Three-verb clusters in Interference Frisian: a stochastic model

0. Abstract

Interference Frisian (IF) is a variety of Frisian, spoken by mostly younger speakers, which is heavily influenced by Dutch. IF exhibits all six logically possible word orders in a cluster of three verbs. This phenomenon has been researched by Koeneman & Postma (2006) who argue for a parameter theory which leaves frequency differences between various orders unexplained. Rejecting K&P’s parameter theory but accepting their conclusion that Dutch (and Frisian) data are input for the grammar of IF, we will argue that the word order preferences of speakers of IF are determined by frequency and similarity. More specifically, 3-verb clusters in IF are sensitive to:

(i) their linear left-to-right similarity to 2-verb clusters and 3-verb clusters in Frisian and in Dutch
(ii) the (estimated) frequency of 2- and 3-verb clusters in Frisian and Dutch.

The estimated frequencies are reasonable enough in themselves, but our model will be shown to not crucially depend on them. If different estimates are taken, the model’s predictions do not change substantially, testifying to its robustness. This analysis is in line with recent ideas that the sequential nature of human speech is more important to syntactic processes than commonly assumed, and that less burden need be put on the hierarchical dimension of syntactic structure.

1. Introduction

1.1. Hierarchy and linearity in verb clusters

Germanic languages (as many others) have the possibility to have various verb forms in a sentence, to express temporal, modal or other aspects of the sentence’s main verb. In so-called Object-Verb-languages, such as German, Dutch and Frisian, these verbs are clustered towards the end of the sentence, except for the finite verb in main clauses, that appears in the so-called Verb-Second position. A typological overview of various contemporaneous and historical varieties of Germanic can e.g. be found in Gerritsen (1984:111). A typical example from Dutch would be:

(1) *Wij zouden dit artikel eerder af hebben kunnen maken.*

We should this article earlier off have can make

‘We might have finished this article earlier’

Generative grammar assigns a hierarchical representation to syntactic structures including verb clusters. The classical generative analysis of verb clusters proposes that the basic order in Dutch is left-branching
(Evers 1975 and many subsequent publications). The order of the cluster *hebben kunnen maken* is produced through a process called Verb Raising, which derives the order in (1) from its underlying mirror image. For a brief overview of problems with this analysis, see Zwart (2011:304-311). Some more recent generative analyses have proposed that the underlying order is head-initial, and that the head-final orders have been derived by movement (for example Kaan 1992:111, Zwart 1993: 336 and subsequent work).

Verb clusters of three verbs have six logically possible word orders. Barbiers & Bennis (2010) studied the variation in word order within such clusters in Dutch and Frisian dialects and found that some orders are rare or even absent. They explain this variation by assuming a hierarchical structure within the cluster (idem: 31). They conclude:

"[…] dat het er op lijkt dat niet alleen de hiërarchische ordening moet worden behouden bij clusterformatie […] maar ook dat de onderlinge hiërarchische volgorde moet terugkomen in de lineaire volgorde […]. (idem: 40)

([…] that it appears to be the case that not only the hierarchical order should be maintained in cluster formation […] but also that the hierarchical order has to be reflected in the linear order […]"

Following their account, only the primary left-branching or the entirely mirrored order, the consequence of complete verb-raising, are syntactically really verbal clusters. Other options are in their account either impossible or the result of a reinterpretation of e.g. participles as non-verbal elements in the sentence. In their view, the surfacing linear order is the result of forces and mechanisms that take place in an underlying, hierarchically organised structure.

Some linguists, many of whom are more computationally oriented, propagate a rather different approach to word order in general, including the order in verb clusters. A central role is assigned to the sequential character of the speech signal, which limits the input for new learners to linearly organised language material and which is the ultimate output format. That changes the role of hierarchical structures from primary governing structures to potential structures, emerging from the analysis and interpretation of linear information, with no other goal than to be able to produce new sequential language utterances. As a consequence of the arbitrary habit in European languages to represent the temporal order of the speech signal as a left-to-right sequence, we consider a left-to-right processing of language sequences as the logical, relevant order. Solan et al. (2005) presents an unsupervised algorithm that is capable of learning complex syntax, including hierarchical structures. Most importantly, it works with raw text or transcribed speech and does not require corpora tagged with part-of-speech information. Here the linearity of both language learning and speech production is primary and abstract hierarchies are only needed to control long-distance dependencies. A somewhat different approach can be found in Bod (2009), where linear input data is parsed to recover potential hierarchical structures of sentences, assuming “that the language faculty has prior knowledge about constituent structure, but no more than that”. (idem: 786). Both
approaches are similar in the sense that the input data is primarily linear and hierarchical structures are only retrieved as far as deducable from statistical linear neighbourhood relations and not from a priori inherent hierarchical syntactic structures.

In Frank et al. (2012), Bod and colleagues seem to go a step further, explicitly asking the question: “How hierarchical is language use?” They claim that, for example, a structure such as auxiliary fronting (in English questions such as ‘Is the man hungry’), which is often claimed to be unlearnable without taking hierarchical dependencies into account “can be learned from sequential sentence structure alone by using a very simple, non-hierarchical model from computational linguistics: a Markov (trigram) model” (idem: 4).

… we argue here that hierarchical structure rarely needs to play a significant role in language comprehension. (Frank et al. 2012: 4526)

We would therefore predict that the processing of constructions should be unaffected by their possible internal structure. That is, constructions with alleged hierarchical structure […] should be processed in a non-compositional manner similar to linear constructions […], which are generally agreed to be stored as whole chunks. Only the overall familiarity of the specific construction should affect processing. (Frank et al. 2012: 4527)

Although they do not reject the hierarchical structure of linguistic data, they take the sequential structure as fundamental to human language processing. In our paper, we do not go deeper into the fundamentals of this discussion, but want to show that linearity is indeed highly relevant to processing in a way that can be quite accurately specified. We do that by showing that both the qualitative and the quantitative variation (frequency of occurrence) in verbal clusters in the Interference Frisian speech of Frisian-Dutch bilinguals can be easily understood, if we assume that these speakers produce their sentences on the basis of a Markov chain, a probabilistic linear analysis of the various input sequences. The observed output is explained without recourse to an underlying, hierarchical structure and the concomitant movement or raising operations. It must be added that this linear explanation is based on data reflecting the linguistic competence of language learners who have imperfectly mastered their first language. Hence this explanation does not necessarily apply to ‘normal’ language learners, that is, those who have fully mastered their language. All informants came from families in which both parents spoke Frisian. However, Dutch is prominently present in all walks of life, including education and the media, and Dutch has more social status than Frisian. As a result, the scenario of imperfect learning is the default for the younger generations of speakers, even though they have Frisian as their mother tongue.

1.2. A generative analysis of verb clusters in Interference Frisian

Interference Frisian, henceforth IF, is a variety of Frisian spoken by younger speakers and heavily influenced by Dutch (Breuker 1993, De Haan 1997 and others). Even when we use the term IF here, it is
not a stabilised, established variety of Frisian, rather a container term for a range of Frisian language utterances that show more or less extensive impact from Dutch. Koeneman & Postma (2006), henceforth K&P, studied the phenomenon of word order in the verbal cluster in IF. A group of secondary school pupils was asked to provide their grammaticality judgments about a number of test sentences involving verb clusters of three verbs. These clusters invariably contained a finite auxiliary of the perfect tense as their first verb, a modal as their second verb, and a main verb as their third verb. In representing verb order, K&P used the notation of Stroop (1970) according to which numbers represent selectional relations between verbs. An example has been provided below from Dutch:

(2)  

\[ \begin{array}{cccc}
\text{Omdat} & \text{de vandaal} & \text{zijn mes niet} & \text{heeft} \\
\text{wollen} & \text{inleveren.} \\
1 \text{FIN} & 2 \text{MOD} & 3 \text{MAIN} \\
\end{array} \]

because the vandal his knife not has want in.hand

‘Because the vandal didn’t want to hand in his knife.’

The highest verb in the syntactic tree, the finite verb of the perfect tense, has been assigned the number 1 (\textit{heeft} ‘has’), the modal selected by the finite verb has been assigned the number 2 (\textit{wollen} ‘want’) and the verb selected by 2 has been assigned the number 3, which is the main verb \textit{inleveren} ‘hand in. The test sentences involved subordinate clauses, since the finite verb ‘moves’ out of the verb cluster in main clauses due to verb-second. Stroop’s notation is shorthand for hierarchical and linear position. For the sake of clarity, we added to Stroop’s notation mnemonic abbreviations glossing the type of verb: FIN for ‘finite verb’, MOD for ‘non-finite modal’, and MAIN for ‘main verb’.

Dutch verbal clusters of the type illustrated by (2) systematically have the hierarchically higher verb in a position more to the left. Their equivalents in Standard Frisian (henceforth Frisian) are the exact mirror image. In the example below from Frisian, the hierarchically higher verb occupies a position more to the right:

(3)  

\[ \begin{array}{cccc}
\text{Omdat} & \text{de fandaal} & \text{syn knyft net} & \text{ynleverje} \\
\text{ynleverje} & \text{wollen} & \text{hat.} \\
3 \text{MAIN} & 2 \text{MOD} & 1 \text{FIN} \\
\end{array} \]

because the vandal his knife not in.hand want has

‘Because the vandal didn’t want to hand in his knife.’

The choice for Stroop’s notation has the effect that the number 2 is not associated with uniform interpretations across clusters of two and three verbs. To make this clear, compare a 2-verb cluster to a 3-verb cluster (examples from Dutch):

(4)  

\[ \begin{array}{cccc}
\text{Omdat} & \text{de vandaal} & \text{zijn mes niet} & \text{heeft} \\
\text{wollen} & \text{inleveren.} \\
1 \text{FIN} & 2 \text{MOD} & 3 \text{MAIN} \\
\end{array} \]

because the vandal his knife not has want in.hand

‘that the vandal didn’t want to hand in his knife.’
The verb marked 2 is a modal in the three-verb cluster in (4): the verb marked 2 is not the main verb in a three-verb cluster, by definition. In a two-verb cluster, the situation is different. The verb marked 2 is the main verb in a two-verb cluster as in (5); it is not a modal selecting a main verb. Thus the interpretation of the verb marked 2 is not uniform across clusters: it is a modal auxiliary in a three-verb cluster, whereas it is the main verb in a two-verb cluster. We will come back to this point below, because it is relevant to our view according to which two- and three-verb clusters in Dutch and Frisian influence three-verb clusters in IF.

The verb cluster facts of IF can be summarised by the statement that all word orders that are logically possible are accepted by some of its speakers, though some orders are accepted by significantly more IF speakers than others (see 2.1 for more information about the data). In order to account for these data, K&P propose that Dutch sentences are input for parameter resetting of Frisian, thus causing a change from Standard Frisian to IF. The parameters responsible for deriving linear order in the verb cluster are cited below (K&P:131):

\[
\begin{align*}
P1: & \quad 1 > 2 \\
P2: & \quad 2 > 3 \\
P3: & \quad 1 > 3
\end{align*}
\]

K&P assume that language learners may only change one parameter at a time. If language learners would be allowed to change all parameters at once, then it would be predicted that they change their clusters in one swoop from Standard Frisian 321 (MAIN-MOD-FIN) to Standard Dutch 123 (FIN-MOD-MAIN), given K&P’s assumption that Dutch clusters are input for parameter change. Thus they would counterfactually predict the absence of hybrid orders, that is, orders displaying a mix of the Frisian and the Dutch order. Such hybrid orders are ungrammatical in both Standard Dutch and Standard Frisian. All logically possible hybrids can be explained with help of the assumption that only 1 parameter is changed at a time. Thus 321 can be changed to 231, as it requires one change only, but not to 123, as the latter change requires more than one change in parameter setting. A second parameter may only be changed after a certain amount of time (left unspecified) has elapsed. This is K&P’s analysis, in a nutshell.

Two points of criticism are relevant in the light of the account to be proposed in the course of this article. First, K&P’s analysis does not explain that the six word orders that actually occur have different acceptance rates, nor can they explain that there is a system in the variation in acceptance rates (see table 1
of section 2.1). In our view, an adequate model not only predicts the kind of variation, but also the degree of variation.

Our second point of criticism concerns the interpretation of the 2 (standing for the hierarchically second verb) in clusters of two and three verbs. The interpretation of the 2 is not the same for clusters of two verbs as compared to clusters of three verbs. Apart from its conceptual inadequacy, this wavering in the interpretation of the 2 is relevant for an auxiliary hypothesis of K&P, which they introduce to account for the rareness of clusters with the ordering 213 (MOD-FIN-MAIN) and 231 (MOD-MAIN-FIN). It turns out that these two orders hardly ever occur in the West Germanic dialect continuum, and they are only rarely accepted by speakers of IF. In order to account for the rareness of these orders, K&P suggest that P1 (1>2) has been changed already on the basis of clusters with two verbs. Changing P1 first (1>2) prevents the derivation of the orders 231 and 213. Thus IF would already feature sentences of the type illustrated below before the order is changed in clusters with three verbs:

\[
\begin{align*}
(7) & \quad \text{Omdat} \quad \text{de fandaal} \quad \text{it kryft} \quad \text{wol} \quad \text{ynleverje}. \\
& \quad \text{because} \quad \text{the vandal} \quad \text{the knife} \quad 1 \text{ FIN} \quad 2 \text{ MAIN} \\
\end{align*}
\]

‘Because I see him arrive.’

The problem with this account is that the interpretation of the 2 is not the same in clusters with two verbs as compared with clusters of three verbs. The 2 is a modal auxiliary in clusters of three verbs, whereas it is the main verb in clusters of two verbs. This is highly unusual for generative theory, which relies on semantically uniform structures across languages which are manipulated by parameters in order to derive surface differences of the type discussed here. From a purely linear point of view, it is much less surprising that the 2 is defined in a way that is less or not concerned with the hierarchical or semantic nature of the verb. Basically, K&P covertly have a purely linear interpretation of the 2, which goes against the spirit of the framework which they are working in. In fact, we will make better sense of this aspect of their analysis by fleshing it out in more detail and incorporating it into a linear analysis of verb clusters. More specifically, we follow K&P in assuming that the order in clusters of two verbs has effect on the order in clusters of three verbs.

1.3. Road map

Our article is structured as follows. Section 2 presents the word order data of three-verb clusters in IF, which have been taken from K&P. It is shown that there is more systemacity to the data than K&P have supposed. More specifically, there is a system in the acceptance rates with which each word order is associated, a point which K&P overlooked, in part because their analysis does not lead them to expect the possibility of a correlation between a type of word order and its frequency. Data analysis also makes it clear that there is a correlation between the frequency of individual word orders in IF and their left-to-right similarity to the word orders of 2-verb and 3-verb clusters in Frisian and Dutch. Section 3 presents a formalisation of these analytical insights in the form of a statistical Markov Chain model in the spirit of
Zipf (1935, 1949 and subsequent work) which is shown to correctly derive the word orders and their associated frequencies. Section 4 tests the model’s robustness for different underlying assumptions.

2. Word order in the verbal cluster

2.1. Data

Verb clusters of three verbs have six logically possible word orders. K&P reported informants’ judgments about the acceptability of these six orders. We will interpret the degree of acceptance as a measure of potential production, assuming that speakers judge as grammatical what they use themselves. This is an idealisation which is based on the concept of grammars being bidirectional: production and perception are the result of the same grammatical system (see e.g. Boersma 2011). Comparison of frequencies of attestations in corpus data and acceptability judgments show high correlations with \( r > 0.8 \) (e.g. Bermel & Knittl 2012: 260). The type of survey affects the weight that items receive in the final results. In so-called “forced-choice” tasks, informants will be inclined to opt for the most common form, which will lead to an over-representation of the more common forms in the dataset. Informants may allow for constructions of low frequency that appear rarely in daily speech, if use is made of a binary acceptability test in which multiple answers are tested. This will lead to an over-representation of uncommon forms. Bermel & Knittl (2012: 268), when testing pairs of morphological competitors, state about it: “Acceptability thus is not a zero-sum game, and in conditions of substantial flux and competition, users’ reluctance to give a negative rating to either form may testify to the potentiality inherent in both forms for use, regardless of the rate at which they are realized.” They found this effect even when the acceptability of the items was scored on a Likert scale. Altogether, the correlations between corpus data and acceptability judgments are so high as to warrant the use of acceptability judgments as a proxy for utterance frequencies, while acknowledging that the percentages for the items of low frequency may be over-rated.

On the basis of the similarity between perception data and production data, we would like to suggest, without pressing this point, that the analysis to be presented holds of production data as well. In this respect, it must be mentioned that verb clusters which are reported by K&P to be acceptable have also been found in production experiments involving primary school children (Ytsma 1995: 90-95). In addition, they have been reported for Frisian spoken by adults in De Haan (1996). The upshot of this discussion is that we feel justified in referring to frequencies, which may equally refer to frequencies of production as to frequencies of acceptance rate (perception), even though, strictly speaking, the data from K&P are based on acceptence rates only.

K&P reported informants’ judgments about the acceptability of the six word orders in Frisian, that are logically possible in a verb cluster consisting of three verbs. The informants were 33 Frisian-Dutch bilingual pupils from secondary school. They came from the highest type of secondary education, given a division of secondary education in three levels of increasing difficulty as far as intellectual skills are involved. The 33 pupils consisted of 18 second graders and 15 fourth graders. Each of these pupils met
the criterium that both of their parents spoke Frisian. The six word orders in the verbal cluster are the six test conditions which we are interested in. Every test condition was scored 6 times by 33 informants: N = 198 for every test condition. Thus the maximal score for a test condition would have been 198. The test condition was scored 6 times by providing 6 sentences, in slightly varying guise, which each embodied the relevant test condition, that is, the relevant word order. Variation in the Frisian sentences was created, for example, by varying the modal. In addition, the Frisian test sentences were mixed with Frisian control sentences. To sum, the informants could indicate for each order whether they considered it to be acceptable in their Frisian spoken language.

Table 1 below presents the distribution of accepted word orders in IF as reported by K&P. The first column contains the test condition. The second column contains the absolute number of times that a sentence containing the test condition was accepted. This may be referred to as the acceptance score. The third column contains a percentual representation of the acceptance score as a proportion of the total number of all acceptance scores (hence not of the total number of all scores):

Tabel 1. Scores for word order in the verbal cluster

<table>
<thead>
<tr>
<th>Testcondition</th>
<th>Absolute YES-score</th>
<th>Proportion of all YES-scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>123 (FIN-MOD-MAIN)</td>
<td>120</td>
<td>32.4%</td>
</tr>
<tr>
<td>321 (MAIN-MOD-FIN)</td>
<td>105</td>
<td>28.4%</td>
</tr>
<tr>
<td>132 (FIN-MAIN-MOD)</td>
<td>58</td>
<td>15.7%</td>
</tr>
<tr>
<td>312 (MAIN-FIN-MOD)</td>
<td>58</td>
<td>15.7%</td>
</tr>
<tr>
<td>231 (MOD-MAIN-FIN)</td>
<td>21</td>
<td>5.5%</td>
</tr>
<tr>
<td>213 (MOD-FIN-MAIN)</td>
<td>8</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

The average frequency for each order is 16.6%. If the informants accepted all orders, then the acceptability scores for each order would be around 16.6%. That is not the case. Instead, and this has been left unexplained by K&P, there is a system in the frequencies associated with the word orders. This system will be analysed in further detail below.

2.2. Parent orders

The six word orders that are logically possibly neatly fall into three groups. The first group consists of the word orders 123 and 321. These word orders are the word orders that are the norm in the two contact languages, which gave birth to IF. Thus, as mentioned in section 1.2., 123 is the order that is the norm in verb-clusters in Dutch in case verb 1 is a finite auxiliary of the perfect tense:
Because the vandal didn’t want to hand in his knife.

Even though Standard Dutch allows for some alternation in clusters of two verbs, the word order is strictly 123 in three verb clusters of the type exemplified in (8), which was the focus of the investigation conducted by K&P.

The reversed order, 321, is the order that is the norm in comparable verb-clusters in Frisian:

‘Because the vandal didn’t want to hand in his knife.’

In the speech of older generation L1-speakers of Frisian, this is the only acceptable word order in a three verb cluster (Tiersma 1999: 128).

Thus 123 and 321 may be grouped together as parent orders, the orders which are used in Dutch and Frisian, the two parent languages of IF. Parent orders are also grouped together on the basis of their scores in the acceptance test (see Table 1). They share the property that they are the only orders which each have an acceptance rate of about one third in the data set. It is a relevant observation that the two parent orders have practically the same acceptance rates, and these rates together make up two thirds of the total.

The origin of the parent orders receives a trivial answer. These derive from the parent languages. The 321 order in IF derives from Frisian, and the 123 order in IF derives from Dutch. The latter implies that Frisian verb forms (which IF shares with Frisian) are associated with the word order specifications of Dutch verbs. This is a clear indication that speakers of IF have not adequately acquired Frisian. It should be borne in mind that speakers of IF do not make word order mistakes in their Dutch clusters: they produce impeccable 123 clusters when speaking Dutch. Thus the reliance of speakers of IF on Dutch grammar directly explains why they produce the ‘Dutch’ word order 123 when attempting to speak Frisian. In this way, IF is produced.

### 2.3. Hybrid orders

The orders 132, 312 share the common property that the first verb, going from left to right, is identical to the first verb of a parent orders (123, 321), whereas the second verb from left to right is not identical to the second verb of a parent order. Thus 132 and 312 may be grouped together as hybrid orders. They begin with their first verb as if a parent order is involved, but they do not continue a parent order. Hybrid
orders can also be grouped together on the basis of their acceptance rates (see Table 1). Both hybrid orders have exactly the same acceptance rates, and these acceptance rates together make up almost one third of the total.

Hybrid orders share with parent orders the ‘correct’ placement of the first verb: hybrid clusters begin with either 1 as in Dutch, or 3 as in Frisian. Hybrid orders differ with respect to the choice of the second verb, which is unlike what happens in either Dutch or Frisian. However, speakers of IF do not make mistakes in their Dutch verb clusters. IF comes into being because its speakers do not adequately acquire Standard Frisian: they make ‘mistakes’ in their Frisian clusters. The question arises how they exactly arrive at the acceptance of hybrid orders (cf. the discussion of production and perception at the beginning of section 2.1).

Our claim is that when attempting to parse or produce three verb clusters, speakers of IF rely not only on word orders found in 3-verb clusters, but also on 2-verb clusters. This can be shown to explain the occurrence of hybrid orders. More specifically, the order 312 arises under the influence of the word order 21 in a two-verb cluster, and the word order 132 similarly arises under the influence of the word order 12 in a two-verb cluster. This can be understood by a left-to-right line-up of 312 with 21, as in Table 2 below, and by a left-to-right line-up of 132 with 12, as in Table 3 below.

Table 2. Left-to-right line-up of 312 with 21

<table>
<thead>
<tr>
<th>Cluster type:</th>
<th>Main Verb</th>
<th>Finite Verb</th>
<th>Auxiliary</th>
</tr>
</thead>
<tbody>
<tr>
<td>312 MAIN-FIN-MOD</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>21 MAIN-FIN</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

At the level of abstraction chosen in Table 2, these two cluster types are similar. Both start out with the main verb and continue with the finite verb.

The match between the first two verbs is almost perfect, the only difference being that the main verb will have the form of an infinitive in 312 and the form of a participle in 21. This difference is not very salient for speakers of IF, for two reasons. First, speakers of IF regularly confuse participles and infinitives, as K&P report. In a number of cases, past participle and ordinary infinitive are distinguished only by the pronunciation of a final /n/ in the case of participles, for example in the minimal pair: *wolle* ‘want’ (ordinary infinitive), *wollen* ‘wanted’ (participle) (for information on the grammar of Standard Frisian, see Tiersma 1999). The same applies to other modals such as *moatte* ‘must’, *kinne* ‘can’ and *sille* ‘shall’, and to main verbs in spoken Frisian such as *sette* ‘put’, *prate* ‘talk’ and other verbs. In Dutch, however, the pronunciation of a /n/ following a schwa is optional. Speakers of IF are influenced by Dutch in this respect, and regularly fail to master the morphosyntactic distribution of the /n/ following a schwa. For this reason, the formal difference between infinitives in 312 and participles in 21 will not be very salient to
speakers of IF. Hence, we claim, the word order 312 is inspired by the occurrence of the word order 21. This is the normal word order for a two-verb cluster in Frisian, and it is a permitted word order in Dutch.

Let us now move on to the left-to-right line-up of 132 with 12.

Table 3. Left-to-right line-up of 132 with 12

<table>
<thead>
<tr>
<th>Cluster type</th>
<th>Finite Verb</th>
<th>Main Verb</th>
<th>Auxiliary</th>
</tr>
</thead>
<tbody>
<tr>
<td>132 FIN-MAIN-MOD</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>12 FIN-MAIN</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

These two cluster types are similar at the chosen level of abstraction in Table 3. Both start out with the finite verb and continue with the main verb. They are not identical, since the main verb will have the form of an infinitive in 132 and the form of a participle in 12, but this is not a salient difference, as was explained above. Hence, we claim, the word order 132 is inspired by the occurrence of the word order 123, the preferred word order for a two-verb cluster in Dutch (Bloem, Versloot & Weerman [forthcoming]), while it is not permitted in Frisian.

2.4. Remaining orders: orders introduced by the intermediate verb

The two remaining orders, 231 and 213, share the common property that the first verb, going from left to right, differs from the first verb in either parent order. More specifically, these orders are introduced by the intermediate verb, the modal auxiliary marked 2. These remaining word orders, 231 and 213, also group together on the basis of their frequencies, which are low.

2.5. Conclusion

The six logically possible verb clusters in IF can be classified in three groups on the basis of their similarity to verb clusters in the parent languages Frisian and Dutch. Parent orders are identical to the orders of Frisian and Dutch. Hybrid orders begin with the same verb as parent orders, going from left to right, but differ with respect to the second verb, whereas the remaining orders begin with a verb which cannot introduce a three-verb cluster in either Frisian or Dutch.

Parent orders each have almost the same frequency of acceptance (almost 1/3), hybrid orders each have the same frequency (almost 1/6) and the remaining orders both have a low frequency (5.5% and 2.2%). Thus there is a system in the correlation between the type of word order and its frequency. In the next section, we will outline a model which accounts for these observations.

3. Model for calculating the probability of each word order inside the verb cluster
Our model, as has been explained above, must accommodate that there are 4 types of clusters in the parent languages which may affect the choice of verb in IF clusters: Dutch 2-verb clusters, Dutch 3-verb clusters, Frisian 2-verb clusters, Frisian 3-verb clusters. We assume that each of these 4 cluster types exerts an influence on the choice of 3-verb clusters in IF, and that the strength of this influence is equally strong for all 4 types. It has been shown (Slofstra, Hoekstra & Versloot 2010, Hoekstra & Versloot [forthcoming]) that the strength of influence of a given element A on an element B correlates with two factors: frequency, on the one hand, and similarity of form and meaning, on the other hand.

As to similarity, the more similar A is to B, the greater the influence of A on B will be. Thus, A and B must have (almost) the same meaning and there must be some formal similarity, that is, when comparing clusters of verbs, the same verbs must be involved, or a subset of them. Of course, 3-verb clusters in IF are more similar to 3-verb clusters in the parent languages than to 2-verb clusters. This would imply that the influence of 3-verb clusters is stronger than that of 2-verb clusters. However, this effect is compensated by the second factor: frequency. The frequency of 2-verb clusters is much greater than that of 3-verb clusters. We hypothesise that these two factors compensate each other so that the effect of 3-verb clusters and 2-verbs upon 3-verb clusters is roughly the same. We also assume that the influence of Frisian parent orders equals the influence of Dutch parents orders. This reflects the socio-linguistic reality for present-day motherthongue speakers of Frisian. In section 4, we will experiment with different assumptions about the strength of influence of 2 and 3-verb clusters and the influence of Frisian and Dutch parent orders. It turns out that varying these assumptions does not significantly affect the predictions of our model, thus testifying to its robustness. In the version of the model, presented below, the strength of influence of each of the four cluster types is equally strong as represented by a probability of 0.25 or 1/4. We assume that the verb cluster is built up from left to right. Consider first the probability of choice of the initial verb, as in Table 4 below:
Table 4. Probability of choice of the first verb in IF.

<table>
<thead>
<tr>
<th>Position 1</th>
<th>Position 2</th>
<th>Position 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dutch 2-verb cluster</td>
<td>Finite verb 1/4</td>
<td>(Main verb 1/3)</td>
</tr>
<tr>
<td>Dutch 3-verb cluster</td>
<td>Finite verb 1/4</td>
<td>Auxiliary 1/3</td>
</tr>
<tr>
<td>Frisian 2-verb cluster</td>
<td>Main verb 1/4</td>
<td>Trivial: main verb</td>
</tr>
<tr>
<td>Frisian 3-verb cluster</td>
<td>Main verb 1/4</td>
<td>Auxiliary 1/3</td>
</tr>
</tbody>
</table>

From this table, it can be read off what the probability is of a cluster starting with the finite verb: it is 1/2 or 0.5. This is empirically as good as correct. It can be gleaned from Table 1 that the percentage of orders starting with the finite verb \((123 + 132)\) is \(32.4 + 15.7 = 48.1\%\).

Similarly, it can be read off what the probability is of a cluster starting with the main verb: it is 1/2 or 0.5. This is empirically as good as correct. It can be gleaned from Table 1 that the percentage of orders starting with the main verb \((321 + 312)\) is \(28.4 + 15.7 = 44.1\%\).

Next consider the calculation of the probability of individual clusters of three verbs. To calculate this, we must consider the probabilities of choice of the first and second verb, and multiply them. The positioning and choice of the third verb are trivial, given that the cluster is constructed from left to right and consists of three verbs. Table 5 below presents a full overview of the probabilities:

Table 5. Probability of choice of first and second verb in IF.

<table>
<thead>
<tr>
<th>Position 1</th>
<th>Position 2</th>
<th>Position 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dutch 2-verb cluster</td>
<td>Finite verb 1/4</td>
<td>(Main verb 1/3)</td>
</tr>
<tr>
<td>Dutch 3-verb cluster</td>
<td>Finite verb 1/4</td>
<td>Auxiliary 1/3</td>
</tr>
<tr>
<td>Frisian 2-verb cluster</td>
<td>Main verb 1/4</td>
<td>Trivial: main verb</td>
</tr>
<tr>
<td>Frisian 3-verb cluster</td>
<td>Main verb 1/4</td>
<td>Auxiliary 1/3</td>
</tr>
</tbody>
</table>

Note that the probabilities for position 2 are conditional as far as main verb and finite verb are concerned: this has been indicated by bracketing them. In this respect, our model resembles a Bayesian Network. The probabilities for position 2 are, however, not causally related to the state (= the type of verb) of position 1, but they are subject to the general restriction that each state may only appear once in the entire chain.

If position 1 is occupied by a finite verb, the probability of a finite verb in position 2 becomes zero leaving only 3 options: Main verb (through Dutch), Auxiliary (through Dutch) and Auxiliary (through Frisian). Hence, each of the three has a probability of 1/3 or, roughly, 0.33. Similarly, if the first position is occupied by a main verb, then the probability of a main verb in second position becomes zero, and the remaining probabilities become 1/3 or, roughly, 0.33. Note that the probability of an auxiliary in second
position is $1/3 + 1/3 = 2/3$ or, roughly, $0.67$. We can now calculate the probability of each of the six orders of IF, as in Table 6 below:

Table 6. Predicted probability of each cluster and observed acceptance rate.

<table>
<thead>
<tr>
<th>Order in IF</th>
<th>Calculation</th>
<th>Predicted</th>
<th>Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>123 FIN-MOD-MAIN</td>
<td>$1/2 \times 2/3$</td>
<td>$1/3$, roughly 33%</td>
<td>32.4%</td>
</tr>
<tr>
<td>321 MAIN-MOD-FIN</td>
<td>$1/2 \times 2/3$</td>
<td>$1/3$, roughly 33%</td>
<td>28.4%</td>
</tr>
<tr>
<td>132 FIN-MAIN-MOD</td>
<td>$1/2 \times 1/3$</td>
<td>$1/6$, roughly 17%</td>
<td>15.7%</td>
</tr>
<tr>
<td>312 MAIN-FIN-MOD</td>
<td>$1/2 \times 1/3$</td>
<td>$1/6$, roughly 17%</td>
<td>15.7%</td>
</tr>
<tr>
<td>231 MOD-MAIN-FIN</td>
<td>$0 \times 1/3$</td>
<td>0%</td>
<td>5.5%</td>
</tr>
<tr>
<td>213 MOD-FIN-MAIN</td>
<td>$0 \times 0.33$</td>
<td>0%</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

The correlation between the predicted values and the observed values is quite high: $r = 0.99$. The explained variance $r^2$ is 0.98. This means that 98% of the variance in empirical results of K&P (Table 1) is predicted on the basis of our model. The model of K&P, in contrast, predicts that all orders are equally likely and enables no predictions about the actually observed variance.

The less likely constructions (231 and 213) are more frequent in the observed data than predicted by the model. This reflects the over-representation of less-likely word orders in the acceptibility judgements as discussed in section 2.1, similar to the bias found by Bermel & Knittl (2012: 261-264).

4. Testing the robustness of the model

In this section the explained variance of the model will be investigated if different assumptions are made about the impact of Dutch and Frisian 2-verb and 3-verb clusters on IF. In the table below, the first row repeats the predictions of the model under the pair of assumptions outlined above: the impact of Dutch clusters equals the impact of Frisian clusters and the influence of 2-verb clusters equals the impact of 3-verb clusters. The second row presents the results for the assumption that the impact of all Frisian clusters is twice as large as those of Dutch clusters. The third row presents the results for the assumption that the impact of Dutch and Frisian is the same, but that 3-verb clusters in both languages have twice as much impact as 2-verb clusters. The last row combines the assumptions of the previous two rows: the impact of Dutch is half of the impact of Frisian and the impact of 2-verb clusters is half of that of 3-verb clusters. The explained variance for each of these options is given in (the third column of) table 7 below:

Table 7. Explained variance under four different sets of assumptions
The table shows that the model is not very sensitive to changes in the assumptions about the impact of Dutch clusters versus Frisian clusters or 2-verb clusters versus 3-verb clusters. The robustness of the model is due to our assumption that IF clusters are built up from left to right on the basis of the knowledge of speakers of IF of Dutch and Frisian 2-verb and 3-verb clusters. Since neither Dutch nor Frisian clusters fill the first position in the verb cluster with a non-finite auxiliary, speakers of IF almost always judge as ungrammatical the option of beginning a cluster with a non-finite auxiliary. The second position is always filled with a non-finite auxiliary in 3-verb clusters in Frisian and Dutch, but the influence of 2-verb clusters is responsible for the tendency of speakers of IF to sometimes choose a main verb or a finite verb. This analysis neatly accounts for the fact that a non-finite auxiliary is chosen twice as often for the second position (for here Dutch and Frisian 3-verb clusters concur) as the option of allowing either a main verb or a finite verb (since here Dutch and Frisian 2-verb clusters do not concur).

5. Conclusion

To sum up, the acceptability of 3-verb clusters in IF can be adequately predicted from the following assumptions:

(i) Speakers of IF have incomplete knowledge of 3-verb clusters in Frisian
(ii) As a result of (i), they take recourse to their knowledge of 3-verb clusters in Dutch
(iii) As a result of (i), they take recourse to their knowledge of 2-verb clusters in Frisian and Dutch.
(iv) Dutch and Frisian clusters and 2- and 3-verb clusters have roughly the same impact on 3-verb clusters in IF.
(v) Position in the verb cluster are filled from left to right

It follows especially from assumption (v) that the processing of this type of clusters can be understood entirely from a linear analysis of input data and a linear speech production routine. Our analysis shows moreover that varying degrees of frequency in acceptability judgments - as a proxy for production ratios - may be systematic and their relative proportions in speech production predictable under the current
interpretation. This may be construed as evidence that syntactic interferences are at least partly based on similarities and dissimilarities between languages on the surface level, the level of the actual sequential speech utterance. This case alone does not prove that syntactic structures have no internal hierarchy, but it shows at least that bilinguals' linguistic knowledge of one of their two languages, as reflected in acceptance rates (and, presumably, in frequency of production), consists of knowledge of linearity, similarity and frequency to such a large extent that an appeal to an 'underlying' hierarchical syntactic structure is not necessary, and, not enlightening.
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