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Labeling via Feature Inheritance and Sharing Meets Freezing Effects*

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Kim, Jaejun and Myung-Kwan Park. 2020. Labeling via feature sharing meets freezing effects. *Korean Journal of English Language and Linguistics* 20, 745–767. This paper deduces the freezing effects from Chomsky's (2008, 2013, 2015) Labeling Algorithm. According to this Algorithm, when a minimal projection and a non-minimal projection merge, a minimal projection determines the label of the merger. When two non-minimal projections merge, there are two ways of implementing the labeling. One is via the trace convention; traces are ignored for the labeling algorithm. The other is via feature-sharing; the prominent features that are shared by two non-minimal projections also provide a label for the merger. We suggest in this paper that feature sharing is implemented by feature inheritance from a higher head to the head of its complement. Given the Labeling Algorithm, the freezing effects are to be accounted for in this paper. It is widely known that there is an asymmetry in sub-extraction from subject and object. The latter generally allows sub-extraction out of it, whereas the former does not. We argue following the long tradition of previous studies on this topic that when an element is base-merged as the complement of a head, it allows sub-extraction out of it. However, when the element which is labeling-wise unresolved is merged with a non-minimal projection, it disallows sub-extraction out of it. The freezing effects in various constructions follow from the system of labeling via feature inheritance and sharing.

Keywords: freezing effect, Labeling Algorithm, sub-extraction, feature inheritance, feature sharing

1. Introduction

The goal of this paper is to investigate the freezing effects based on Chomsky's (2013) Labeling Algorithm (LA), focusing on one particular component of labeling via feature

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sharing. Simply put, the freezing effects arise when the sub-extraction out of moved elements is prohibited. Starting from the background of the early investigation into the freezing effects, we provide a labeling-based analysis for the relevant empirical cases. The crucial point of the current label-based account for those cases is that movement of unlabeled elements is categorically banned.

The paper is organized as follows. Section 2 briefly rehearses Chomsky's Labeling Algorithm, particularly introducing three ways of how labeling is determined. Section 3 reviews the previous studies on the freezing effects, focusing on the asymmetry in sub-extraction from different structural positions, followed by recounting the two recent label-based approaches to the freezing effects in section 3.1. Building on these two approaches reviewed in section 3.1, section 4 develops a labeling-based account for the freezing effects specifically by virtue of feature sharing. Section 5 addresses some remaining issues in sub-extraction out of non-moved, in-situ elements. Section 6 wraps up the paper with a conclusion.

2. Background: Labeling Algorithm

Chomsky (2013) proposes the Labeling Algorithm to the effect that the syntactic objects (SO) built by Merge needs to be labeled, so that it can be properly interpreted at the interfaces. The process of the LA is a minimal search (MS) for determining the relevant label for the SO, which applies at phase levels in tandem with spell-out points.

In the LA, there are three sub-components of labeling the SO built by Merge. When a minimal projection (head) and a non-minimal projection (XP) merge as in (1a), the MS finds a head H as the labeler of the merger, resulting in HP in this case. When it comes to the merger of the two non-minimal projections as in (1b), there are two ways of determining the label of the merger.

(1) a. SO = {H, XP} → $[_{HP}$ H, XP]
b. SO = {XP, YP}
(i) XP_i ... {t_i, YP} → $[_{YP}$ *t*, YP]
(ii) $\{XP_{[F]}, YP_{[F]}\}$ → $[_{<F, F>} XP_{[F]}, YP_{[F]}]$

The first is via the trace convention; traces are ignored for the purpose of labeling. In other words, the trace of the moved element cannot participate in the labeling process; hence the YP projects in (1bi). The second is through feature-sharing; what the LA has access to is the prominent features that are present and thus shared by both non-minimal projections. In this case, it is, for example, the feature [F] that is present at both XP and YP. Then the MS locates the shared feature [F], providing a label for {XP, YP} as <F, F>.

Since the LA decides the labeling of the SO built by Merge, the theory subsumes the presence of unlabeled projections in the course of derivation, where the labeling process can be postponed until one element moves as in (1b-i). Chomsky suggests that unlabeled projections need to be labeled in order to be properly interpreted by the interfaces. He argues that the timing when the labeling needs to be done is at the interfaces. In other words, labeling takes place at the phasal level where the elements are sent to the spell-out to get proper interpretation at the interfaces. In this regard, labeling and phase interact closely in tandem with each other. Since the labeling requires a phase and a phase requires a labeling, one of them must precede the other. Hence, the timing of labeling needs to be handled more carefully.

Using the rudimentary but effective components of labeling the SO built by Merge, let us apply them to the constructions at issue in the next section. Given the LA, the freezing effects will follow from the system of labeling, as shown below.

3. Sub-extraction Asymmetry

This section is to briefly introduce the analyses regarding the freezing effect asymmetry between subject and object sub-extraction. It is widely noted in the literature that there is a difference between subject and object when it comes to the sub-extraction out of a DP that they host, as in (2). An object DP allows sub-extraction out of it, whereas a subject DP does not. In other words, the latter is frozen in place, barring further extraction out of it.

(2) a. *Who$_i$ did [$_{\text{subject DP}}$ a story about t_i] amuse you?[1]
b. Who$_i$ did you hear [$_{\text{object DP}}$ a story about t_i]? Lasnik and Saito (1992)

To account for this asymmetry, the Subject Condition (Chomsky 1973, Huang 1982, Chomsky 1986, Freidin 1992) was initially proposed to explain the ungrammaticality of (2a), claiming that the subject does not allow extraction out of it.

(3) Subject Condition:
No element may be moved out of a subject.

However, as noted by Lasnik and Park (2003), the in-situ subject DP allows sub-extraction out of it, as in (4).

(4) a. Which candidate$_i$ were there poster of t_i all over the town?
b. [$_{\text{CP}}$ Which candidate$_i$ were [$_{\text{TP}}$ there [$_{v\text{P}}$ [posters of t_i] all over the town]]]?
in-situ subject

Instead of the movement of the subject DP from the Spec-vP to the Spec-TP, expletive *there* fills the Spec-TP position, allowing the sub-extraction from the VP-internal in-situ subject DP. In this case where the subject DP does not move into the Spec-TP, a violation of the Subject Condition in (2) does not arise. As (4) shows, not every subject DP disallows extraction out of it. Thus, the Subject Condition in (3) needs to be re-characterized.

At this point, it seems reasonable to conclude that only moved elements are prevented from undergoing sub-extraction out of them. However, as (5) shows, not all moved elements disallow extraction out of them.

(5) Of which car was [the driver] awarded a prize?[2] Chomsky (2005)

[1] In subject extraction, pied-piping the preposition does not change the grammaticality of the sentences in question.

(i) a. *Who(m)$_i$ has a comment about t_i annoyed you?
b. *About whom$_i$ has a comment t_i annoyed you? Müller (2010)

[2] It is worth noting that sub-extraction from passive subjects is only allowed when accompanied by

Passive subjects, unlike transitive subjects as in (2a), allow sub-extraction out of them. Clearly, the subject DP in passives starts from the Comp-V (i.e., the complement of a V), eventually moving into the Spec-TP. Thus, there is a certain case like the passive construction where the sub-extration out of the moved subject is, in fact, possible.

Concerning the freezing effects manifested by subject DPs, the previous studies claimed that either Spec-TP (Boeckx 2003, Stepanov 2007, Gallego 2007, Gallego and Uriagereka 2007, Takahashi 1994) or Spec-*v*P (Chomsky 2008, Nunes and Uriagereka 2000, Uriagereka 1999) is the position that induces the freezing effects, assuming the *v*P-internal Subject Hypothesis. But it is widely being debated whether its final landing site (Spec-TP) or its base-generated position (Spec-*v*P) is responsible for inducing the freezing effects.

Regarding the asymmetrical difference between subject and object DPs in light of freezing, the crucial difference between them lies in their base-generated positions, in that subject DPs are generated at the Spec-*v*P and object DPs are generated at the Comp-V. Depending on the types of grammatical constructions involving sub-extraction from the DP in question, the outcome varies; hence it must be investigated in greater details.

3.1 Label-based Analyses

Regarding the well-known asymmetry between subject and object DPs, the recent two analyses applying the Labeling Algorithm to it are to be briefly reviewed in the next sub-sections. Section 3.1.1 rehearses Bošković's (2018) analysis, and section 3.1.2 goes over Nakashima's (2019) analysis.

3.1.1 Recent analysis [I]: Boškosvić (2018)

Bošković (2018) attempts to account for the freezing effect-triggering movement out of a moved element under the phase theory (Chomsky 2000, 2001) using the LA. He postulates the condition (6), based on the assumption that only phases can undergo

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pied-piping. Thus, extraction out of passive subjects pied-piping the preposition allows sub-extraction out of them, whereas extraction out of passive subjects stranding the preposition does not. In other words, pied-piping *of* as in (ib) makes the sentence grammatical, but preposition stranding of it (leaving *of* behind in the Spec-TP) in (ia) does not.

(i) a. *Who$_i$ was [a picture of t_i] taken by Peter?
b. Of whom$_i$ was [a picture t_i] taken by Peter? Kuno (1973)

movement. Under Bošković's analysis, the label-less SO is not a phase; hence it cannot undergo further movement.

(6) Unlabeled SOs cannot undergo movement.

Let us again examine (2a) under Bošković's analysis, repeated as (7a).

(7) a. *Who$_i$ did [a story about t_i] amuse you?
b. [$_?$ Who$_i$ [$_{DP}$ a story about t_i]] [$_{vP}$ v [$_{VP}$ ...]]?
c. T [$_?$ who$_i$ [$_{DP}$ a story about t_i]] [$_{vP}$ v [$_{VP}$ ...]]?

The *wh*-phrase that is to be moved out of the subject DP first moves to the periphery of the DP, as in (7b). The *wh*-phrase needs to move before the subject DP is introduced to the Spec-*v*P, owing to the Phase Impenetrability Condition (PIC). The PIC requires that the element like a *wh*-phrase generated within a phase needs to move to its edge in order to escape out of it. The complement of the phase head is then sent to the interfaces for interpretation. Since the movement out of the phase after the completion of the phase is prohibited, the *wh*-phrase must move to the edge of the DP phase before the entire subject DP merges into the Spec-*v*P. Crucially, according to Bošković (2018), it is the movement of *who* to the edge of the DP that is responsible for the ungrammaticality of subject extraction, but not the movement of the entire subject DP from the Spec-*v*P to the Spec-TP. Its initial movement to the periphery of the DP is the main culprit of the ungrammaticality of the sentence, owing to the condition in (6). The merger of *who* and the DP (in the configuration of {XP, YP}) cannot be labeled since there are no features for them to share. Eventually, even after T is introduced, the subject DP containing the *wh*-phrase in its edge (*[$_?$who$_i$ [$_{DP}$ a story about t_i]]*) cannot undergo further movement to the Spec-T since the entire subject phrase itself is unlabeled (marked as ?-notation).

By contrast, regarding the object extraction in (8), he assumes Chomsky's (2013) proposal that successive-cyclic movement does not involve feature sharing, attributing it to Bošković's (1997, 2002, 2007, 2008, 2018) earlier proposal.

(8) a. Who$_i$ did you hear [a story about t_i]?
b. [$_{VP}$ hear [$_?$ who$_i$ [$_{DP}$ a story about t_i]]]?
c. v [$_{VP}$ hear [$_{DP}$ t_i [$_{DP}$ a story about t_i]]]?

Assume that there is a phrase XP that undergoes successive-cyclic movement, dropping by intermediate positions. Along the way, the XP can obviously merge with another phrase YP. At this point, the labeling of the merger composed of XP and YP can be delayed because its labeling is only done when the relevant XP moves away. Recall that feature sharing (see 1b-ii) in intermediate positions is not a viable option because the element undergoing successive-cyclic movement is about to be moved out of that intermediate position. In this case, the labeling is determined via the trace convention (see 1b-i), with the moved element not taking part in labeling determination. In other words, the element that is about to move successive-cyclically does not rely on the feature sharing option of labeling along its way.

The object extraction is possible for this reason. Again, the *wh*-phrase needs to move to the edge of the object DP before the latter merges with the verb. At this time, the unlabeled status does not matter because as soon as *v* (which is a phase head) merges, the *wh*-phrase moves away to the edge of *v*, owing to the PIC. Eventually, the masked ?-phrase of the object element is now labeled as DP as in (8c). Thus, in the case of sub-extraction out of the object DP, the temporaryily unlabeled status of the object DP does not matter since after the *wh*-phrase undergoes further movement to its final position it is resolved via the trace convention.

However, this account can face a potential problem in handling passive subjects. As mentioned above, the passive subject DP is base-generated as Comp-V. Before undergoing the merger with the Comp-V, the *wh*-phrase needs to move to the edge of the DP as in (9b) owing to the PIC.

(9) a. Of which car$_j$ was [the driver t_j]$_i$ awarded t_i a prize?
b. [$_{VP}$ [$_V$ awarded] [$_?$ of which car$_i$ [$_{DP}$ the driver t_i]] ...]?
c. [$_?$ of which car$_i$ [$_{DP}$ the driver t_i]] T [$_{VP}$ [$_V$ awarded] t_j ...]?

After it is introduced into the Comp-V, the entire phrase (*[$_?$ of which car$_i$ [$_{DP}$ the driver t_i]]*) needs to undergo movement to the Spec-T as in (9c). However, this movement is barred due to the condition in (6). In other words, the passive subject DP cannot undergo further movement to the Spec-T since it is unlabeled in its base-generated position, leaving no difference with the transitive subject DP. However, sub-extraction out of the passive subject DP is known to be permitted.

3.1.2 Recent analysis [II]: Nakashima (2019)

Nakashima (2019) attempts to explain the freezing effects by proposing one simple locality condition on feature sharing of the two phrases, as in (10).

(10) An XP-YP structure provides a label via feature sharing between X and Y only if X and Y have the same depth of embedding. Only the form {XP, YP} = {{$X_{[F]}$, WP}, {$Y_{[F]}$, ZP}} provides a label via feature-sharing.

This condition proposes that as in (1b), when two non-minimal projections merge, the MS requires the prominent feature of the two phrases to be embedded in the same level of depth. As (10) dictates, the F-features in the two phrases are in the same level of depth, being a member in the set of XP and YP. According to (10), in the structure of (11) where the two non-minimal projections merge to form {XP, YP}, feature sharing is a viable option for labeling.

(11) {XP, YP} = {{$X_{[F]}$, WP }, {$Y_{[F]}$, ZP }}

However, when each feature is in the different level of depth, feature sharing is not permitted. The same depth of features are in need to feed into labeling via feature sharing. Feature sharing is possible only in the schema of {XP, YP} = {{$X_{[F]}$, WP}, {$Y_{[F]}$, ZP}}, where the features concerned reside in the outermost heads of the two phrases.

Given Nakashima's proposal, let us take a look at the cases where sub-extraction out of a moved element leads to the ungrammaticality of the sentence as in (12a). Following Chomsky (2008), assume that the landing site of the shifted object is the Spec-V and the non-shifted object stays in its base-generated position.

(12) a. *Who_i did Mary call [friends of t_i]$_j$ up t_j?
b. Who_i did Mary call up [friends of t_i]? Lasnik (2001)

The structures of the given sentences are represented in (13) and (14), each corresponding to (12a) and (12b).

(13) a. {who, {$D_{[\varphi]}$, {friends, ... }}}
b. {{who, {$D_{[\varphi]}$, {friends, ... }}}, {$V_{[\varphi]}$, t_{Obj}}}

(14) a. {who, {$D_{[\varphi]}$, {friends, ... }}}
b. {$V_{[\varphi]}$, {who, {$D_{[\varphi]}$, {friends, ... }}}}

Looking at the shifted object first, the extraction out of the moved object DP is not allowed because prior to building the merger in the Comp-V, the DP has the *wh*-phrase *who* move to its periphery, obeying the PIC. After merging as Comp-V, the whole phrase (*[? who$_i$ [friends of t_i]]*) moves into the Spec-V as in (13b). This is the point where the labeling failure occurs since the two φ-features in question are embedded in different levels of depth as shown in (13b). Thus, labeling via feature sharing is not allowed, with the result that the sentence turns out to be ungrammatical. However, in the case of the non-shifted object, this problem does not arise. Like the shifted object DP, the non-shifted object DP has the *wh*-phrase *who* move to its periphery; in this case the entire object phrase (containing the *wh*-phrase in its edge) does not move but stay in situ as shown in (14b). It stays in its base-generated position, and the labeling problem is obviated since it is the same with the structure of (1a), where the head projects {$_{HP}$ H, XP}. Without incurring a label-less problem, the *wh*-phrase can then move successive-cyclically all the way up to the Spec-CP without engendering any problem.

Nakashima (2019) also entertains Bošković's (2018) proposal that the initial movement of a *wh*-phrase to the edge of a DP is the culprit of the ban on the ultimate sub-extraction out of the DP to be moved. Let us again examine whether Nakashima's analysis can handle the passive construction as repeated in (15), already discussed in (9) in terms of Bošković's analysis.

(15) a. Of which car$_j$ was [the driver t_j]$_i$ awarded t_i a prize?
b. {wh$_i$, {D, {driver, { t_i }}}}
c. {$V_{[\varphi]}$ {wh$_i$, {$D_{[\varphi]}$, {driver, { t_i }}}}
d. {wh$_i$, {$D_{[\varphi]}$, {driver, { t_i }}}, {$T_{[\varphi]}$, ...}

Again, the *wh*-phrase (together with the pied-piped preposition, with the *wh*-phrase abbreviated to *wh* for ease of exposition) needs to move to the edge of DP due to the PIC, as in (15b). It then merges with V as Comp-V. At this point the failure of labeling does not arise since it is the form of H-XP. However, the problem arises when the entire phrase (with the *wh*-phrase in the edge) undergoes movement to the Spec-TP. The feature sharing cannot occur, owing to the condition in (10), since the φ-features are located in different levels of depth, shown in (15d). Since feature sharing at the same level of depth is impossible in this case, the sentence would be dismissed as ungrammatical, which is contrary to the fact.

Regarding pied-piping, Nakashima assumes that, following Cable's (2010) Q-system, it is headed by the Q particle that bears the Q-feature as in (16a). (16a) shows the pied-piped phrase (*of which driver*) itself before merging with another head or phrase. By applying the Q-system, (15d) can be transformed to (16b). In this case as well, the φ-feature sharing is not allowed, due to the condition in (10). The φ-feature of D is too deeply embedded; hence the MS cannot succeed in labeling via feature sharing of the two heads.

(16) a. $\{Q_{[Q]}, \{of, which\ car\}\}$
b. $\{\{Q_{[Q]}, \{of, which\ car\}\}, \{D_{[\varphi]}, \{driver, \{ t_i \}\}\}, \{T_{[\varphi]}, ...\}\}$

This section briefly reviewed the previous two analyses for the freezing effects particularly under the frame of labeling and feature sharing. Their analyses effectively explain the freezing effects. Although the above-mentioned two analyses are attractive, a few problems may still remain within each system.

4. Freezing Effects Based on Labeling via Feature Sharing

This section develops an analysis for the freezing effects based on labeling via feature sharing, suggesting a hybrid account for the effects at issue. Essentially, we concur that the movement out of a moved element is banned (Browning 1991, Collins 1994, Rizzi 2006, Wexler and Culicover 1980) and assume that the highest phrase in the extended projection of any lexical category is a phase, following Bošković (2014). At the same time, additional conditions are in need to explicate the afore-mentioned phenomena. A hybrid approach based on Bošković (2018) and Nakashima (2019) will give a handle, in that it can account for the problematic cases. In keeping with Bošković's and Nakashima's insights, we endorse the idea that the initial internal movement of the *wh*-extractee that undergoes sub-extraction is the key ingredient in capturing the freezing effects.

Slightly adjusting Bošković's condition (6), we suggest the following condition regarding labeling.

(17) Unlabeled categories built by merging two non-minimal projections cannot move.

In the case of the form SO = {XP, YP}, the unlabeled SO cannot undergo further

movement. However, as for the SO = {H, XP} where the XP hosts a *wh*-phrase in its periphery, the XP can undergo movement, based on the idea that inheriting the feature(s) from the head H, the X or actually its non-minimal projection can enter into feature sharing with the *wh*-phrase in its Spec.[3] Of course, the head H projects the label for the containing SO as in Nakashima's (2019) system. Thus, the merged position of the element in question crucially determines whether to move or not. To reiterate, let us assume that the phrase XP is base-generated in Comp-Y ({Y, XP}). Following the condition (17), the XP is allowed to move thanks to the feature inheritance from Y to X. Before the sub-extraction out of the XP applies, it will be properly labeled by the feature(s) inherited by Y. In this situation, before the insertion of the head Y, the labeling of the XP (which contains *wh*-phrase in its edge) is temporarily delayed because the external head Y, not the XP, always determines the relevant labeling. Of course, after the sub-extraction out of the XP, the labeling of the XP will be determined via the trace convention.

With the condition (17) in mind, let us examine each construction one by one, starting with the freezing effects of the subject DP in (18).

(18) a. *Who$_i$ did [a story about t_i] amuse you?
b. [$_?$ who$_i$ [$_{\text{subject DP}}$ a story about t_i]]
c. [$_?$ who$_i$ [$_{DP}$ a story about t_i]] [$_{vP}$ v [$_{VP}$ ...]] ?
d. [$_?$ who$_i$ [$_{DP}$ a story about t_i]] T [$_{vP}$ v [$_{VP}$ ...]] ?

As in (18b), the *wh*-phrase needs to move to the edge of the base-generated subject DP, owing to the PIC, before the completion of the phase. Then the entire subject DP merges into the Spec-*v*P as in (18c). At this point, the entire phrase cannot undergo further movement as in (18d) due to the condition (17). Since the entire phrase *[$_?$ who$_i$ [$_{DP}$ a story about t_i]]* (merged in the form of {XP, YP} with *v*P) is left unlabeled, it is not allowed to undergo further movement. In other words, its unlabeled status (due to the movement of *who* to the

[3] We rely on Chomsky (2008) and Chomsky (2015) for labeling via feature inheritance. Chomsky (2008) proposes that phase heads, C and *v*, can be specified for probing features and EPP, and T inherits its probing features and EPP from C via feature inheritance (FI). According to Chomsky, FI is a general property of all phase heads and should be at play in the domain of *v*-V. Chomsky (2015) also proposes to extend FI to lexical roots that are featurally too weak to label. When *v** is merged, the uPhi (uninterpretable phi-features) of *v** are inherited to the lexical root R, and the uPhi agree with the Spec-R, which remerges with the RP. The result is that shared phi-features label the structure {Spec-R, RP}.

edge of the containing phrase) as (18b) that is due to merging of the *wh*-phrase with another non-minimal projection prevents its further movement to the spec-TP.

This also explains the legitimate sub-extraction out of in-situ subject DPs, repeated in (19).

(19) a. Which candidate$_i$ were there posters of t_i all over the town?
b. [[$_?$ which candidate$_i$ [$_{DP}$ posters of t_i]] [$_{vP}$ *v* [...]]]?
c. [there T [[$_?$ which candidate$_i$ [$_{DP}$ posters of t_i]] [$_{vP}$ *v* [...]]]]?

As (19b) shows, after the *wh*-phrase moves to the edge of the DP, the entire DP merges with the *v*P. Since the unlabeled phrase does not move as dictated by the condition (17), the sentence becomes grammatical only when the expletive *there* is merged into the Spec-TP, filling the surface position that the ordinary subject DP occupies. In this situation, following Lasnik's (1999) analysis of *there* existentials in English, an in-situ subject DP counts as a subject in the small-clause complement of the existential verb *be*, thereby being properly labeled thanks to the feature inheritance from the *be* verb to *v* (in this case, the latter serving as the Pred head of the small clause) even after it allows sub-extraction out of it. Then the *wh*-phrase in question at the periphery of the in-situ subject DP can safely undergo sub-extraction upon the introduction of the next phasal head C. By undergoing sub-extraction, the *wh*-phrase inevitably leaves a trace behind, which cannot participate in a labeling determination.

Before moving on, it should be remembered that traces are ignored for the purpose of labeling, as mentioned in (1b-i). In the middle of the derivation, let us assume that labeling via feature sharing can proceed as in (20).

(20) a. [XP [$Y_{[F]}$ ...]] [$Z_{[F]}$ ...]
b. [t_i [$Y_{[F]}$ ...]] [$Z_{[F]}$ ...]] → movement of XP
c. [$_{<F, F>}$ [$Y_{[F]}$ ...]] [$Z_{[F]}$ ...]]] → labeling via feature-sharing
d. ?
XP [$Y_{[F]}$...] [$Z_{[F]}$ ...] = (20a) before XP moves
e. <F, F>
[$Y_{[F]}$...] [$Z_{[F]}$ ...] = (20c) after XP moves, labeling succeeds via feature-sharing

As Nakashima argues in (20a), feature sharing is not possible when the features are in different levels of depth. However, we argue that this situation can be resolved. Suppose

that the labeling-wise offending phrase XP undergoes movement; then the feature sharing is allowed as in (20b), with the trace being ignored in the labeling process. The result after the movement of the XP is that <F, F> is the label as in (20e).

The condition in (17) can also account for the ECM subjects, in which the sub-extraction is not allowed.[4]

(21) a. *Of whom$_i$ does Mary believe [friends t_i] to be stupid?
b. [$_?$ of whom$_i$ [friends t_i]]
c. [$_?$ of whom$_i$ [friends t_i]] [$_{vP}$ v [...]]? Sabel (2002)

As with the other typical subject DPs, the *wh*-phrase initially moves to the edge of the DP due to the PIC, shown in (21b). It merges with the *v*P (of the embedded clause) just as transitive subject DPs do. At this point, further movement is blocked due to the proposed condition in (17). The failure of labeling in (21b) precludes the embedded subject DP from undergoing a further syntactic operation.[5] As Bošković (2018) argues, the initial merger of the *wh*-phrase and the DP is unable

[4] Chomsky (2008) claims that sub-extraction out of an ECM subject is allowed, using the following example in (i):

(i) Of which car did they believe [the driver] to have caused a scandal? (Chomsky 2008)

However, other scholars claim that it is not allowed, as in (iia-d).

(ii) a. *Of whom does Mary believe [friends] to be stupid? (Sabel 2002: 293)
b. *Who do you expect [stories about] to terrify John? (Chomsky 1973)
c. *Which artists did you find [works by] to be offensive? (Uriagereka 2004: 10)
d. *Who did John believe [pictures of] to have caused the riot? (Boeckx 2012: 116)

In fact, Jurka (2010) reports a survey of the mean average rating for the sentences like (iii) where sub-extraction out of the ECM subject applies, registering 2.24/7 of Likert scale. Unlike Chomsky's claim, they are rated as unacceptable.

(iii) Which politician did John believe a book about to have caused a scandal? (2.24/7)

[5] Chomsky (2008) also notes that sub-extraction is allowed out of the subject DP moved from the infinitival complement clause of a raising predicate, as in (i):

(i) Of which car is [the driver] likely to cause a scandal?

to undergo feature sharing. To reiterate, the merger of the two non-minimal projections complies with Bošković's thesis, in that the failure of labeling leads to the immobility of the SO in question.

Moving onto the problematic passive structure in (22), let us see how the condition in (17) can account for the alleviation of the freezing effects in the case of passive subjects.[6]

(22) a. Of which car$_j$ was [the driver t_j]$_i$ awarded t_i a prize?
b. [$_?$ wh$_i$ [D$_{[\varphi]}$ [driver t_i]]]
c. [V [wh$_i$ [D [driver t_i]]]]
d. [wh$_i$ [D$_{[\varphi]}$ [driver t_i]]] [T$_{[\varphi]}$ ...]
e. C [wh$_i$ [D$_{[\varphi]}$ [driver t_i]]] [T$_{[\varphi]}$ ...]
f. [wh$_{[Q]}$ [C$_{[Q]}$ [t_i [D$_{[\varphi]}$ [driver t_i]]] [T$_{[\varphi]}$ ...]]]
g. [D$_{[\varphi]}$ [driver t_i]] [T$_{[\varphi]}$ ...]

After the *wh*-phrase moves to the edge of the DP, it merges with V as a complement in (22b). The phrase in question is not yet labeled, but since it is merged in the schema of {H, XP}, the head X of the complement XP inherits features from the head H, thereby entering into featuring sharing with the *wh*-phrase at the edge of the DP. As mentioned above, in the schema of {H, XP}, the XP can undergo further movement. When the entire passive subject DP moves via the Spec-*v*P into the Spec-TP, (22d) is yielded. The φ-feature sharing of D and T is not possible due to the presence of the *wh*-phrase, blocking the feature-sharing. However, feature sharing can be postponed as in the case of successive-cyclic movement. When the immediate phasal head C is merged as in (22e), the *wh*-phrase can move to the Spec-C (owing to the Q-feature in C). The remaining phrase in (22g) (with the trace being ignored for the purpose of labeling) can be now labeled via feature sharing since the relevant features are in the same level of depth, that is, in the outermost periphery of the phrases concerned.

Unlabeled elements can move only when they are base-merged as {H, XP} and they get labeled properly via feature inheritance. Otherwise, they are not allowed to move any further, owing to the condition (17). Let us examine some more complex structures involving, first,

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We provisionally assume that the raising infinitive marker allows feature inheritance from T to the head of DP in the embedded [Spec-*v*P] (in the mode of Exceptional Case Marking), thereby allowing for feature sharing between the DP-peripheral *wh*-phrase and its sister non-minimal projection DP.

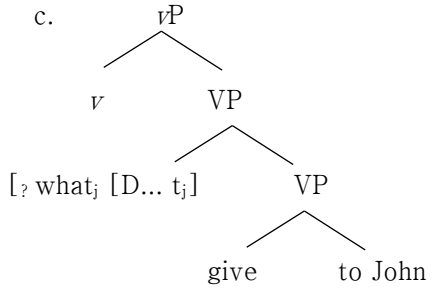
[6] The presence or absence of *v*P does not matter in the discussion at hand since the labeling of the moving element in its base-generated position is critical in allowing sub-extraction out of it.

Heavy NP Shift in the sentence containing a ditransitive verb. Let's look at (23).

(23) a. *What$_j$ did you give t_i to John [a book about t_j]$_i$?

b. [$_?$ what$_j$ [a book about t_j]]

c.



d. [$_?$ what$_j$ [D$_{[\varphi]}$ ... t_j]] [$_{VP}$ V$_{[\varphi]}$ [to John]] Corver (2017)

The *wh*-phrase must first move to the edge of the containing DP. The direct object of the ditransitive verb is base-generated in the Spec-V, shown in (23c). Upon the merger as Spec-V in (23d), the *wh*-phrase is frozen in place because it is unlabeled with the structure of {XP, YP}, which in turn bleeds Heavy NP Shift. In other words, the base-generated position of the direct object DP in ditransitive verb constructions prevents the *wh*-phrase from undergoing sub-extraction. As a result, the initial movement of the *wh*-phrase to the edge of the object DP is again responsible for the ungrammaticality of (23a).

As an alternative analysis, the DPs that undergo Rightward Focus Movement are known to bear focus features. Recall that when the *wh*-phrase moves to the periphery of such a focused DP as in (23b), the head of the DP needs to inherit a feature from the higher head to resolve the resulting unlabeled merger. We suggest, however, that focus features on the focused DP preclude feature inheritance from the higher head to the head of the DP, forbidding the further movement of the focus-bearing unlabeled SO. Since the Comp-V object DP that undergoes Rightward Focus Movement does not allow sub-extraction out of it, we endorse that the alternative analysis is more effective in accounting for the freezing effects on sub-extraction out of focused elements.

Topicalized phrases are another construction displaying the interaction between freezing effects and discourse features that renders evidence in favor of the alternative analysis in the previous paragraph, shown in (24).

(24) a. Who$_i$ do you think that John wanted [pictures of t_i]?

b. $^{?*}$Who$_i$ do you think that [pictures of t_i]$_j$ John wanted t_j ? Stepanov (2007)

(25) a. [$_{?}$ who$_{i}$ [pictures of t_{i}]]
b. V [$_{?}$ who$_{i}$ [pictures of t_{i}]]
c. v [V [$_{?}$ who$_{i}$ [pictures of t_{i}]]]
d. [$_{?}$ who$_{i}$ [$_{DP}$ D$_{[\varphi]}$ pictures of t_{i}]] [$_{vP}$ v [$_{VP}$ V$_{[\varphi]}$ ...]]

The example in (24a) allows the sub-extraction out of the canonical object DP, whereas extraction out of the topicalized phrase (i.e., the moved element) is not allowed as in (24b). The derivation in (25) explains the topicalization construction. After the *wh*-phrase moves to the edge of the DP, the entire DP merges as Comp-V. Owing to the condition (17), the unlabeled status is fine since it is in the schema of {H, XP}; it can get properly labeled thanks to the feature inheritance from V to D. The next question is whether the DP at hand can undergo movement to the Spec-*v*P. We argue that the DP in (24b) cannot. Just as focus features prohibit feature inheritance, topic features on the DP to be topicalized in (24b) also do.[7] Thus, the failure of feature sharing within the DP leads to the unlabeled status, which eventually bans further movement of topicalization banning sub-extraction in (24b).

So far, it has been noted that the base-generation of the element in question plays a pivotal role in accounting for the freezing effects. In sum, the base-generated and the intermediate positions of the given constructions are summarized, as in (26). The asterisk marks the position where the freezing effects arise when the condition in (17) applies.

(26)

Construction	Positions (base to final)
Transitive subject	*Spec-*v*P → Spec-TP
Passive subject	Comp-V → Spec-*v*P → Spec-TP
ECM subject	*Spec-*v*P → Spec-TP (→ matrix Spec-*v*P)
Object Shift or Rightward Focus	*Comp-V/*Spec VP → Spec-*v*P or Right
DP movement	Adjunction to VP
Topicalized phrase	*Comp-V → Spec-*v*P → Spec-CP

[7] We assume that on a par with the DP in (24b) that undergoes TP-peripheral topicalization, the DP in (12a) also undergoes VP-peripheral topicalization. Thus, owing to the presence of focus features on it, the unlabeled DP cannot move further via the Spec of *v*P ultimately to the final landing site of topicalization, which in turn accounts for the ungrammaticality of (12a).

Well-known examples involving the freezing effects are to be accounted for using the condition that bans the movement of the base-merged structure {XP, YP}. The fact that a head can provide a label via feature inheritance when merged with a complement phrase XP that contains the moved *wh*-phrase to its edge allows the XP in question to undergo further movement, ultimately permitting sub-extraction of an XP-internal element.

5. Remaining issues: Freezing Effects in Non-moved Elements

There seem to be cases where the overt movement apparently does not take place, but it is still impossible to extract an element out of unmoved elements, leading to the freezing effects for them. Those cases include Locative Inversion, Predicate Inversion and the Presentational *there* construction, as shown below. In the case of Locative Inversion in (27), it seems that the *wh*-extractee is base-generated within the Comp-V as an *wh*-extractee out of object DPs does; remember that ordinary object DPs allow sub-extraction out of them (see (2b)).

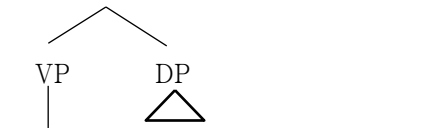
(27) Locative inversion

a. *Who$_i$ do you think on this wall hung [a picture of t_i]?

b. *Who$_i$ do you think [on this wall]$_j$ hung [a picture of t_i] t_j ?

c. [$_?$ who$_i$ [a picture of t_i]]

d.



Müller (2010)

However, it is not the case with Locative Inversion. Bruening (2010) argues that the post-verbal subjects are adjoined to VP at the surface, which is in the form of {XP, YP}. Assuming that Bruening is on the right track, (27c-d) go on with the following derivation. Under the condition (17), assuming that *hang* is an unaccusative verb, after the *wh*-phrase is displaced to its edge, the DP generated in the schema of {X, YP} would be allowed to move because it could get labeled via feature inheritance. However, since the post-verbal

DP in Locative Inversion always bears focus features on it, the feature inheritance is not successful; thus the DP at hand cannot get labeled properly. The result is that the DP in question cannot undergo Rightward Focus Movement to adjoin to the right periphery of VP, eventually disallowing the sub-extraction out of the post-verbal DP.

Alternatively, there seems to be another way of preventing sub-extraction out of the post-verbal DP in Locative Inversion. Let us think about the underlying canonical word order (SVO) of Locative Inversion. *A picture of who* would serve as a subject DP (in the Spec-TP) in that word order when the inversion is not applied. After the movement of the *wh*-phrase to its edge, the DP would merge as Spec-*v*P as in (28).

(28) [$_{?}$ who$_i$ [$_{DP}$ a picture of t$_i$]] [$_{vP}$ *v* [...]]?

Assuming the *v*P-internal Subject Hypothesis, this subject DP in the Spec-*v*P moves to the Spec-TP or post-poses and adjoins to the VP, but it cannot because it cannot be labeled in the Spec-*v*P. The unlabeled element when merged in the form of {XP, YP} thus cannot undergo further movement. By considering the canonical word order (which can be considered as a base sentence of the Locative Inversion construction), the freezing effects of the subject DP in this construction can be captured.

Predicate Inversion, as well, is observed to be ungrammatical when extracting the *wh*-phrase out of the post-verbal subject, as in (29).

(29) Predicate inversion

*Which wall$_i$ do you think the cause of the riot was [a picture of t_i]? Moro (1997)

Similarly with Locative Inversion, Predicate Inversion does not allow sub-extraction out of the post-verbal DP that apparently seems to be located in Comp-V at the surface. Again, considering the canonical word order, *a picture of which wall* is a DP generated in [Spec-*v*P/RelatorP]. The labeling of the *[$_{?}$ which$_i$ [a picture of t_i]]* cannot be executed successfully because of its positional set-up or focus-bearing constraint, thus its further leftward (to [Spec-TP]) or rightward (to the right edge of VP) movement being banned.

The passive construction is an apparently similar case where it, as well as (27) and (29), is associated with the canonical underlying word order when the inversion does not apply. The passive subject DP in (30b), in fact, counts as an object DP when reconstructed to its base-generated position, that is, Comp-V in the canonical underlying word order

sequence. As base-generated as Comp-V like a canonical object DP that stays in situ, the sub-extraction out of it is allowed thanks to the feature inheritance strategy available.

(30) a. Of which car$_j$ was [the driver t_j]$_i$ awarded t_i a prize?
b. V [the driver of which car]

In a similar vein, there is one more peculiar phenomenon involving in-situ subjects in (4), repeated in (30).

(31) Existential *there*-BE
Which candidate$_i$ were there [poster of t_i] all over the town?

This sentence is grammatical since it obeys the condition in (17) well, with the apparently unlabeled element staying in situ; however, recall Lasnik's (1999) proposal that the in-situ subject DP in English *there*-existentials counts as a subject in the small-clause complement of the existential *be* verb, which can enter into proper labeling with its sister by virtue of the feature inheritance. However, there is one more construction, that is, Presentational *there* construction that looks similar to (31), but does not allow sub-extraction out of the in-situ subject DP.

(32) Presentational *there*-V
a. *Who did there arrive [a friend of t_i] at the party?
b. *Who did there appear [a picture of t_i] in the Daily Telegraph? Hartmann (2005)

In Presentational *there* constructions as (32), the sub-extraction out of the in-situ subject DP is not possible although the subject DP did not undergo movement to the Spec-TP. This peculiar case like (32a-b) shows us that the freezing effects emerge not only owing to the immobility of unlabeled elements, but also owing to the peculiar properties of some in-situ elements as well. Regarding this issue, Hartmann (2005) suggests that there is a pragmatics-related definiteness effect, distinguishing the Existential *there*-BE construction from the Presentational *there* construction, sorting out what can be introduced in the post-verbal DP positions of the two constructions. We suggest along the line of analysis for Locative Inversion as well as Rightward Focus Movement that feature

inheritance cannot proceed into focused in-situ subject DPs, which in turn also accounts for the impossibility of sub-extraction out of them in Presentational *there* constructions.

To summarize, there are peculiar cases that show that the freezing effects arise not only to moved elements, but also to some apparently in-situ elements. We argue that when it comes to the freezing effects of the inversion constructions, it is worth considering the constructions where the inversion DOES take place, *vis-à-vis* the canonical word order constructions where the inversion does not apply. Based on that, we suggest that feature inheritance cannot occur to focused apparently in-situ subject DPs, thus precluding them from undergoing further inversion-inducing movement.

6. Conclusion

In this paper, the label-based approach to the freezing effects has been developed. Traditionally, the freezing effects were argued to be accounted for using the ban on moved elements. However, upon the introduction of the Labeling Algorithm (Chomsky 2013), researchers have attempted to investigate the freezing effects in terms of both labeling and phase. Among them, Bošković (2018) and Nakashima (2019) advance compelling arguments by focusing on feature sharing and the unlabeled status of a certain phrase. Based on their proposals, we propose a slight modification of the condition on labeling, precluding the movement from applying to the unlabeled SO, {XP, YP}. The idea is that a head projects while traces are ignored in the determination of a label. Feature sharing is limited to the cases where both features are in the outermost heads of the same level of depth. At the same time, feature inheritance from a higher head to a lower head plays an instrumental role in implementing feature sharing within the projection of the lower head, thus ultimately obviating the freezing effects. Using the proposed condition, we account for the constructions involving moved elements such as transitive subjects, passive subjects, ECM subjects, shifted objects, and topicalized objects. To reiterate, the important factor in determining the sub-extraction in each construction lies in the base-generated position of an XP from which the sub-extraction occurs, since under the proposed condition a head of the XP that inherits features from the immediately higher head can enter into feature sharing and label the containing SO, allowing a movement of its complement. In sum, well-known sentences involving freezing effects are accounted for under the proposed condition using labeling via feature inheritance and sharing.

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Examples in: English
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