Object shift in the Scandinavian languages : syntax, information structure, and intonation

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Chapter 4. Statistical Data

In this chapter, I present statistical data on downstep in all the Scandinavian varieties investigated.[107] The downstep size is expressed in terms of a musical scale, using the semitone as a convenient unit of measurement for the perceived magnitude of a change in pitch.[108] The semitone is one-twelfth of an octave. An octave is a doubling of the fundamental frequency F0, the most important acoustic determinant of vocal pitch.[109] The Praat software measures the F0 in hertz (Hz). The interval between any two key pitch points P_1 and P_2 in Hz can be converted to semitones by formula (158):[110]

(158) $12 * [\log(P_1/P_2) / \log(2)]$

A complication is that the pitch of a spoken sentence normally declines from the beginning to the end. This is the phenomenon of declination, which was introduced in § 3.1.2. In my recordings, the time interval between P_1 and P_2 is shorter than 3 seconds; it does not normally exceed the duration of one second. It can be estimated that the pitch lowering in the sentence types I used should be roughly 2 semitones.[111] Thus, I define a proper instance of downstep in my materials as a pitch decrement between P_1 and P_2 larger than 2 semitones. This indicates that the difference in semitones between P_1 and P_2 must be larger than 2 to say that downstep actually occurs in a sentence.[112]

For each sentence type, two dependent variables which characterize the extent of downstep are defined as follows. The first one is the incidence of downstep. This variable expresses what percentage of the utterances recorded for a given sentence type in a given Scandinavian variety shows downstep (where the pitch decrement between P_1 and P_2 is larger than 2 semitones). The second variable is the mean size of the pitch decrement between P_1 and P_2, irrespective of whether the pitch decrement qualifies as a downstep or not (i.e. regardless of whether the semitone between two points is larger than 2 or not).

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107 I am indebted to Vincent van Heuven for computation of the downstep size and the presentation of the statistical data in this chapter.

108 See also traditional works, e.g. Liberman and Pierrehumbert (1984), who propose to compute the downstep size by exponential decay.

109 See Van Heuven (1994a) and references given therein for details.

110 Without multiplication by 12, this formula computes the pitch interval in octaves.

111 This estimate is based on the formula ($D = -11 / t + 1.5$) to compute the declination in semitones per second (= D) for utterances shorter than 5 seconds, where t is the duration of the utterance ('t Hart, Collier and Cohen, 1990:128; Rietveld and Van Heuven, 2009:311).

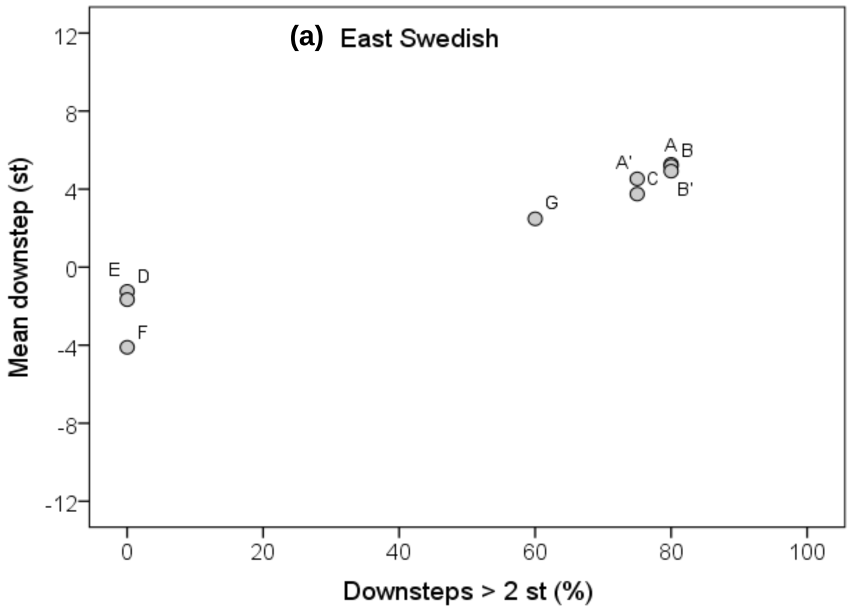
112 In hindsight, it would have been better to actually measure the time intervals between P_1 and P_2 (in ms) and the overall duration of the test utterances so that the expected declination effects could have been computed and corrected for more precisely.

The incidence and mean size of the downstep size were computed by choosing two representative male and two representative female speakers in each of the Scandinavian varieties investigated. The F0 was computed for each utterance by using the autocorrelation method implemented in the Praat software. Reasonable upper and lower frequency bounds were set depending on the gender and vocal characteristics of the speaker. As stated in § 3.1.2, all test sentences were in most cases articulated by every syllable in advance. Each syllable was marked off by boundaries on a time-aligned annotation grid in Praat. Within each target syllable, the F0 maximum could then be automatically found and extracted by the Praat software. The F0 values (in Hz) extracted at P_1 and P_2 were then converted to semitones and further processed with the SPSS statistical software. Each sentence type was repeated five times by each speaker. When one token did not yield a measureable F0 at a pitch target point, the token was simply discarded. This led to occasional missing data. Given the large number of tokens per sentence type, this was not considered a problem.

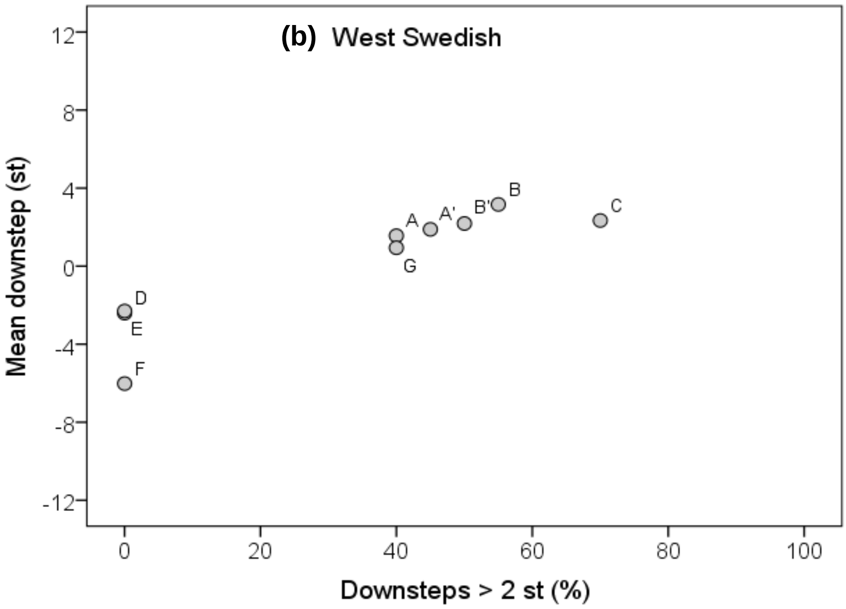
Below, I graphically characterize the sentence types in the Scandinavian varieties investigated two-dimensionally by plotting the mean size of the pitch decrement between P_1 and P_2 (mean downstep) against the incidence of downstep (percentage of proper downsteps). In the following graphs, each code letter stands for a corresponding test sentence type. See Table 1 in § 3.1.1 for the test sentence constructions and the corresponding code letters. The x-axis shows the percentage at which downstep actually occurs, i.e., the semitone value is larger than 2, in all the utterance tokens of a relevant sentence construction by four (i.e. two male and two female) speakers. The y-axis shows the mean size of the downstep of all the utterance tokens of a relevant sentence construction computed by formula (158) above. As we have seen in chapter 3, the more positive value a sentence has, the larger the downstep size is; the more negative value a sentence has, the more likely is upstep, instead of downstep, to occur in it. Thus, the more to the upper right corner a data point is located, the more likely is downstep to occur and the larger the downstep size in the corresponding sentence is. Towards the lower left corner of a plot, downstep is more unlikely to occur (/upstep is more likely to occur) and the downstep size is smaller (/or even an upstep occurs) in the corresponding sentence.

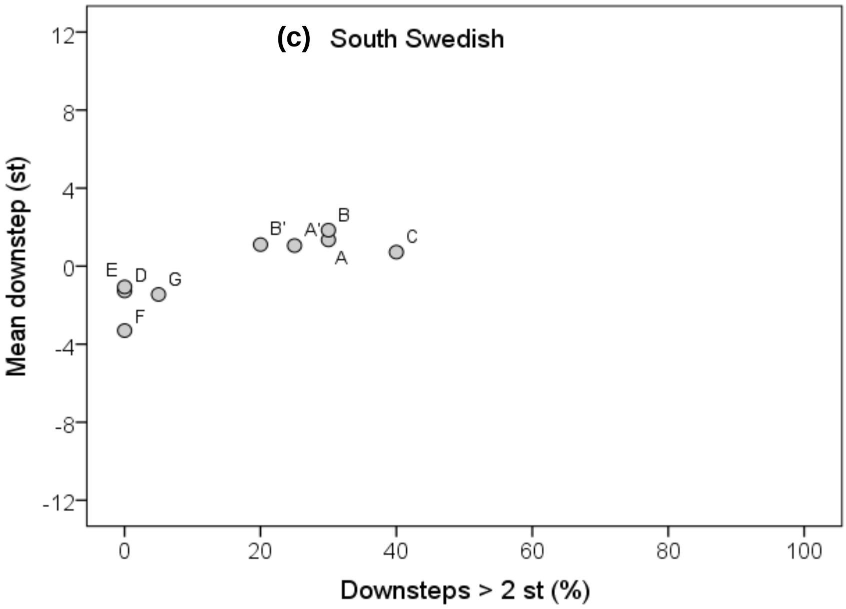
First, consider the statistical data of the Swedish varieties. A striking fact is that A(')-B(') (simple tense forms) and C (Verb Topicalization) are mostly located at the upper right, and D-E (complex tense forms) and F (embedded clauses) at the lower left. This indicates that downstep is likely to occur in the former, but upstep is likely to occur in the latter. The status of G (contrastive argument-focus) vacillates among the Swedish varieties: downstep may or may not occur in it. Note that A(')-B(') are located further to the lower left in Övdalian than in the other Swedish varieties.[113] This indicates that downstep is much less likely to occur in those constructions in the former than in the latter. This data supports the claim made so far: downstep does not occur in Övdalian.

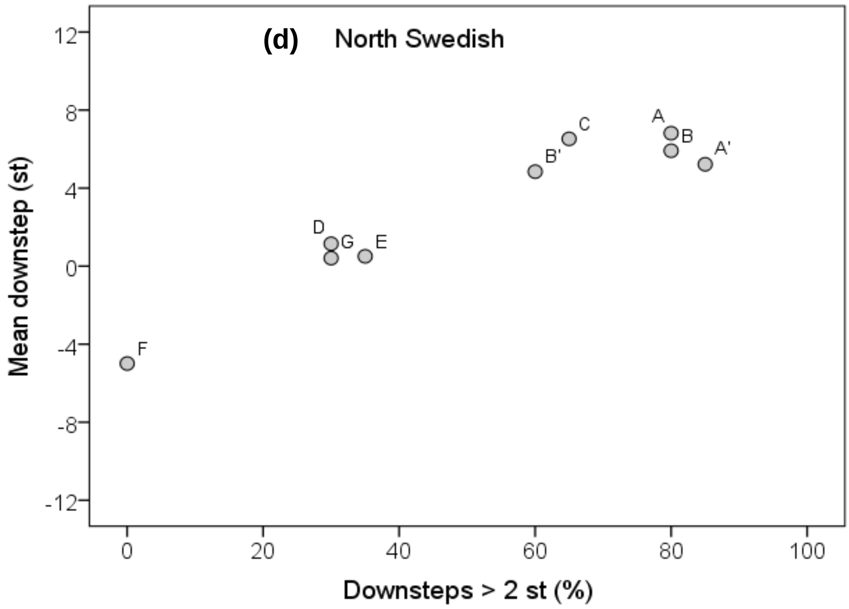
(159) Downstep size and incidence in the Swedish varieties:

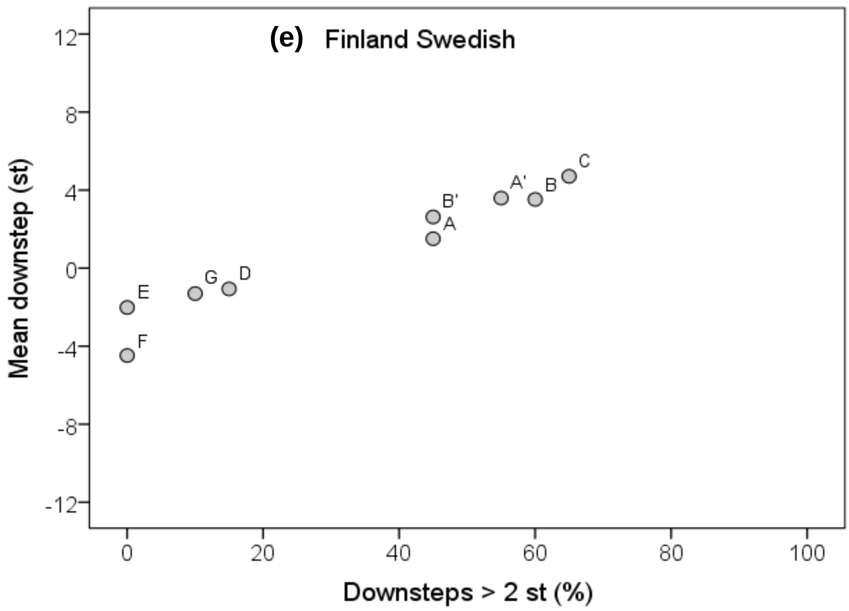


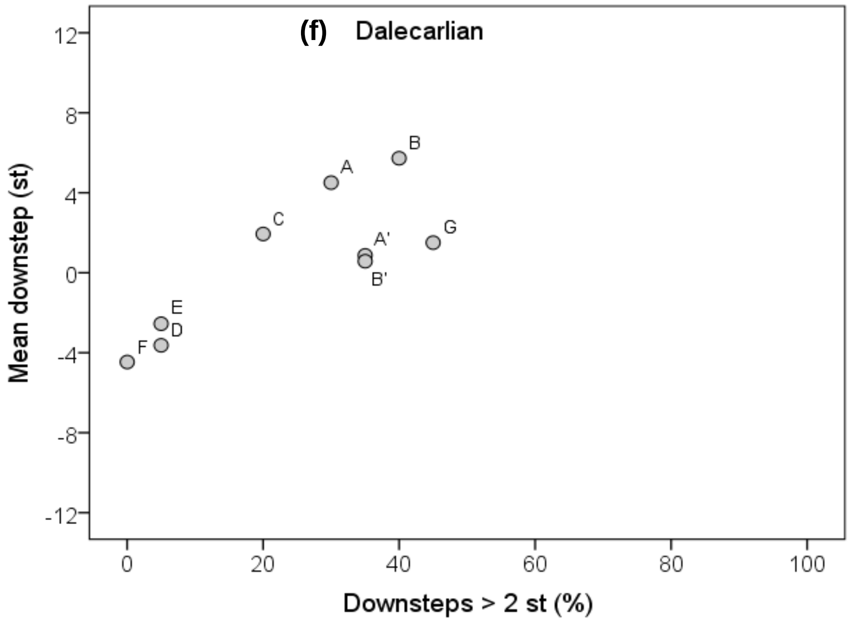
113 Recall that A-B (simple tense forms with a shifted object pronoun) are ungrammatical and A'-B' (simple tense forms with an in-situ object pronoun) are grammatical for Övdalian speakers. G' is contrastive argument-focus with a shifted object pronoun, which all informants judged as ungrammatical. See Appendix II.

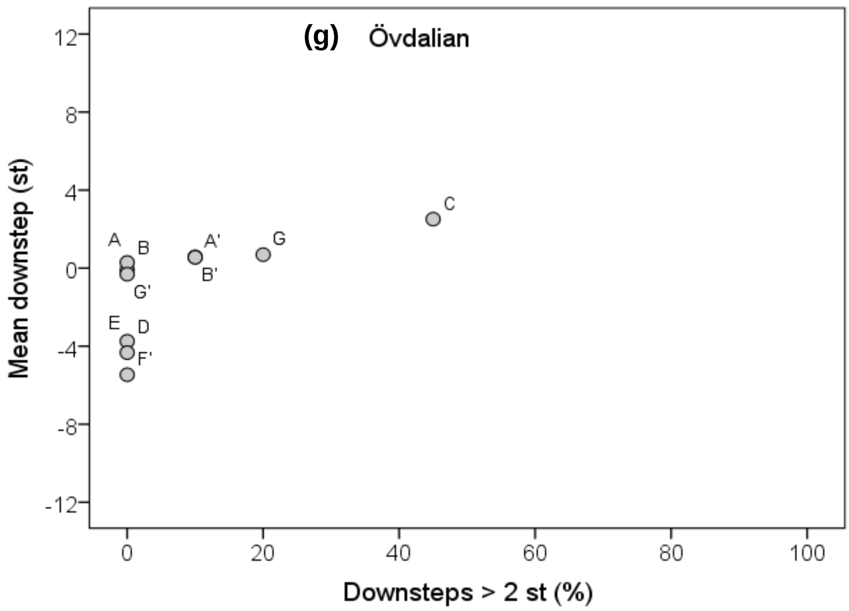

(b) West Swedish
Mean downstep (st)
Downsteps > 2 st (%)
12
8
4
0
-4
-8
-12
0
20
40
60
80
100
A
A'
B'
B
C
G
D
E
F


(c) South Swedish
Mean downstep (st)
Downsteps > 2 st (%)
12
8
4
0
-4
-8
-12
0
20
40
60
80
100
B'
A'
B
A
C
E
D
G
F


(d) North Swedish
Mean downstep (st)
Downsteps > 2 st (%)
12
8
4
0
-4
-8
-12
0
20
40
60
80
100
A
B
C
A'
B'
D
G
E
F

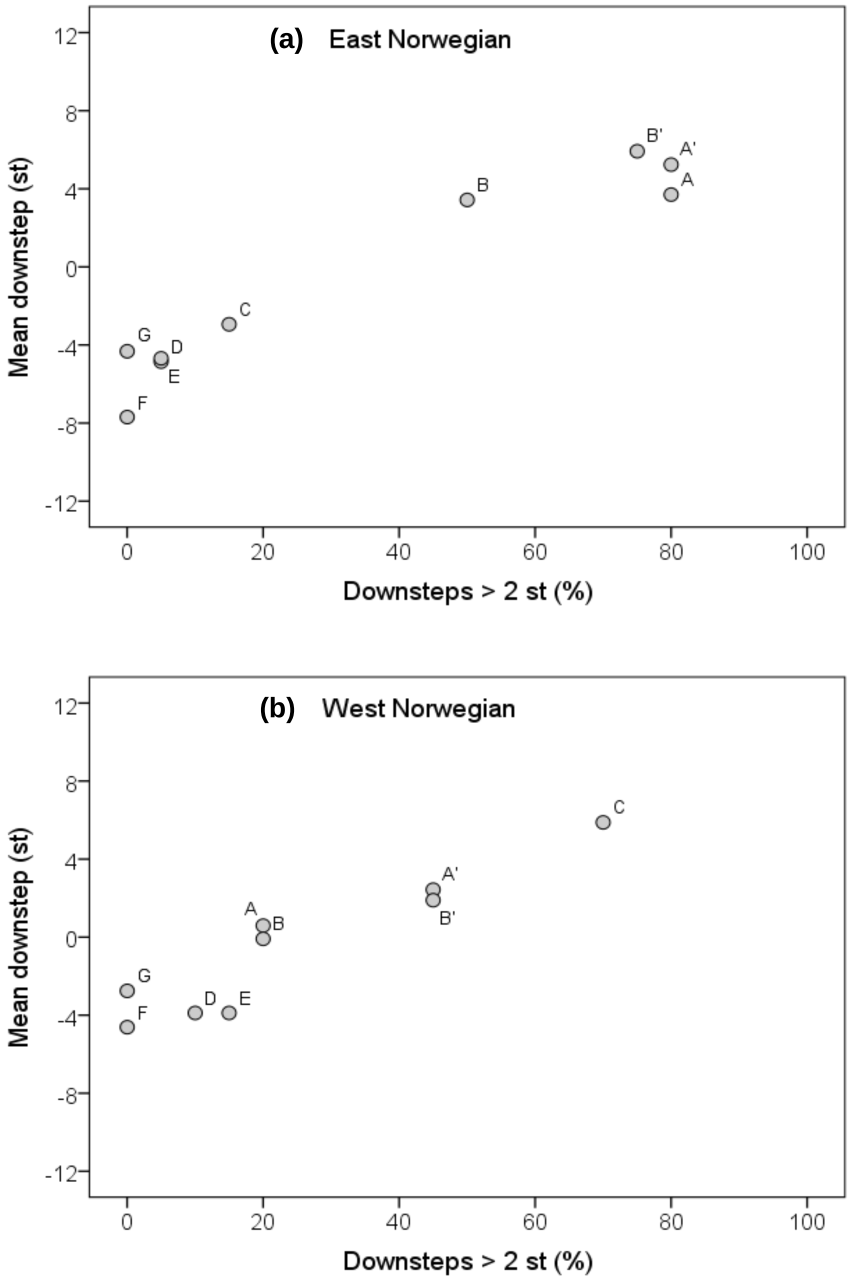

(e) Finland Swedish
Mean downstep (st)
Downsteps > 2 st (%)
12
8
4
0
-4
-8
-12
0
20
40
60
80
100
C
A'
B
B'
A
G
D
E
F


(f) Dalecarlian
Mean downstep (st)
Downsteps > 2 st (%)
12
8
4
0
-4
-8
-12
0
20
40
60
80
100
A
B
C
A'
B'
G
E
D
F


(g) Övdalian
Mean downstep (st)
Downsteps > 2 st (%)
12
8
4
0
-4
-8
-12
0
20
40
60
80
100
A
B
G'
A'
B'
G
C
E
D
F'

Next, let us observe the statistical summary data of the Norwegian varieties:

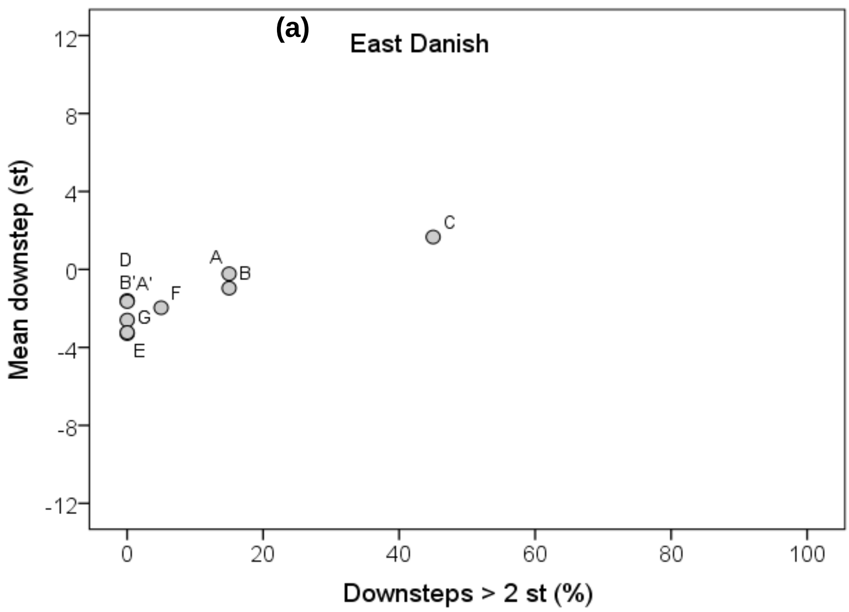
(160) Downstep size and incidence in the Norwegian varieties:

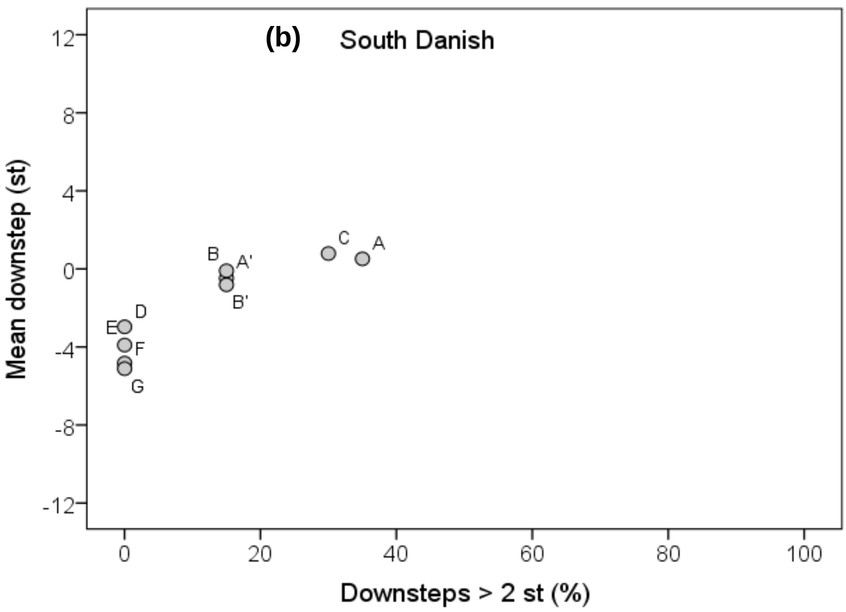


The tendency we saw in Swedish, i.e. that A(')-B(') (simple tense forms) and C (Verb Topicalization) are located towards the upper right, and D-E (complex tense forms) and F (embedded clauses) towards the lower left, is observed in Norwegian, too. This indicates that downstep is more likely to occur in the former, but upstep is more likely to occur in the latter. Unlike in Swedish, G (contrastive argument-focus) is located towards the lower left in both East and West Norwegian: downstep is less likely to occur in this sentence type in Norwegian.

Next, consider the statistical data of the Danish varieties. Remarkably, the downstep ratio in A(')-B(') (simple tense forms) is relatively low compared with the other Scandinavian varieties, though downstep is likely to occur in C (Verb Topicalization). This is unexpected since it has long been argued that declination occurs in the unmarked case in Danish, as we saw in § 3.2.3. D-E (complex tense forms), F (embedded clauses) and G (contrastive argument-focus) are located towards the lower left: downstep is less likely to occur in those constructions in Danish, too.

(161) Downstep size and incidence in the Danish varieties:

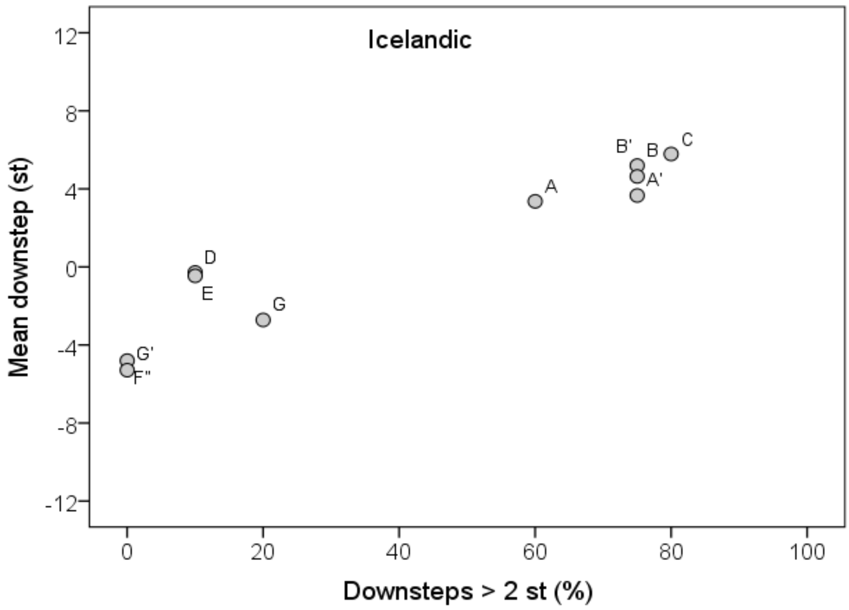




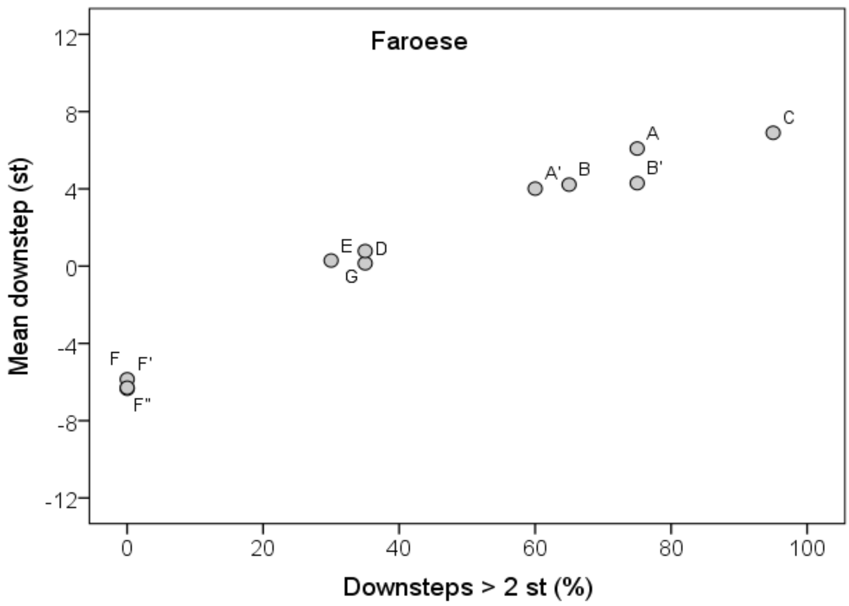
Finally, see the statistical data of Insular Scandinavian, Icelandic and Faroese:[114]

[114] G' in Icelandic is contrastive argument-focus with a shifted object pronoun. The grade of acceptability is vacillating among speakers: some informants prefer the construction in which a strong object pronoun moves; others prefer the one in which it remains in situ. See Appendix II. In Faroese, F is the embedded clause with Neg+V+Obj_{pro}, F' with V+Neg+Obj_{pro}, and F" with V+Obj_{pro}+Neg.

(162) Downstep size and incidence in Icelandic:



(163) Downstep size and incidence in Faroese:



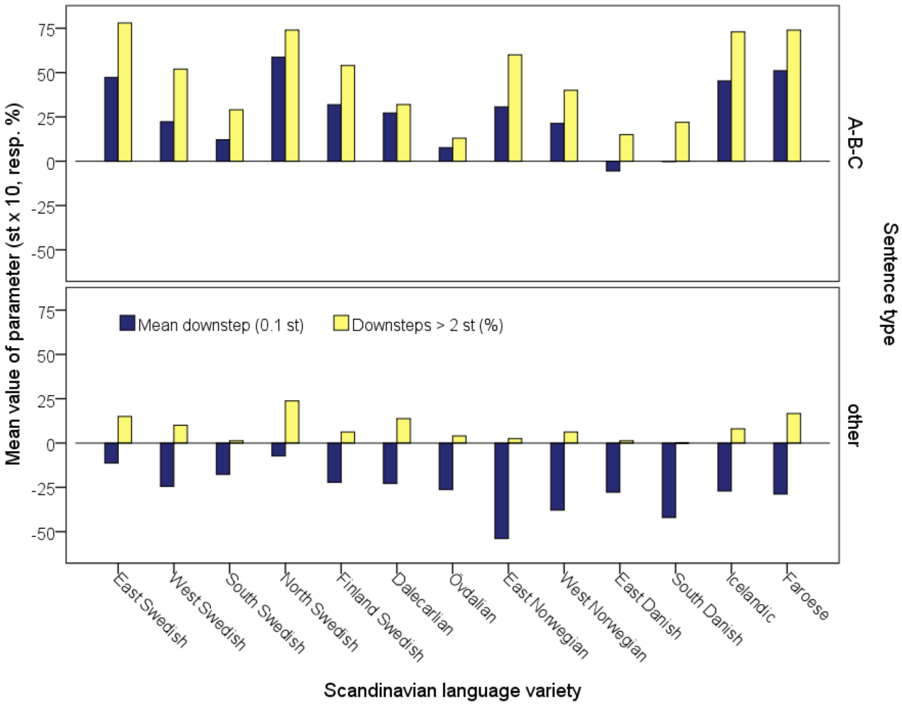
The tendency we saw in Swedish and Norwegian, i.e. that A(')-B(') (simple tense forms) and C (Verb Topicalization) are located towards the upper right, is strikingly observed in Insular Scandinavian: downstep is more likely to occur in those constructions. D-E (complex tense forms), F (embedded clauses) and G (contrastive argument-focus) tend to be located at the lower left compared with A(')-B(') and C: upstep is more likely to occur in the former than in the latter.

In general, the OS constructions, A-B (simple tense forms with a shifted monosyllabic/disyllabic object pronoun) and C (Verb Topicalization), are located in the upper right; D-E (complex tense forms with a monosyllabic/disyllabic object pronoun), F (embedded clauses) and G (contrastive argument-focus), which are all typically the non-OS construction, are found towards the lower left.

The following graphs are the comparison of the mean downstep parameters of A-B-C (upper) with that of all the others (lower). In each graph, a light bar and a dark one are plotted side by side. The former stands for the mean percentage of the cases in which the semitone value is larger than 2, which was plotted along the x-axis in the graphs above. The latter stands for the mean downstep size computed by formula (158), which was plotted along the y-axis in the above graphs.[115] The mean percentage (light bars) at which downstep actually occurs is substantially higher in the constructions A-B-C (upper) than in the others (lower). The mean downstep size (dark bars) of the constructions A-B-C has a positive value in almost all the Scandinavian varieties except in East Danish, whereas that of the others has a negative value (indicating the absence of downstep) in all the varieties. This indicates that downstep is more likely to occur in the constructions A-B-C but less likely to occur in the others (where, in fact, upstep may occur).

[115] In figure (164) the downstep size is multiplied by a factor 10 in order to obtain bars of approximately the same height as the percentages of downsteps realized (between 0 and 75).

(164) Mean downstep size (dark bars) and mean incidence of proper downsteps (light bars) in between sentence types A-B-C (upper panel) and in all other types together (lower panel).



Finally, I refer to Appendix III for the actual numerical values of the mean downstep size and mean downstep incidence of all the test sentences of all the Scandinavian varieties investigated, and the actual values of the comparison of the mean downstep size and incidence in the OS construction (A-B-C) with that in all the other constructions.