A Phase-Based WH-Movement and Matrix Verbs*

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Kim Young-roung, A Phase-Based WH-Movement and Matrix Verbs. *The Linguistic Association of Korea Journal, 10*(3), 25-42. This paper aims to present a solution to some problems with a phase-based movement proposed by Chomsky (1998, 1999). Problems arise even when C has EPP and *wh*-movements follow in a successive-cyclic way. To reveal the problems arising in *wh*-movement, I start this paper with the review of Chomsky's proposals regarding checking uninterpretable features via Agree or Move. Though extracting *wh*-phrases out of islands is prohibited in English, this does not hold always, in fact. When an embedded CP is the object of matrix verbs, it is possible to extract *wh*-phrases out of the embedded clause; while extracting *wh*-phrases out of non-object adjunct and relative clauses (complex NP) is not allowed. Regarding such a derivation, I bring the notion absolute/non-absolute scope of *wh*-questions into the extraction of *wh*-phrases. To see the role that the verbs of matrix clauses play in *wh*-phrase extraction, I cited GB-based classical data presented in Manzini's paper.

Key words: phases, absolute/non-absolute scope, (in)complete features

1. A Phase-Based Movement and Its Problems

Chomsky (1998) claims that syntactic operations, overt and covert, are applied successive-cyclically, based on a phase-based cycle. He also claims that *v*P and CP are phases and that only the head and the Spec of a *phase* are accessible to a higher category. According to Chomsky (1999), checking uninterpretable features between Probe and Goal is done by Agree or Move. If Probe has EPP, Move takes place; if C has

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EPP, *wh*-movement follows in English.

Pesetsky (2000) claims that, since both Probe and Goal have uninterpretable features, Agree takes place. In *wh*-questions, there are two features: Q and WH. C has interpretable Q-feature and uninterpretable *wh*-feature; a *wh*-phrase has uninterpretable Q-feature and interpretable *wh*-features.

As both C and *wh*-phrase have uninterpretable features, Agree takes place. Uninterpretable features of Probe are split into two: Probe has an uninterpretable WH features, μWH(+EPP) or μWH(-EPP). If Probe has μWH(+EPP), *wh*-movement takes place.

Chomsky (1999) claims that Probe searches a matching feature (goal) from its domain. But this matching is not enough for Agree to take place. Both Probe and Goal must be activated to initiate Agree. He adds that lexical items must have uninterpretable features to be activated. Therefore, both Probe and Goal must have uninterpretable features for Agree[1]. The relations of Probe and Goal can be specified as follows. The most important one is the notion of chain.

(1) Chain: The nodes A and B form a chain (A, B) iff
   i. A c-commands B and
   ii. A is one of the same phrasal status as B
   iii. A has a marked feature f which is also a feature of B

The marked feature is called Probe; the feature on B which the Probe seeks is called Goal. It essentially says: look at two nodes which are either both heads, or both phrases; check to see whether one node c-commands the other.

Then the nodes are in a chain relationship if the c-commanding node

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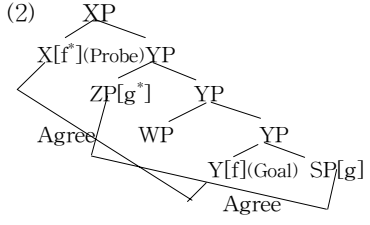
1) Chomsky (1999) says that "matching of probe-goal induces Agree, eliminating uninterpretable features that activate them. A number of questions arise; specifically, with regard to the theses:

(i) Probe and goal must both be activated for Agree to apply
(ii) α must have a complete set of φ-features (it must be φ-complete) to delete uninterpretable features of the paired matching element β."

has a marked feature on it and there is a matching feature on B. By marked feature here, we simply mean that this feature is the one which is responsible for setting up the chain relationship.

It could be any feature of the head-which particular one is specified by the lexical entry. The marked feature is sometimes called a Probe, and we will notate it with an asterisk after the feature in the specification. The feature on B which the Probe seeks is called a Goal. This definition is illustrated below:



Here X and Y are both heads, so they are of the same phrasal status. X c-commands Y. X has a Probe [f*] and Y has an appropriate Goal [f], so we can set up a head-chain (X, Y). Similarly, ZP and SP are both phrases, so they too are of the same phrasal status. ZP c-commands SP, so, assuming ZP has a Probe and SP a matching Goal, we can set up the phrasal chain (ZP, SP)

To make matters a little concrete, we could imagine that Y is a verb and YP its VP projection, and that X in (2) is actually T. Assume that T has a tense-feature Probe, which is matched by the tense-features of the verb. We can then set up a head-chain (T, V)[2].

Based on Chomsky's (1998, 1999) theory, I examine *wh*-movement to find out the problems with his claim and present a proposal for the

2) Usually it is assumed that the formation of a chain can be blocked. This blocking takes place when, between A and B in the tree, there is another node C, which is of the same phrasal status as A and B. This node C is said to intervene A and B. The notion of intervention between A and B can be made explicit in terms of c-command. C intervenes between A and B if and only if, A c-commands C which c-commands B.

solution to the problems arising in Chomsky's claim. Extracting *wh*-phrases out of islands is prohibited in English, because Subjacency condition is applied as a syntactic rule in movement. Consider the examples to see the overall pictures of the Subjacency conditions:

(3) What$_i$ did Mary buy t_i?
(4) What$_i$ do you think [that Mary bought t_i]?
(5) *What$_i$ was Mary bothered [because you repaired t_i]
(6) *What$_i$ do you know [the girl [that repaired t_i]]?[3)]

(3) is a simple *wh*-question. The rest examples are about long-distance *wh*-movement. As in (4), when the embedded clause is the object the matrix verb, moving *wh*-phrases across clauses is possible. Ill-formedness follows as in (5) and (6). As seen in (5) and (6), moving *wh*-phrases across adjunct clause and relative clause (Complex NP) results in ill-formedness. We see that the violation of Subjacency condition has something to do with the *wh*-phrases, which cross adjunct and relative clauses, that is, non-object CPs of the matrix verbs. Even in the case of the relative clause, the embedded clause is a complement to the NP. Even so, extraction out of the complement clause is not permitted.

Let us account for the ungrammaticality based on the notion of Chomsky's (1998, 1999) *phase*. Derivations proceed in a cyclic way. In deriving a sentence, the computation does not try to build the whole sentence at one derivation. The derivation is done through several *phases* and the computation can access one *phase* at a time. When one *phase* is finished, it is sent to LF and PF. When the computation starts to build a new *phase*, it can no longer access the old *phase* (except its head and spec). When all *phases* are carried out, they are combined so that the whole sentence is pronounced and its meaning as a whole is available.

One advantage of this notion is that we can decrease computational

3) The examples (3-4) are cited from Manzini (1992)

complexity. We understand that, when *wh*-phrases move across clauses, they move successive-cyclically. This means that there are kinds of boundaries and that syntactic relations cannot be formed beyond the boundaries.

It is impossible to access old *phases,* because the *phase* has already converged so that the computation cannot see inside the category. But Chomsky adds that the head and the spec of *phases* are accessible for the computation[4]. Chomsky assumes that *v*P and CP are phases. Thus, if phases manage to move via spec of CP and *v*P, they are allowed to move up further into a new phase, from which successive-cyclic movement of *wh*-phrases follows.

However, this causes an empirical problem, which does not render support to the notion of *phase*. Consider the example of extracting *wh*-phrases out of adjunct clauses. Consider (5), repeated:

(5) *What was Mary bothered [because you repaired t_i]?

We need to explain why *wh*-phrases in adjunct clauses cannot move into the Spec of CP. Adjunct clauses are not accessible for higher clauses. Moving *wh*-phrases across clauses is possible in (4), but not possible in (5). Why are adjunct clauses not accessible for a higher clause? Why is it not possible to raise *wh*-phrases to Spec of CPs which head adjunct clauses? The difference between (4) and (5) is that the embedded clause in (4) is the object of the matrix verb; while the embedded clause in (5) is a non-object adjunct clause. Judging from this, we can see that verbs and their complements CPs have a major role in allowing a part to raise to the spec of CP.

We are still unable to account for the relative clause based on the notion of a phase. One possible solution is to assume that DP is a phase, too[5]. If so, it is understandable that extracting *wh*-phrases out of

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4) This condition on phase are called Phase-impenetrability Condition, which prevents extraction of lexical items from older phases

5) It is known that CP and DP have a similar structure as follows:

(i) I know [that Ken is happy]

DPs is impossible. In relative clauses, even if a *wh*-phrase manages to reach the spec of the embedded CP, the matrix CP cannot access the *wh*-phrase because DP, which is a phase, intervenes between the two[6]. However, it is not desirable to introduce DP as a new phase, because it is arbitrary. In addition, when it is regarded as another phase, other functional categories can also be a phase for convenience' sake on occasion.

We know that arguments and adjuncts show different behaviors. In the case of WH islands, extracting adjunct *wh*-phrases causes more serious ungrammaticality than extracting argument *wh*-phrases as seen in (7) and (8):

(7) *Whom$_i$ do you know the date when Mary hit t_i?
(8) **When$_i$ do you know the man whom Mary hit t_i?

Furthermore, adjunct *wh*-phrases cannot be extracted from adjunct clauses while argument *wh*-phrases can be extracted as in (9) and (10):

(ii) [That Ken is happy] is not true
(iii) I know the fact

In (i), the embedded clause is CP and a complement to the matrix verb. In (ii), the embedded clause can be a subject as well, which suggests that CP also functions as DP. (i) and (iii) show that both CP and DP can occupy object position. Therefore, it seems to be universally the case that CP and DP have something in common structurally.

6) There is a view that PP is also a phase. Consider the following examples:

(i) Who did you look at?
(ii) What did you take pictures of?

Example (i) is a case where extraction out of PP is possible. (ii) is a case where extraction out of DP and PP at the same time is possible. These data simply seem to cancel the above claim that DP and PP are *phases*. However, it is possible to think that the prepositions might be incorporated into the verb so that the verb and preposition constitute one verb in (i) following Kayne (1994). Similarly, the DP and PP, 'picture of,' might be incorporated into 'take' so that 'take picture of' was as a whole is one verb. If so, it is no wonder that movement of *wh*-phrases in these cases is fine because phases disappear after incorporation. Generally, incorporation is applied to arguments, not adjuncts.

(9) Who$_i$ did Mary go to Korea [to visit t_i]?
(10) *Where$_i$ did Mary go to Korea [to work t_i]?

Considering these differences, we can claim that arguments are more accessible to a higher clause than adjuncts. Thus, we can argue that, in the case of extracting *wh*-phrases out of adjunct clauses, higher clause cannot access *wh*-phrases at spec of CPs which head adjunct clauses, so that adjunct clauses are islands.

However, this view has still a few problems that should be further addressed, including the fact that some non-adjunct clauses can be a barrier, too.

2. Absolute/Non-Absolute Scope and Q-Feature

Suppose that only embedded CP, which is the object of matrix verbs, can have uninterpretable Q-feature, μQ, which triggers successive-cyclic movement. Consider the following sentence, repeated:

(4) What$_i$ do you think that Mary bought t_i?

'What' does not directly move to spec of the matrix CP. Rather, it moves to spec of the embedded CP and then to spec of the matrix CP, which is called successive-cyclic movement of *wh*-phrases. What does attracts the *wh*-phrase to the embedded CP?

Following Chomsky (1999), we assume that the embedded C can have Q (as EPP). We further assume that there should be two kinds of Q features: one that marks the absolute scope of *wh*-question, that is, adjunct and relative clauses have the absolute scope of *wh*-question; and the other that marks the non-absolute scope of *wh*-question, that is, the embedded CP as the object of the matrix verb has non-absolute scope of *wh*-question.

In the absolute scope of *wh*-question, *wh*-phrases check Q-features

via Move or Agree and then the uninterpretable Q features of *wh*-phrases are checked and deleted. It follows that no further Move (or Agree) of the *wh*-phrases is necessary. In the meantime, in the non-absolute scope of *wh*-question, the uninterpretable Q features of *wh*-phrases are not checked off, hence, not deleted by C. Thus, the *wh*-phrases should go through another checking with a higher category for their uninterpretable Q features to be checked. This implies that successive-cyclic movement of *wh*-phrases occurs as follows: First, movement to an intermediate C is caused in the non-absolute scope of *wh*-question; second, movement to a higher category for the checking of uninterpretable Q features that are not checked in the non-absolute scope of *wh*-question as seen in (11).

In Chomsky (1998, 1999), selection of categories is determined by status of categories which are to be selected. For example, C selects T_{comp} and V selects T_{def}. T_{comp} is ϕ-complete whereas T_{def} is ϕ-incomplete. Therefore, what selects T depends upon the status of T, being complete or defective.

As Chomsky claims, we also assume C selects T_{comp} and V selects T_{def}. T_{comp} is ϕ-complete whereas T_{def} is ϕ-incomplete[7]. This also strongly implies that the verb in matrix clause plays a significant role in selecting φ-complete or φ-incomplete and in allowing *wh*-phrases to raise. Therefore, when T_{def} has ϕ-incomplete and μWH, a *wh*-phrase raises to its spec of CP. But, after the *wh*-phrase raises, both ϕ-incomplete (of the T) and μQ (of the *wh*-phrase) is not checked off. This is because both are uninterpretable, so one of them cannot value the other. Hence, they remain unchecked, which triggers the *wh*-phrase to raise to a higher CP. This is illustrated as follows:

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7) Chomsky says in Derivation by Phase: "Unless selected by C or v^*, T and V are defective (raising T, passive/unaccusative V, respectively). They do not enter into Case-agreement, and have no EPP-feature. When selected by C or v^*, T and V are φ-complete, entering into Case-agreement structures (with raising of associate or not, depending on optionality of the permitted EPP-feature and availability of alternatives to satisfy it)."

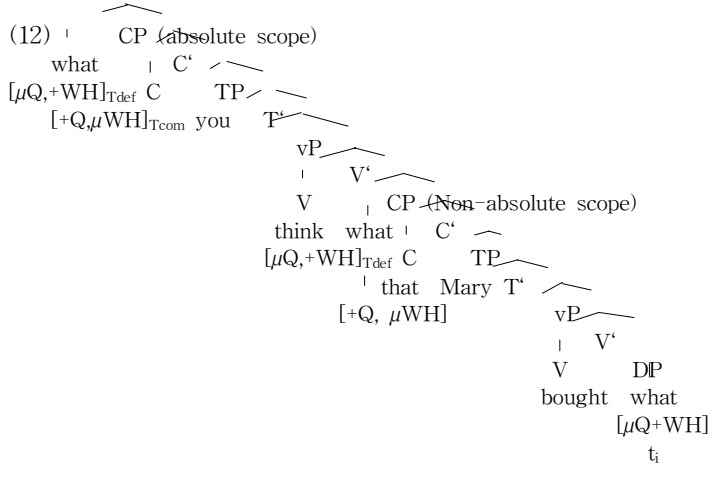
(11) a. [C Mary bought what]
[+Q, μWH] [μQ,+WH]

b. [what C Mary bought] (non-absolute scope)
[μQ, +WH] [+Q, μWH]

c. [V what C Mary bought]
[μQ,+WH]$_{Tdef}$ [+Q, μWH]

d. [what C you think C Mary bought] (absolute scope)
[μQ,+WH]$_{Tdef}$ [+Q, μWH]$_{Tcomp}$

(12)



In (11a), since Probe has [μWH], *wh*-movement takes place as claimed by Pesetsky. In (11b), only μWH of C is checked off. As we assumed above, it has non-absolute scope, thus the uninterpretable Q features of *wh*-phrase are not checked off, hence, not deleted by C. Such being the case, the *wh*-phrase should go through another checking with a higher category for their uninterpretable Q-features to be checked off. In (11c), the whole embedded CP merges with V, and 'what' has [μQ, +WH] with T_{def}, because it is selected by V. In (11d), 'what' raises to spec of the matrix CP. Here the [μQ, +WH]$_{Tdef}$ that 'what' has is checked with [+Q, μWH]$_{Tcomp}$ that C has. Thus, all uninterpretable features are

checked off. This shows how successive-cyclic movement takes place.

In the case of adjunct and relative clauses which have absolute scope, *wh*-phrases check Q-features via Move or Agree, and the uninterpretable Q-features of *wh*-question are checked and deleted. Therefore, no further Move (or Agree) follows. This is fine with adjunct and relative clauses, because they are not selected by V, which selects T_{def}.

However, one problematic case needs to be explained in the present account. Consider the following sentence:

(13) What$_i$ do you wonder [$_{CP}$ t_i′ Ken bought t_i]?

As the embedded clause in (13) is an adjunct clause, it marks the absolute scope of *wh*-question as we assumed above. In the absolute scope, as *wh*-phrases check Q-features via Move or Agree and then the uninterpretable Q features of *wh*-phrases are checked and deleted, it follows that there is no further Move (or Agree) of the *wh*-phrases. Despite this, the embedded clause behaves as if it were the object of the matrix clause with non-absolute scope, going through another checking with a higher category for their uninterpretable Q features to be checked and thus showing successive-cyclic movement of *wh*-phrase. This is the question that remains to be further addressed. To find a solution to this problem, I invoke Manzini's proposal on Unification Theory of Subjacency.

3. CP Split: Object CP and Non-Object CP

It has been regarded that Manzini's (1992) theory of locality could solve the problems facing Chomsky's (1986) barriers. It is thus regarded that Manzini's theory is a better one than Chomsky's barriers. After briefly reviewing Manzini's locality theory, based on this, I propose a solution to the problems arising in the recent Chomsky's (1998, 1999) theory that we have seen above.

There are a number of dependencies in grammar that display strictly local behavior: anaphor, A-movement, A-bar movement of adjuncts and arguments. We wonder if they should be dealt with separately or there is a unified theory of locality that can be applied to all these domains.

Relative clauses (complex NP), adjunct islands, and subject islands are regarded as strong islands, while *wh*-islands, inner islands, and pseudo-opacity islands are regarded as weak islands[8].

The problems, which remain in Chomsky's (1986) barriers, are that nothing in the theory predicts difference between objects of Ns in complex CPs and objects of Vs.[9]

To solve such a problem, Manzini proposes the definition of barrier[10]. Manzini proposes that the positions from which extraction can take place, adjoined positions aside, are as in (14), where α_3 is taken to be the adjunct position. In (14) the embedded CP is represented as the object of the matrix V.

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8) This means that the sentences become bad regardless of what we extract; weak island means that the sentences are bad only for non-argument extractions.

9) In fact, the interaction between *wh*-islands and Tense cannot be accounted for without stipulating that tensed IP is an inherent barrier. Also, the ill-formedness of multiple *wh*-extraction cannot be achieved without additional stipulations concerning the cumulativity of barriers crossing at different stages of the derivation. The major contents of Chomsky's (1986) barriers includes Ancillary Definitions, Definition of Barrier, Subjacency, Creating Escape Hatches, the ECP, the Minimality Barrier, and Additional Stipulations.

10) Manzini's Definitions of barrier, Subjacency, and ECP are as follows:

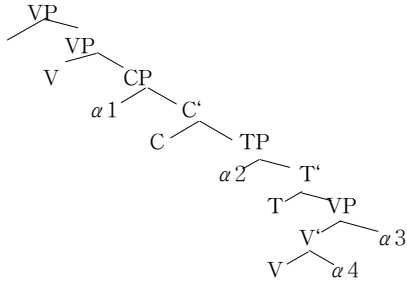
(i) β is a barrier for α iff β is a maximal projection, β dominates α, and β is not L-marked.

(ii) Subjacency
If α is a trace, α is θ-governed, there is an antecedent β for α such that α is subjacent to β

(iii) An argument cannot be adjoined to.

(iv) ECP
If α is a trace, there is an antecedent β for α such that
a. α is θ-governed and there is a c-(command) set (β, . . . α) that satisfies government; or
b. (β, α) satisfies government

(14)



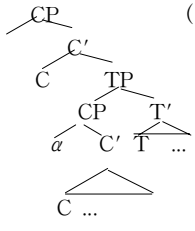
Consider the embedded object, α_4 in (14). If α_4 is to form a chain[11], it must move to a VP-adjoined position, then to an IP-adjoined position, and then to the Spec of CP position α_1. If the embedded CP is in an object position, as in (14), it is not a barrier (phase) for α_1; hence, α_1 can move to the next VP-adjoined position, and so on. However, if the embedded CP is a subject, adjunct, and relative clauses, as in (15), (16), and (17), then CP is a barrier (phase) for α_1; hence, no movement can take place.

(15) *What$_i$ does [repairing t_i] bother you?

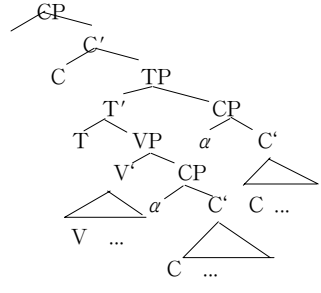
(16) *What$_i$ was Mary bothered [because you repaired t_i]?

(17) *What$_i$ do you know [the girl [that repaired t_i]?

(15′)

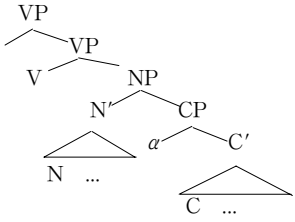


(16′)



11) Specific definitions for forming chain used in Manizini are left out here.

(17′)



If α_4 moves successive cyclically, then it is predicted to be sensitive to subject islands, adjunct islands, and complex NP islands under antecedent government. If α_4 moves in one step and a c-set (α_1, C, I, V, α_4) is constructed to satisfy locality, exactly the same sensitivity to islands is predicted. The result is that (15), (16), and (17) are predicted to be ill formed under all possible derivations, as desired.

If CP is not an object, as in (18)-(20), subject, adjunct, and complex NP island violations are correctly predicted to arise[12].

(18) *How$_i$ does [repairing it t_i] bother you?
(19) *How$_i$ was Mary bothered [because you repaired it t_i]?
(20) *How$_i$ do you know [the girl [that repaired it t_i]]?

Consider on the other hand, so-called weak island, to which α_4 is insensitive, as in (21), which is the case that remains to be addressed in the recent Chomsky's theory as we pointed out above.

(21) What do you wonder [how$_j$ to repair t_i t_j]?
(22) *How$_i$ do you wonder [what$_j$ to repair t_j t_i]

If α_4 moves successive cyclically, a violation arises because the Spec of CP position α_1 is independently filled, and movement from the embedded IP-adjoined position to the matrix VP-adjoined position in

12. Based on the former government notion, the sentences violate the antecedent government.

(14) crosses a phase, the embedded CP. However, suppose that α_4 moves in one step, as it is also allowed to do. Then, in (14) there is always a well-formed c-set relating α_4 to a position external to the embedded CP, (. . .,V, C, I, V, α_4), which is entirely insensitive to whether the Spec of CP position of CP position is filled or not. Thus, *wh*-islands are predicted to be irrelevant for α_4, as desired.

As we assume above, this confirms that, when an embedded CP as the object of the matrix verb has non-absolute scope of *wh*-question, the uninterpretable Q features of *wh*-phrases are not checked off, hence not deleted by C. Thus the *wh*-phrases should go through another checking with a higher category for their uninterpretable Q features to be checked.

By employing the claim that Manzini made, we can have a new interpretation to account for subject, adjunct, and complex NP (relative clause) islands. As for nonobject extractions, it additionally accounts for complex NP islands. Furthermore, this interpretation correctly accounts for *wh*-island violations with nonobjects as in (22).

4. Conclusion

This paper reviewed Agree and Move in checking uninterpretable features. Regarding *wh*-movement, Chomsky's view is different from Pesetsky's view: Chosmky claims that if Probe has EPP, Move takes place; if C has EPP, *wh*-movement follows in English. However, Pesetsky claims that uninterpretable features of Probe are split into two: Probe has an uninterpretable WH features, μWH (+EPP) or μWH(-EPP). If Probe has μWH(+EPP), *wh*-movement takes place.

Extracting *wh*-phrases out of islands is prohibited in English, based on Subjacency condition applied as a syntactic rule in movement. However, empirical problems of *wh*-movements arise in Chomsky's (1998, 1999) recent theories. As a mechanism to present a solution to the problems, I focus on the different role of of the matrix verb that plays in object embedded clauses and in non-object embedded clauses

like adjunct and relative clauses. When the embedded clause is the object of the matrix verb, moving *wh*-phrases across clauses is possible; in other cases, ill-formedness follows as in (5) and (6). Moving *wh*-phrases across adjunct clause and relative clause (Complex NP) results in ill-formedness. This shows that the violation of Subjacency condition has something to do both with the role that the verb of matrix clauses plays and with the *wh*-phrases, which cross adjunct and relative clauses, that is, non-object CPs of the matrix verbs.

In accounting for the ungrammaticality based on Chomsky's (1998, 1999) phases, we see that an empirical problem arises, which does not render support to the notion of a phase. Given that object clauses are accessible to higher clauses and adjunct clauses are not accessible to higher clauses as seen in (4-6), this strongly implies that verbs play a major role in allowing *wh*-phrases to move up further into a new phase based on successive-cyclic movement.

As a way to find a solution to such an asymmetrical problem, I employ the absolute/non-absolute scopes of *wh*-questions, supposing that there are two kinds of Q features: one that marks the absolute scope of *wh*-question, that is, adjunct and relative clauses have the absolute scope of *wh*-question; and the other that marks the non-absolute scope of *wh*-question, that is, the embedded CP which is the object of the matrix verb has non-absolute scope of *wh*-question. In the absolute scope of *wh*-question, *wh*-phrases check Q-features via Move or Agree and then the uninterpretable Q features of *wh*-phrases are checked and deleted. It follows that no further Move (or Agree) of the *wh*-phrases is necessary. In the meantime, in the non-absolute scope of *wh*-question, the uninterpretable Q features of *wh*-phrases are not checked off, hence, not deleted by C. Thus, the *wh*-phrases should go through another checking with a higher category for their uninterpretable Q features to be checked, through the successive-cyclic movement of *wh*-phrases.

I follow Chomsky's (1998, 1999) selection of categories determined by status of categories on T_{comp} and T_{def}. Then, in the case of embedded CP which is the object of the matrix verbs, $[\mu Q, +WH]_{Tdef}$ of the *wh*-phrase, which is selected by the matrix clause in the non-absolute

scope, cannot be completely checked off and deleted by the [+Q, μWH] in C, because [μQ, +WH]$_{Tdef}$ is in the non-absolute scope and it has the T_{def}. For this reason, [μQ, +WH]$_{Tdef}$ should further move up to a higher category, Spec of CP. Here, [μQ, +WH]$_{Tdef}$ of the *wh*-phrase is checked and deleted by the [+Q, μWH]$_{Tcomp}$ in C.

To further prove the role that the verbs of matrix clauses play in allowing the extraction of *wh*-phrases, I review some GB-based classical data presented in Manzini's paper. Accordingly, CPs, which are the object of a matrix verb, should be viewed differently from CPs which are not the object of a matrix verb. According to the properties of the matrix verbs, Manzini is thought to develop the configurations shown in (15′-17′). This strongly supports my claim that according to the role of the matrix verbs, the scope of *wh*-questions can be split into two: the absolute scope that is found in adjunct clauses; the non-absolute scope that is found in the object clause, which triggers movement up to a higher category in a successive-cyclic way.

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