

Resumption and Chain Reduction in Danish VP Left Dislocation*

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1. Introduction

Danish VP fronting may leave behind a gap, as in (1), or a resumptive element, as in (2).

- (1) [Sy korssting]_i kan jeg godt ____.
sew cross.stitch can I PPI
'I can do cross stitch.'
- (2) [Sy korssting]_i hvem kan det_i?
sew cross.stitch who can DET
'Who can do cross stitch?'

Following the literature, we refer to (1) as VP topicalization (VPT) and to (2) as VP left dislocation (VPLD).¹ We argue that both constructions in Danish are derived by movement, and that the presence of a resumptive element in (2) is the result of the nature and landing site of the particular movement involved and its interaction with general and language specific principles that govern spell out of movement dependencies.

This analysis makes sense of a long-standing observation in the literature that, despite the presence of a resumptive element, left dislocation displays an array movement-like properties like island sensitivity and reconstruction (e.g., Cinque 1977, Dobrovie-Sorin 1990, Mahajan 1990, Kayne 1994). These properties present the chief challenge for analy-

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¹The literature further distinguishes contrastive vs. hanging-topic left dislocation. The Danish construction in (2) patterns most closely with contrastive left dislocation. On the typology of left dislocation, see Riemsdijk & Zwarts 1997.

ses that base generate the initial, left dislocated XP in its surface position (e.g. Ross 1967, Cinque 1990, Iatridou 1994, Anagnostopoulou 1994).²

Our proposal is that VPLD in Danish is derived through a type of movement that involves adjunction of the left dislocated VP to the host CP (section 3), displays connectivity and reconstruction effects, and sensitivity to islands (section 4), and involves one-fell-swoop rather than successive cyclic movement—i.e. it does not pass through Spec,CP prior to adjunction to CP (section 5). This movement in VPLD interacts with pressures on Chain Reduction, the process which determines how movement related occurrences of a given syntactic object are pronounced, to yield the presence of a resumptive element (section 2).

2. Chain Reduction and PF recoverability

Two competing pressures govern Chain Reduction. One is Economy of Pronunciation, which marks a lower occurrence of a syntactic object for non-pronunciation:

- (3) *Economy of Pronunciation* (adapted from Landau 2006:30)
Mark an occurrence of an element X for non-pronunciation if it is c-commanded by another occurrence of X.

The other is P-Recoverability, which forces pronunciation of an occurrence of a given syntactic object based on PF requirements specific to the position it occupies:

- (4) *P-Recoverability* (Landau 2006:31)
An element X in position P cannot be unpronounced if P is required to be associated with phonological content.

Research on a wide range of languages has established various types of requirements, given in (5), which force a position to be associated with phonological content.

- (5) a. Bound morpheme requirements (e.g. Landau 2006, Scott 2018)
b. Requirements for intonational events to be anchored to phonological material (e.g. Landau 2006, Kandybowicz 2007, Sturgeon 2008, Grimberg 2017)
c. Other phonological well-formedness requirements (e.g. “phonological EPP”) (e.g. Holmberg 2000, Landau 2007, Sigurðsson 2010, van Urk 2018)

In many cases, when the requirements imposed on a particular position by Economy of Pronunciation and P-Recoverability are in conflict, the result is spelled out of the syntactic object occupying that position in a reduced phonological form (e.g. a proform). This reduction can be viewed as a way to meet both requirements simultaneously: associate the given position with as little phonological material as possible while still associating it with some phonological material.

²Ott 2014 argues for a third type of analysis in which contrastive left dislocation involves juxtaposition of two clauses and deletion of all but the left dislocated XP within the left-most clause. See den Dikken & Surányi 2017 for discussion and critical assessment of this analysis.

The requirements in (5) are all imposed locally on a given syntactic position. The fact that the resumptive element in VPLD (2) occurs in the same syntactic position as the silent gap in VPT (1) indicates that there is no such local requirement that this position (i.e. the position of the low VP occurrence) be associated with phonological content. Instead, we propose, the requirement operative in VPLD (2) has to do with the relative distance between the movement related VP occurrences. If the position of a higher occurrence is “too far away” from the position of a lower occurrence, that lower position must be associated with (at least, some) phonological content. Concretely, we propose the Phasemate Condition in (6) and identify the relevant locality domain as the phasemate domain, as in (7).

(6) *Phasemate condition on association with phonological content*

Position P, occupied by an element X, must be associated with phonological content if there is no higher occurrence of X contained in P’s phasemate domain.

- (7) a. Given (i) a position P, (ii) a phase head Y, the closest phase head to P that c-commands P, and (iii) a phase head Z, the closest phase head to P that P c-commands, the *phasemate domain* of P contains the material dominated by YP and not dominated by the complement of Z (cf. Chomsky’s (2001) Phase Impenetrability Condition). If there is no such Y or Z, the phasemate domain of P extends to the top or bottom of the tree, respectively.

- b.
$$[\text{YP adjunct } \underbrace{[\text{YP spec Y } [\dots [\text{ZP adjunct } [\text{ZP spec Z } [\dots]]]]]}_{\text{phasemate domain of P, a position between Y and Z}}]$$

Crucial for our purposes is that, according to (7), specifiers of YP but not adjuncts to YP are contained in the phasemate domain of any position between Y and Z. This follows from the segment theory of adjunction (May 1985:57, Chomsky 1986:7) whereby, if A is adjoined to B, as in $[_B A [_B \dots]]$, A is not dominated by the multisegment category B (since an element is dominated by a category only if it is dominated by all of the segments of that category). Here, we assume dominance is irreflexive, asymmetric, and transitive.

2.1 VP left dislocation

The assumptions laid out above lead to the expectation that, if movement of an XP crosses a phase head without stopping off in its specifier, P-recoverability and the Phasemate Condition would collectively force a reduced realization of the lower occurrence of that XP.

Given this much, consider the derivation of VPLD in Danish examples like (2): first, the VP moves to adjoin to the host CP in one fell swoop—i.e. without passing through Spec,CP—as in (8). Then, at PF, Economy of Pronunciation marks VP₁ for non-pronunciation because VP₁ is c-commanded by VP₂. However, complete non-pronunciation of VP₁ is prevented by P-recoverability and the Phasemate Condition because VP₂ is not contained in VP₁’s phasemate domain, as in (9).


- (8)
$$[_{CP} \text{VP}_2 [_{CP} \dots C \dots \text{VP}_1]]$$
-

$$(9) \quad [_{CP} VP_2 \underbrace{[_{CP} \dots C \dots VP_1]}_{\text{phasemate domain of } VP_1}] \Rightarrow [_{CP} VP_i [_{CP} \dots C \dots \text{det}_i]]$$

This conflict between Economy of Pronunciation and P-Recoverability is resolved by spelling out as little as possible of VP_1 .³ How much that is is determined by what the smallest pronounceable piece of a VP is. In Danish, *det* can spell out just the information that VP is a maximal projection.⁴

2.2 VP topicalization

If, in contrast, movement of an XP targets the specifier of a phase head instead, the assumptions above predict that Economy of Pronunciation would force deletion of the lower occurrence of XP in its entirety. This is what takes place in the derivation of VPT in Danish. First, the VP moves to Spec,CP, as in (10). Then, at PF, Economy of Pronunciation marks VP_1 for non-pronunciation. In contrast to what happens in VPLD, complete non-pronunciation of VP_1 is now not prevented by P-recoverability. This is because VP_1 is, in fact, P-recoverable for the purposes of the Phasemate Condition, since VP_2 is within the phasemate domain of VP_1 , as shown in (11). As there is no conflict between Economy of Pronunciation and P-recoverability, the position of VP_1 is associated with no phonological material.

$$(10) \quad [_{CP} VP_2 \quad C \quad \dots \quad VP_1]$$


$$(11) \quad \underbrace{[_{CP} VP_2 \quad C \quad \dots \quad VP_1]}_{\text{phasemate domain of } VP_1} \Rightarrow [_{CP} VP \quad C \quad \dots \quad __]$$

3. The left dislocated VP is an adjunct to CP

A key part of our analysis of VPLD in Danish is that the left dislocated VP is adjoined to the host CP. This results in a two-segment CP category:

$$(12) \quad \begin{array}{c} CP^2 \\ \swarrow \quad \searrow \\ VP \quad CP^1 \\ \swarrow \quad \searrow \\ \dots \text{det} \dots \end{array}$$

³See, e.g., Pesetsky 1998, Landau 2006, van Urk 2018 on how pressures on Chain Reduction like Economy of Pronunciation and P-recoverability interact to yield reduced pronunciation.

⁴In addition to VPs, *det* can also resume CPs, nonverbal predicates, bare NP arguments, certain adverbials, as well as neuter-gender DPs (the 3SG neuter pronoun is *det*). Other phrase types are resumed by more highly specified proforms (Hansen & Heltoft 2011:1828). We leave it for future work to provide a precise featural analysis of all resumptive elements in Danish that explains why other phrase types are not resumed by *det* but our hypothesis is that *det* is the least specified among these resumptive elements and thus the elsewhere case.

The adjunction analysis is supported by three considerations: the position of the finite verb in left dislocation structures, the prosodic status of the left dislocated VP, and the distribution of VPLD in embedded clauses.

3.1 Verb-third order

As is well-known, Danish root clauses are characterized by verb-second (V2) order. V2 comes about through movement of the finite verb to C in conjunction with movement of some XP to Spec,CP. Given the adjunction structure in (12), we expect VPLD in a root clause to result in V3 order, since the V2 root clause CP serves as the host of adjunction, as in (13). As observed by Houser et al. 2011:282 and Mikkelsen 2011:88, this expectation is borne out; VPLD invariably results in V3 order, as shown in (14) and (15).

- (13)
-
- (14) Sy korssting, hvem kan det?
sew cross.stitch who can DET
'Who can do cross stitch?'
(cf. *Sy korssting, kan hvem det?)
- (15) Sy korssting, det kan jeg.
sew cross.stitch DET can I
'I can do cross stitch.'
(cf. *Sy korssting, kan jeg det.)

In contrast, VPT in a root clause results in V2 order, since the topicalized VP moves to Spec,CP and nothing adjoins to CP:

- (16)
-
- (17) *Sy korssting hvem kan?
sew cross.stitch who can
'Who can do cross stitch?'
- (18) Sy korssting kan jeg godt.
sew cross.stitch can I PPI
'I can do cross stitch.'
(cf. *Sy korssting jeg kan godt.)

In other words, a topicalized VP “counts” for verb second, whereas a left dislocated VP does not. This contrast is accounted for by the structures we propose above for each construction.

Without making a claim about the applicability of the adjunction analysis crosslinguistically, we note that this kind of syntactic inertness is characteristic of left Dislocation cross-linguistically. In no Germanic language does what has been identified as left dislocation count for V2 (Ott 2015, Riemsdijk & Zwarts 1997). Analogously, Sturgeon (2008) observes that, in Czech, left dislocated XPs do not “count” for second-position clitic placement, whereas other fronting does. And in Spanish left dislocation does not require inversion, unlike other instances of fronting (Torrego 1984).

3.2 Prosody

A second characteristic of left dislocated XPs in Danish is that they are separated from the rest of the clause by a pause (Hansen & Heltoft 2011:1840, Tøndering 2008:125). Like the kind of syntactic inertness described above, prosodic separation is also characteristic of left dislocated elements crosslinguistically (e.g. Deal 2016 on Nez Perce, Ott 2015 on German, Rizzi 1997 on Italian, Sturgeon 2008 on Czech, Thráinsson 2007 on Icelandic, Zaenen 1997 on Germanic). In Danish this pause is represented by a comma in standard orthography, and we follow this convention here:

- (19) Holde vagt ved slottet, det kan en almindelig hund ikke.
 keep guard by the.castle DET can an ordinary dog not
 ‘An ordinary dog can’t guard the castle.’

Following Aissen’s (1992) work on topicalization in Mayan, we propose that this pause signals an Intonational Phrase (ι P) boundary between the left dislocated XP and the host clause (see also Tøndering 2008:99-104):

- (20) (ι P holde vagt ved slottet) (ι P det kan en almindelig hund ikke)

While space prevents us from providing a full analysis, we suggest that the prosodic separation of the left dislocated VP has its basis in the proposed adjunction structure and, in particular, the constraint that a CP must be matched by an ι P (cf. Aissen’s (2017) MATCH ROOT and Selkirk 2011 on MATCH constraints in general). This constraint forces the left dislocated VP and its CP sister to be phrased as separate ι Ps, inducing a prosodic break between them, as in (21). Contrast (21) with the VPT structure in (22). The sister of the topicalized VP is a non-maximal projection of C (namely, C’), and not a CP, and thus the two are phrased together, in a single ι P:

- (21) [CP [$\text{VP} \dots$] [$\text{CP} \dots$]] (22) [CP [$\text{VP} \dots$] [$\text{C}' \dots$]]
 (ι P) (ι P) (ι P)

In empirical terms, this means that we expect no prosodic break between a topicalized VP and the rest of the clause. This is exactly how (23) is described by Hansen & Heltoft 2011:1840 and, more generally, a topicalized phrase is not characterized by a following pause:⁵

- (23) Holde vagt ved slottet kan en almindelig hund ikke.
 keep guard by the.castle can an ordinary dog not
 ‘An ordinary dog can’t guard the castle.’

⁵To be clear: we are not claiming that a topicalized phrase cannot be followed by a pause. It clearly can be, but it is not characterized by a pause the way a left dislocated phrase is in that a topicalized phrase does not have to be followed by a pause. One specific hypothesis that deserves to be tested empirically is that the more material a topicalized phrase contains, the more likely it is to be followed by a pause. Thanks to John Tøndering for discussion.

3.3 VP left dislocation in embedded clauses

If VPLD involves adjunction, we expect it to obey general restrictions on adjunction. Below we show that the Adjunct Prohibition Condition accurately captures the distribution of VPLD in embedded clauses, lending further support to our claim that the left dislocated VP is adjoined. The Adjunct Prohibition Condition can be formulated as follows (see Chomsky 1986, McCloskey 2006, and Schwartz & Vikner 1996 for motivation):

(24) *Adjunction Prohibition Condition*

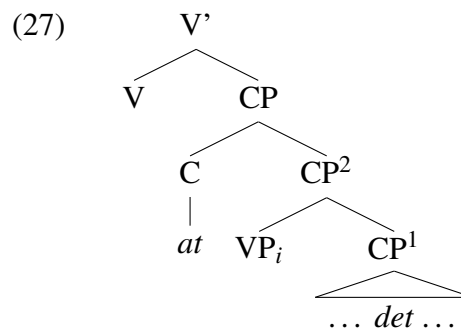
No adjunction to a phrase which is s-selected by a lexical (open class) head.

In (25a), the complement clause (*at de godt kan sy korssting*) is s-selected by the matrix verb *siger*. Given the Adjunction Prohibition Condition and the adjunction analysis of VPLD, we expect VPLD to be prohibited in the embedded clause, and it is:

- (25) a. Han siger (at) de godt kan sy korssting.
 he says (that) 3PL PPI can sew cross.stitch
 ‘He says they can sew cross stitch.’
 b. *Han siger sy korssting, (at) de godt kan det.
 he says sew cross.stitch (that) 3PL PPI can DET

Left dislocation in an embedded clause is only possible when the embedded clause involves CP recursion with the inner, lower CP as the host of left dislocation (on CP recursion in Danish see Vikner 1995 and Nyvad et al. 2017):

- (26) Han siger at sy korssting,
 he says that sew cross.stitch
 det kan de godt.
 DET can they PPI
 ‘He says that they can sew cross
 stitch.’



The adjunction structure in (27) does not violate the Adjunction Prohibition Condition because the CP host of the adjoined VP, CP¹, is not s-selected by a lexical head; CP¹ is selected by the complementizer *at*, which is a functional head. In contrast, VPLD to the outer CP in (27) is impossible:

- (28) *Han siger sy korssting, at det kan de godt.
 he says sew cross.stitch that DET can they PPI
 ‘He says that they can sew cross stitch.’

On our analysis, this is because (28) runs afoul of the Adjunction Prohibition Condition: in this example, the left dislocated VP is adjoined to the CP that is selected by the matrix predicate, which is a lexical head. In sum, the adjunction analysis of VPLD, together with the independently established Adjunction Prohibition Condition, accurately accounts for the limited distribution of left dislocation in embedded clauses.

4. VP left dislocation involves movement

The second key component of our analysis of VPLD in Danish is that the left dislocated VP reaches its CP-adjoined position by movement. There is extensive evidence for movement in VPLD structures in the existing literature. First, Houser et al. 2011:286-287 show that VPLD patterns with VPT in Danish in exhibiting reconstruction effects for Principles A, B and C. Houser et al. (2011) further show (p. 284-286) that both VPLD and VPT are island sensitive, and cannot proceed out of sentential subjects, adjuncts, *wh*-clauses or coordinate structures. To this we add the impossibility of VPLD out of embedded V2 clauses, which Nyvad et al. (2017) show to be islands for extraction in Danish:⁶

- (29) a. *Sy korssting, hvem tror [at det kan jeg godt] ?
 sew cross.stich who thinks that DET can I PPI
 ‘Who thinks that I can sew cross stitch?’
 b. *Sælge gården, hvem tror [at næste år vil han det] ?
 sell the.farm who think that next year will he DET
 ‘Who thinks that he will sell the farm next year?’

The final piece of evidence for movement comes from the morphology of the fronted verb.⁷ In general, non-finite verbal inflection is determined by the immediately preceding auxiliary, and Mikkelsen (2011) shows (p. 86-87) that the inflection on the verb in VPLD is determined by the auxiliary stranded by the VP fronting:

- (30) a. Jeg tror nu ikke de har gem-t/*gemm-e den særligt godt.
 I think now not they have hide-PPT/hide-INF it especially well.
 ‘I don’t think they have hidden it very well.’
 b. Gem-t/*gemm-e den særligt godt, det tror jeg nu ikke de har.
 hide-PPT/hide-INF it especially well DET think I now not they have

⁶We use a *wh*-phrase in Spec,CP of the matrix clause in order to force the resumptive to stay within the embedded V2 clause. This is to rule out an alternative analysis where the left dislocated VP is base generated in its left peripheral position and it is the resumptive *det* that is undergoing the movement constrained by the islands. This is not a possibility for the examples above because *det* remains within the embedded clause.

⁷Houser et al. (2011) also discuss (p. 287-289) parasitic gaps and crossover as possible diagnostics for movement in VPLD, and the confounds that render them inconclusive.

- (31) a. Jeg tror ikke de kan overtal-e/*overtal-t banken.
 I think not they have persuade-INF/persuade-PPT the.bank
 ‘I don’t think they can persuade the bank.’
 b. Overtal-e/*overtal-t banken, det tror jeg ikke de kan.
 persuade-INF/persuade-PPT the.bank DET think I not they can

If VPLD is derived by movement, this inflectional connectivity is accounted for by the same syntactic mechanism that enforces the inflection in the absence of VPLD. Mikkelsen (2011) herself argues against a movement analysis of VPLD on the grounds that it cannot account for V3 order and leaves no “room” for a resumptive element in situ. Both of these issues are resolved by the analysis we develop here: movement is to an adjoined position accounting for V3, while P-recoverability forces the low VP occurrence to be pronounced as a resumptive element.

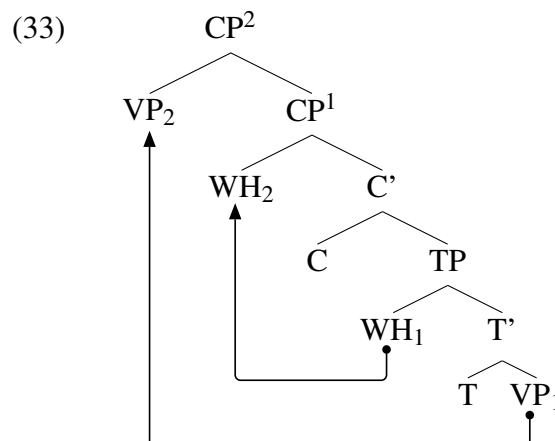
5. Movement in VP left dislocation is direct

The final key component of our analysis of VPLD in Danish is that the VP movement involved in its derivation is one-fell-swoop movement rather than successive cyclic movement. Below we show that the movement is indeed direct in the sense that it does not target the specifier of a CP prior to adjunction to that CP. We then show that this is true even when multiple Spec,CP positions intervene between the base position of the left dislocated VP and its final, adjoined position.

5.1 VPLD within a single clause

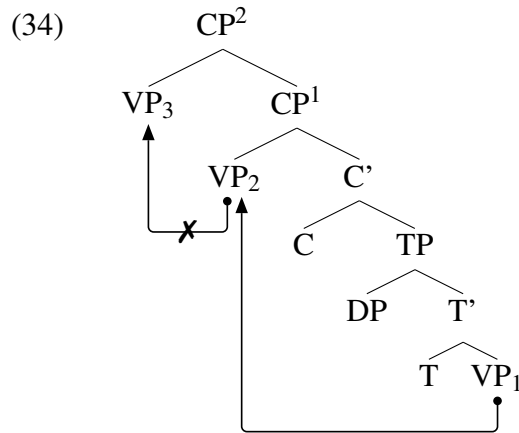
The movement of the left dislocated VP to a CP-adjoined position can be direct, since movement of the VP can cross a Spec,CP occupied by another element. In examples like the following, the left dislocated VP moves across Spec,CP, which is occupied by the *wh*-phrase *hvem* ‘who’, and yields a V3 order:

- (32) Sy korssting, hvem kan det?
 sew cross.stitch who can DET
 ‘Who can do cross stitch?’



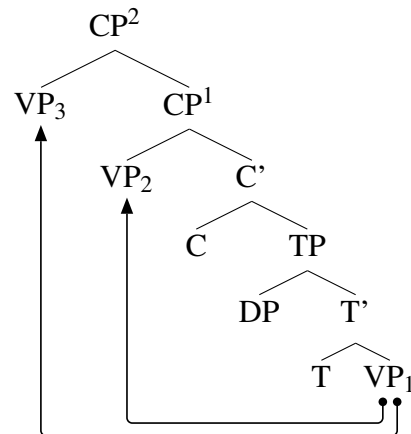
We assume, additionally, that the movement of the left dislocated VP to a CP-adjoined position not only can but also must be direct, since movement of the VP from Spec,CP to

a CP-adjoined position is “too local” (e.g., Abels 2003, Grohmann 2003). We take anti-locality to rule out the following derivation:⁸



An objection to this approach may be that examples like (15), repeated below, are actually possible. However, such examples under our analysis are the result of the direct movement derivation in (36), which also involves movement of the VP to Spec,CP, with concomitant spell out of *det* in Spec,CP.

- (35) Sy korssting, det kan jeg godt. (36)
 sew cross.stitch DET can I PPI
 ‘I can do cross stitch.’



It is worth observing that the reason *det* is spelled out in Spec,CP here cannot be the Phasemate Condition. That is because VP₃ in (36) is, in fact, contained in VP₂’s phasemate domain and, therefore, VP₂ is P-recoverable for the purposes of the Phasemate Condition. However, VP₂ in (36) is not P-recoverable for the purposes of a requirement of type (5c): we take the C head in (36) to bear a phonological EPP feature that demands its specifier be associated with phonological material, thereby ensuring V2 order within CP¹.⁹

⁸Richards 2004 proposes a derivation for certain multiple *wh*-questions in Bulgarian that looks superficially similar to the one we are assuming is ruled out by anti-locality. What might be crucial is that, as far as we can tell, the two derivations differ in that the movement in (34) targets an adjunct position while the movement in Richards’s (2004) (2) on page 454 targets an additional specifier. We leave open the question of why this difference may correlate with whether the movement in question is sensitive to anti-locality. We thank Omer Preminger for bringing this to our attention and for discussion.

⁹Thanks to Emily Clem and Amy Rose Deal for helpful discussion of these issues.

5.2 VPLD across clausal boundaries

It is possible for an embedded VP to undergo long-distance VPLD out of an embedded (non-V2) clause to a CP-adjoined position. In such cases, if the matrix Spec,CP is occupied, *det* surfaces in the CP of origin:

- (37) Sy korssting, hvem tror (at) jeg godt kan det?
 sew cross.stitch who thinks that I PPI can DET
 ‘Who thinks that I can do cross stitch?’

At PF, the Phasemate Condition forces partial pronunciation of the low VP occurrence (VP₁) since the next higher VP occurrence (VP₂) is not contained within VP₁’s phasemate domain:

- (38) a. [CP VP₂ [CP WH C ... V [CP (C_{at}) ... Aux VP₁]]] (Syntax)
 ↑
 b. [CP VP_i [CP WH C ... V [CP (C_{at}) ... Aux *det*_i]]] (PF)

It is also possible for an embedded VP to undergo long-distance VPT to the matrix Spec,CP (by successive cyclic movement) and VPLD (by direct movement). In this case, the result is resumption in the CP that hosts VPLD:

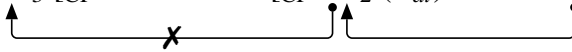
- (39) Sy korssting, det tror de (at) jeg godt kan.
 sew cross.stitch DET think they that I PPI can
 ‘They think that I can do cross stitch.’

The PF derivation of such an example proceeds as follows. In (40), both VP₁ and VP₂ are deleted in their entirety because, for each of them, there is a higher VP occurrence within each of their phasemate domains. However, even though VP₄ is within the phase-mate domain of VP₃, the latter is pronounced partially. As in the case of (35), this partial pronunciation of VP₃ is forced by the phonological EPP feature on C that demands its specifier be associated with phonological material:

- (40) a. [CP VP₄ [CP VP₃ C ... V [CP VP₂ (C_{at}) ... Aux VP₁]]] (Syntax)
 ↑ ↑ ↑ ↑
 b. [CP VP_i [CP *det*_i C ... V [CP _i (C_{at}) ... Aux _i]]] (PF)

Finally, our analysis allows for an understanding of why it is impossible for an embedded VP to move successive cyclically part of the way (e.g. to an intermediate Spec,CP) and directly the rest of the way (to a higher CP-adjoined position), with resumption in the intermediate Spec,CP:

- (41) *Sy korssting, hvem tror det (at) jeg godt kan?
 sew cross.stitch who thinks DET that I PPI can
 ‘Who thinks that I can do cross stitch?’

- (42) a. $[_{CP} VP_3 [_{CP} WH C \dots V [_{CP} VP_2 (C_{at}) \dots Aux VP_1]]]$ (Syntax)

 b. $[_{CP} VP_i [_{CP} WH C \dots V [_{CP} det_i (C_{at}) \dots Aux _]]]$ (PF)

The reason for this is that the intermediate C_{at} bears an OCC(URRENCE) feature that enables extraction out of its complement, but prohibits spell-out of its specifier. Nyvad et al. 2017:449 offer independent support for such a feature on this complementizer in Danish (see also Chomsky 2004:24 and McCloskey 2002 on this kind of feature in general).

6. Concluding remarks

Danish VPLD involves movement (section 4) that is one-fell-swoop (section 5) and targets a CP-adjoined position (section 3). It is the kind of representations that this movement creates and how they are interpreted at PF, in particular by Chain Reduction, that give rise to resumption in Danish VPLD. These results raise important questions about the workings of Chain Reduction and the competing pressures that govern its behavior more generally. Two particularly pressing ones concern the reason why conflicts between Economy of Pronunciation and P-Recoverability are resolved by the observed kind of resumption and whether the Phasemate Condition, a key ingredient in our analysis, can be derived from more basic properties and principles of phase based spell out.

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