In particular, conditional clauses put a particular constraint on the processing of complex sentences. As I have argued in Diessel (2005), conditional clauses provide a particular conceptual framework for the interpretation of the semantically associated clause. More precisely, the conditional clause indicates that the main clause is a hypothetical statement that is contingent on the realization of the event expressed in the subordinate clause. If the conditional clause precedes the main clause, it is immediately obvious that the sentence describes a hypothetical situation, but if the conditional clause follows the main clause the hearer may at first misinterpret it as a factual statement. Since the reanalysis of previous clauses is difficult to process, conditional clauses tend to occur at the beginning of the sentence or their occurrence is announced in the initial main clause by intonation or a subjunctive verb form.

In addition to the meaning, the pragmatic function can influence the positioning of adverbial clauses. As has been repeatedly argued in the literature, initial and final adverbial clauses serve different discourse-pragmatic functions. While final adverbial clauses are commonly used to provide new information or to spell out information that was pragmatically presupposed in the preceding main clause, initial adverbial clauses are commonly used to provide a thematic ground that facilitates the semantic processing of subsequent clauses (see Section 1.1. for relevant references). Moreover, we may assume that causal clauses typically follow the main clause because causal clauses are commonly used to back up a previous statement, i.e., the final occurrence of causal clauses is a consequence of the fact that causal clauses are often embedded in a particular discourse routine (cf. Diessel 2006; see also Diessel 2004: Ch 7, who discusses the discourse function of causal clauses in early child language).

Finally, length is an important factor for the processing of complex sentences because the length of constituents defines the recognition domain (see above). Adopting Hawkins' parsing theory, we may assume that final adverbial clauses are easier to parse than initial adverbial clauses because complex sentences with final adverbial clauses have a shorter recognition domain than complex sentences with initial adverbial clauses. This explains the predominance of final adverbial clauses in English. Note that in left-branching languages like Japanese adverbial clauses are often consistently placed before the main clause because in this language type complex sentences are easier to process if the adverbial

clause occurs at the beginning of the sentence (cf. Diessel 2001, 2005). However, in right-branching languages like English, final position is the default and the initial occurrence of adverbial clauses is motivated by competing processing forces.

Adopting an incremental model of sentence comprehension in which the overall processing load of linguistic structures is determined by the cumulative effect of syntactic, semantic, and other processing constraints (cf. MacDonald et al. 1994), we may assume that speakers tend to avoid structures in which the overall processing load exceeds a certain level. This may explain why iconicity of sequence exerts a particularly strong effect on complex sentences with initial adverbial clauses. Since the combined effect of the initial position of the adverbial clause (which is difficult to parse) and the occurrence of a non-iconic clause order (which is difficult to conceptualize) can raise the overall processing load to a very high level, speakers seek to avoid the use of non-iconic clause orders in complex sentences with initial adverbial clauses. Put differently, if the adverbial clause follows the main clause there is less processing pressure to use an iconic clause order because complex sentences with final adverbial clauses are easier to parse; there is thus more tolerance in complex sentences with final adverbial clauses for the increased processing load that arises from the violation of the iconicity principle.

In sum, this paper has shown that the positional patterns of temporal adverbial clauses are consistent with the hypothesis that clause order in complex sentences is usually iconic. While iconicity of sequence is often characterized as a semantic factor, it can be seen as a processing principle that is especially relevant for complex sentences with initial adverbial clauses because these structures are difficult to parse, so that speakers seek to limit the overall processing load by using an iconic clause order.

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Appendix

Table 7. *Position, length, conceptual order, and implicit meaning*

		CONCEPT ORDER		*MEANING*			LENGTH MEAN PROP.
		+prior	−prior	temp.	caus.	cond.	
WHEN	initial	15	36	31	—	20	0.425
	final	11	127	95	4	39	0.472
AFTER/BEFORE	initial	27	6	32	2	—	0.388
	final	70	81	128	20	2	0.412
ONCE/UNTIL	initial	77	5	24	—	57	0.359
	final	21	94	78	28	10	0.498

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