Arguments against reanalyses of Pair-MERGE as Set-MERGE

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1. Introduction

This paper demonstrates that the reanalysis of Pair-MERGE as Set-MERGE based on Zermelo-Fraenkel Set-Theory with the Axiom of Choices (**ZFC**) proposed by Omune (2018) is untenable. Furthermore, we point out that another reformulation of Pair-MERGE as Set-MERGE based on a subspecies of MERGE (i.e., Asymmetric MERGE) of Nakashima (to appear) has a self-contradiction problem. Omune (2018) attempts to reformulate Pair-Merge/MERGE as Set-Merge/MERGE within ZFC. We show that his analysis has both conceptual and empirical problems. On the conceptual side, we point out that head raising under ZFC-based analysis inevitably violates the principle of Determinacy (Chomsky 2019a,b, Chomsky et al. 2019). On the empirical side, we show that the ZFC-based reformulation of Pair-MERGE as Set-MERGE does not explain the observation that a head-raised NEG in English licenses an NPI in its c-commanding domain (Roberts 2010). Given these limitations, we conclude that any reformulation of Pair-MERGE based on ZFC is untenable. Moreover, we demonstrate that Nakashima's (to appear) recent attempt to derive adjuncts from a variant of MERGE has a conceptual problem, which can be rephrased as an element in the Workspace (**WS**) being accessible and inaccessible from Minimal Search at the same time. We conclude that the current minimalist model which adopts the system of MERGE (Chomsky 2019a,b) must assume Pair-MERGE as an independent operation.

In this paper, we mainly focus on internal Pair-MERGE of heads, also known as head-to-head adjunction, as a representative manifestation of Pair-MERGE in the syntactic theory. The rest of this paper is organized as follows. In Section 2, we briefly review the ZFC-based analysis of Pair-MERGE as Set-MERGE, advocated by Omune (2018) and then point out a conceptual problem in the ZFC-based reanalysis. Under the MERGE-based system (Chomsky et al. 2019: 245-246), Determinacy is ensured by restricting accessible elements in WS to the minimum. We point out that any ZFC-based reformulation of Pair-MERGE as Set-MERGE violates the Principle of Determinacy. Furthermore, we address an empirical problem of the ZFC-based analysis of internal Pair-MERGE of heads. We take up the syntactic NEG-raising phenomenon in English as a case study and demonstrate that the analysis of Omune (2018) faces a serious problem of undergeneration. In Section 3, we turn to Nakashima's (to appear) reanalysis of adjunction/Pair-MERGE as Asymmetric MERGE as he calls it. We point out that the way Nakashima incorporates the Determinacy principle in his analysis is problematic. Section 4 concludes the paper by stating that Omune's (2018) reformulation of Pair-MERGE based on ZFC is untenable and that the current minimalist model under MERGE (Chomsky 2019a,b) must assume Pair-MERGE, or possibly Form Sequence (Chomsky 2021), in the theory.

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2. Determinacy and the ZFC-based analysis of Pair-MERGE

2.1. Omune (2018)

In this section, we review an instance of ZFC-based reformulations of Pair-Merge/MERGE proposed by Omune (2018). Pair-Merge/MERGE has been assumed to be an independent operation that takes two syntactic objects α, β and forms an ordered pair $<\alpha, \beta>$ (Chomsky 2000). Omune (2018) points out that Pair-Merge can be eliminated if we adopt the definition of an ordered pair within ZFC as follows:

(1) $<\alpha, \beta> = \{\alpha, \{\alpha, \beta\}\}$ (see Tourlakis 2003)[1]

He argues that an ordered pair $<\alpha, \beta>$, which has been postulated to be created by Pair-Merge, is reduced to $\{\alpha, \{\alpha, \beta\}\}$ created by Set-Merge.

Omune (2018) argues that reformulating $<\alpha, \beta>$ as $\{\alpha, \{\alpha, \beta\}\}$ allows us to capture the asymmetry between α and β in $<\alpha, \beta>$ without postulating Pair-Merge. That is, an unordered set $\{\alpha, \{\alpha, \beta\}\}$ is sufficient to represent an adjunct structure where β adjoins to α and becomes invisible. This is the essence of the ZFC-based reformulation of Pair-Merge as Set-Merge. Given this, Omune (2018) proposes that Pair-Merge of heads (i.e., head-to-head adjunction) is also reformulated by Set-Merge. In his analysis, an unordered set in (2a) created by Set-Merge represents a head adjunction structure in (2b) created by Pair-Merge, where H_1 adjoins to H_2.

(2) a. $\{H_1, \{H_1, H_2\}\}$
b. $<H_1, H_2>$

The rest of this section shows that while eliminating Pair-MERGE is theoretically desirable, Omune's (2018) reformulation of Pair-MERGE as Set-MERGE has both conceptual and empirical problems.

2.2. A conceptual problem of the ZFC-based analysis of Pair-MERGE

We first point out a conceptual problem of the ZFC-based reanalysis of Pair-MERGE. We demonstrate that head-to-head raising, especially NEG-to-T raising, under Omune's (2018) ZFC-based analysis inevitably violates the principle of Determinacy, which prohibits ambiguous rule applications in syntactic computation (Chomsky 2019a: 275).

Linguistic theories in the generative tradition have always pursued the grammar that makes it possible for languages to be learnable or acquirable; hence, any operation or derivation in the grammar must proceed in a deterministic fashion (Chomsky 2019a). Here is a quote from Chomsky (2019a: 270), in which he refers to Charles Yang's series of works on language acquisition: "[T]here's a specific consequence of Charles' work, namely, if you take a look at it, his results depend on the assumption that rules are determinate [i.e., deterministic]." Being 'deterministic' here means that once the structural conditions for some rule are satisfied, then the corresponding structural change must take place in a deterministic way (Chomsky 2019a). Suppose that MERGE, which is innately localized in the brain of human infants, does not apply deterministically. What may happen then is that the process of language acquisition becomes *unconstrained*, contrary to the empirical facts. This is our understanding of a possible problem regarding MERGE being non-deterministic in the linguistic theory.

Under the MERGE-based system, Determinacy is ensured by restricting accessible elements in WS to the minimum (Chomsky et al. 2019: 245-246). As Chomsky (2019b: 36) suggests, there are already ways to ensure Determinacy within syntactic theory. One is to limit accessibility using the notion of c-command, which reduces to Minimal Search. To illustrate, suppose that X undergoes successive cyclic movement and forms a chain. Given two copies of X in a c-command relation, a subsequent operation deterministically applies to the higher copy by Minimal Search, which renders the lower copy inaccessible.

With this in mind, let us consider how head raising in English is analyzed under Omune's (2018) analysis. In English, NEG syntactically head raises to T and then to C in interrogatives, as in (3c).

[1] More precisely, the equivalence relation under the set theory should be as follows: $<\alpha, \beta> = \{\{\alpha\}, \{\alpha, \beta\}\}$. We thank Naoki Fukui (p.c.) for pointing this out.

(3) a. John did not take Ling 101.
b. John didn't take Ling 101.
c. Didn't John take Ling 101?

(4) illustrates a derivation of NEG-to-T raising under Omune (2018). In (4a), MERGE takes NEG and T as its input and forms {NEG, T}. In (4b), MERGE takes NEG and {NEG, T} to form {NEG, {NEG, T}} so that the asymmetry between NEG and T is represented in the complex head.[2]

(4) a. $[_{TP}$ {NEG, T} $[_{NegP}$ **NEG** $[_{vP}$ [VP ...]]]]
b. $[_{TP}$ {NEG , {NEG, T}} $[_{NegP}$ **NEG** $[_{vP}$ [VP ...]]]]

Notice, however, that NEG in (4a) does not c-command its lower copy **NEG** in the head of NegP; hence, a Determinacy violation occurs. In (4a), MERGE takes NEG and T, and forms {NEG, T}. At this point, NEG and **NEG** in (4a) violate the Principle of Determinacy (*Output Determinacy* of Chomsky et al. 2019), because neither copy is made inaccessible by Minimal Search. Furthermore in (4b), the structural change obtained by applying MERGE(NEG, {NEG, T}) is not unique; we cannot tell where the higher NEG in (4b) came from.

As we have seen, the derivation in (4) is filtered out if we assume the so-called *Output Determinacy* of Chomsky et al. (2019). The same derivation violates the Principle of Determinacy even if we assume that Determinacy applies at the *input* of MERGE (Chomsky et al. 2019) (the so-called *Input Determinacy*), which states that Determinacy applies at the *input* of MERGE (Goto & Ishii 2020: 30).[3] The Determinacy violation occurs when MERGE applies to NEG in (4a) to derive (4b). Because NEG and **NEG** do not c-command each other, the derivation from (4a) to (4b) violate the *Input* Determinacy. Therefore, as we have seen, the ZFC-based analysis of head-to-head raising inevitably violates the Principle of Determinacy, regardless of whether we assume Input or Output Determinacy (cf. Chomsky et al. 2019, Goto & Ishii 2020).

In addition to Minimal Search, the Phase Impenetrability Condition (**PIC**) also plays a role in satisfying Determinacy in the current minimalist model (see Chomsky 2019b). However, the aforementioned problem is not resolved by PIC, either. If we assume that *v* and C are phase heads (Chomsky 2008), PIC makes the VP complement of *v* (shaded in (4)) inaccessible. It follows that PIC does not make either copies of NEG inaccessible, and thus a Determinacy violation is not obviated. Since these technical problems arise once the ZFC in (1) is assumed, any ZFC-based reformulation of Pair-MERGE as Set-MERGE violates the Principle of Determinacy (Chomsky 2019b). In the next section, we point out that the ZFC-based analysis of Pair-MERGE also faces an empirical problem concerning (head-to-head) adjunction in Narrow Syntax.

2.3. An empirical problem of the ZFC-based analysis of Pair-MERGE

Let us now turn to an empirical problem. In this section, we take up syntactic NEG-raising in English and its NPI-licensing as a case study. Roberts (2010: 10) claims that a head-raised NEG licenses an NPI in its c-commanding domain. Let us assume that this is correct, at least for certain constructions in English.[4] (5a) and (6a), in which NEG does not c-command the NPI, are ungrammatical because the NPIs are not licensed. In contrast, (5b) and (6b) are grammatical because NEG raises to interrogative C and c-commands the NPI.

(5) a. *Which of them does anybody not like?
b. Which of them doesn't anybody like?

(6) a. *They succeeded in finding out which one of them anybody didn't like.
b. They succeeded in finding out which one of them wasn't liked by anybody.

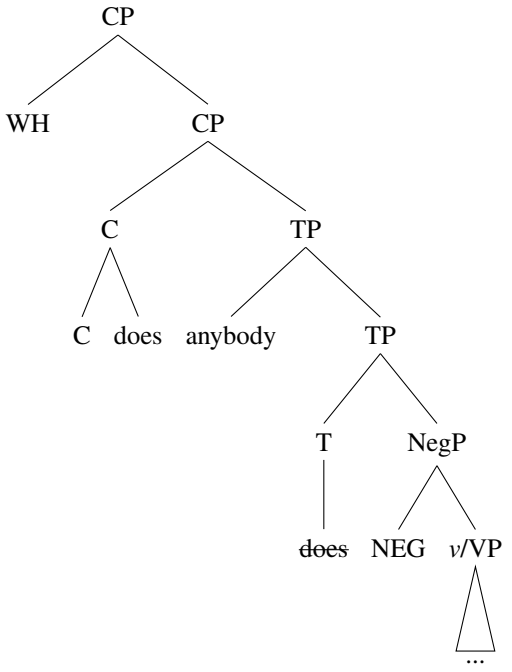
(Roberts 2010: 10)

[2] The labels of each node are indicated solely for expository reasons in (4).
[3] Note that Goto & Ishii (2020) do not assume Minimal Search. We thank Toru Ishii (p.c.) for pointing this out to us.
[4] The undergeneration problem of the ZFC-based reformulation of Pair-MERGE arises if there is at least one instance of syntactic NEG-raising.

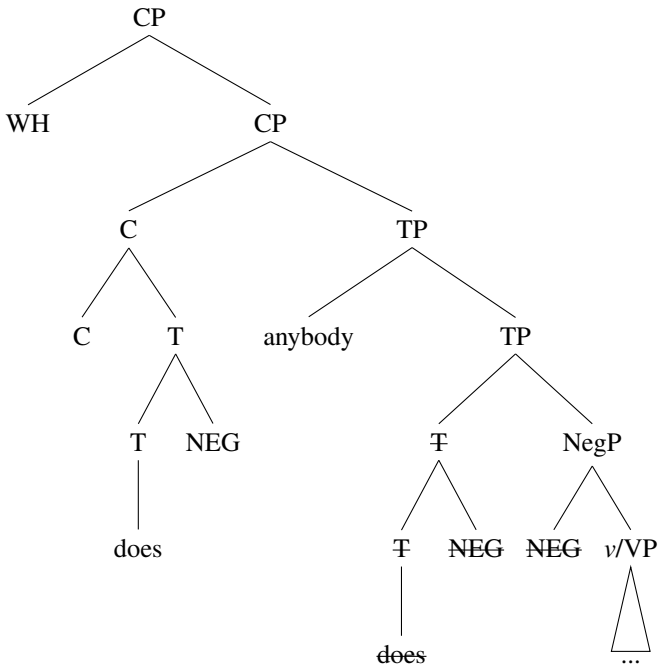
The standard definition of c-command assumed in this remark for the structure of adjuncts is in (7) and the tree-diagrammatic representations of (5a) and (5b) are in (8) and (9), respectively. In (8), NEG does not c-command the NPI *anybody*, while it does in (9). In (9), the adjoined *does* is a segment, not a category. Thus, NEG in (9) c-commands the NPI because every category that dominates NEG, namely CP, also dominates the NPI, and NEG and the NPI do not dominate each other.

(7) Definition of c-command in Chomsky (1986):
X c-commands Y iff every category that dominates X also dominates Y and X does not dominate Y and Y does not dominate X.

(8)



(9)



Now, we show that the ZFC-based analysis of Omune (2018) faces a problem in analyzing the data of syntactic NEG-raising in (5) and (6). To this end, we follow Omune (2018) and assume Chomsky's (2015) system of head adjunction (i.e., internal Pair-MERGE of heads), in which the host head adjoins to the raised head. Accordingly, NEG-to-T-to-C raising is represented as in (10a-b). In (10a), T (the host) first adjoins to the raised NEG. In (10b), C (the host) adjoins to the raised amalgam <NEG, T> and becomes invisible. As a result, NEG-to-T-to-C raising yields a complex head in (10b), where NEG is the only visible element.

(10) a. <NEG, T>
b. <<NEG, T>, C>

Based on the assumption of Chomsky (2015), NEG-to-T-to-C raising is formulated under Omune's (2018) reformulation of Pair-MERGE as in (11a-b). Notice that in the complex head formed by Set-MERGE in (11b), NEG only c-commands {NEG, T} or T. This means that in Omune's analysis, NEG cannot c-command the NPI in (5b) and (6b); hence, the fact that the raised NEG licenses the NPI in these cases is unaccounted for. Note that one cannot resort to the definition of c-command in (7) here, since Omune's (2018) analysis is entirely based on Set-Merge/MERGE, which discards the segment-category distinctions. Accordingly, Omune (2018) suffers an undergeneration problem: his analysis wrongly predicts that (5b) and (6b) are ungrammatical.

(11) a. {{NEG, {NEG, T}} (=(10a))
b. {{NEG, {**NEG, T**}}, {{NEG, {NEG, **T**}}, C}} (=(10b))

In contrast, if we assume that a head adjunction structure is created by Pair-MERGE as in (10), a raised head takes scope outside of a complex head under the definition of c-command in (7), repeated below in (12). Since Pair-Merge/MERGE incorporates the asymmetrical relation between α and β in $<\alpha, \beta>$, it is possible to distinguish between segments from categories. Accordingly, the data in (5) and (6) are explained since the raised NEG that is visible in the amalgam <<NEG, T>, C> c-commands the NPI in both cases.[5]

(12) Definition of c-command in Chomsky (1986):
X c-commands Y iff every category that dominates X also dominates Y and X does not dominate Y and Y does not dominate X.

Again, needless to say, the definition in (12) does not save Omune (2018) because (12) is incompatible with any ZFC-based reformulation of Pair-MERGE. That is to say, Omune's analysis, which is a departure from the classic asymmetric adjunction structure, does not distinguish segments from categories. Therefore, a head in an amalgam cannot c-command elements outside of the amalgam.

3. Determinacy and the Asymmetric MERGE analysis of adjunction

3.1. Nakashima (to appear)

In this section, we address a problem of another reanalysis of adjunction/Pair-MERGE in the latest Minimalist model with MERGE and WS (Chomsky 2019a,b, Chomsky et al. 2019). Let us briefly review Nakashima's (to appear) analysis. Suppose that the WS contains α and β, as in (13). He claims that the following four types of derivations are available. (13a-d) each depicts a possible output obtained via a single application of MERGE to the WS = $[\alpha, \beta]$.

(13) WS = $[\alpha, \beta]$
a. WS' = $[\{\alpha, \beta\}]$
b. WS' = $[\{\alpha, \beta\}, \alpha]$
c. WS' = $[\{\alpha, \beta\}, \beta]$

[5] NEG c-commands the NPI because every category that dominates NEG, namely CPs, also dominates the NPI, and NEG and the NPI do not dominate each other, under the definition in (12).

d. WS' = [{α, β}, α, β] (Nakashima to appear: 4)

Chomsky et al. (2019) suggests that the outputs in (13b-c) are excluded by the Determinacy principle governing the output of MERGE, which requires MERGE to determinisitically yield (13a). However, extending Goto and Ishii's (2020) idea of *Input* Determinacy, Nakashima (to appear) claims that deriving (13b-c) from the WS = [α, β] actually does not violate Determinacy.[6] In his view, it is only when MERGE applies to α in (13b) (or β in (13c)) that the derivation crashes.

On this assumption, Nakashima (to appear) calls the type of MERGE which yields outputs like (13b-c) Asymmetric MERGE, and proposes that adjuncts are introduced by this operation. According to his Asymmetric MERGE analysis, α in (13b) and β in (13c) are seen as adjuncts that are inaccessible to MERGE. Importantly, Nakashima argues that they are inaccessible because applying MERGE to α in (13b) violates Input Determinacy; that is, MERGE taking α as its input is ambiguous between α in {α, β} and α left in WS. To take a concrete example, the sentence with a PP adjunct in (14) is derived as illustrated in (15).

(14) John [$_{v*P}$ met Mary] [$_{PP}$ in the garden].

(15) a. WS = [v*P, PP]
b. WS' = [{v*P, PP}, PP]

Nakashima (to appear) claims that in (15), the number of accessible terms does not increase, because both PP in the set v*P, PP and PP left in the WS are inaccessible due to Determinacy (Nakashima to appear: 4). The only accessible element in (15b) is v*P, which derives the invisibility of the adjunct PP.

3.2. A self-contradiction problem of the Asymmetric MERGE analysis of adjunction

While Nakashima (to appear) successfully derives (16a-b) from the WS = [α, β] in a technical way, we point out that his attempt overlooks a fundamental issue regarding the so-called seven desiderata, namely Determinacy (Chomsky 2019a: et seqq.). In what follows, we elaborate on why this is the case.

(16) WS = [α, β]
a. WS' = [{α, β}, α]
b. WS' = [{α, β}, β]

As we have seen in Section 2.2, MERGE must apply to the WS in a deterministic fashion; otherwise, human languages are not learnable or acquirable (Chomsky 2019a: 269-270). Nakashima (to appear) claims that if Goto & Ishii (2020) are right in assuming *Input* Determinacy in the theory, adjuncts can be represented with no modification to MERGE itself in a technical way. However, we point out that determinacy cannot apply to input of MERGE (i.e., *Input* Determinacy), but it must apply to the output of MERGE (i.e., *Output* Determinacy) as originally proposed by Chomsky et al. (2019). Recall from Section 2.2 that Determinacy is a principle that any linguistic theories must satisfy as long as language is acquirable. Put another way, the fact that language *is* indeed acquirable tells us that syntactic computations proceed in a deterministic fashion, any theories that do not meet this condition lack explanatory power, regardless of their empirical coverage. From this view point, the outputs in (16a-b) could not be obtained to begin with, and this point should not be affected by whether a subsequent application of MERGE takes α or β as its input.

Furthermore, in Nakashima's (to appear) analysis, α is rendered inaccessible in (16a), because he concurs with Goto & Ishii (2020) and assumes that Determinacy governs the *input* of MERGE. In the WS' in (16a), both α left in the WS' and another α in the set {α, β} are inaccessible due to the *Input* Determinacy. However, it is not clear at all exactly how and why α becomes inaccessible in (16a). The point is that both α left in the WS' and another α in the set {α, β} in (16a) must be accessible whenever Minimal Search determines that α in WS' in (16a) is inaccessible. In other words, Minimal Search must "access" both αs in (16a) to check whether the WS' violates the Principle of Determinacy in the sense

[6] Note that (13d) is ruled out due to a labeling failure, which we do not discuss in this paper. Readers are referred to Nakashima (to appear: 6) for further details.

of Goto & Ishii (2020) (i.e., the *Input* Determinacy).[7] If we assume the Input Determinacy (for the sake of discussion), then Nakashima is right in that the ambiguous application of MERGE to α in (16a) leads to a derivational crash. However, this in turn means that Nakashima ends up assuming that α in (16a) is accessible to MERGE. In other words, Nakashima seems to define accessibility/inaccessibility by whether applying MERGE to a syntactic object leads to a crash, but in fact, such an analysis is possible only if the syntactic object in question is accessible to MERGE. To sum up, Nakashima (to appear) falls into the contradiction of a syntactic object being inaccessible and accessible at the same time.

4. Conclusion

In this paper, we have demonstrated that the ZFC-based reformulation of Pair-MERGE as Set-MERGE (Omune 2018) has both conceptual and empirical problems. Furthermore, we have addressed that another reanalysis of adjunction as Set-MERGE recently proposed by Nakashima (to appear) has a problem of contradiction regarding the accessibility of syntactic objects in derivations.

If we accept that Pair-MERGE exists in Universal Grammar, Chomsky's (1986) definition of c-command concerning adjunction continues to be available, which retains empirical coverage of the theory of adjunction within the latest theory with WS and MERGE (Chomsky 2019a,b, Chomsky et al. 2019). Although eliminating Pair-MERGE significantly simplifies syntactic theory, we are led to a conclusion that the current minimalist model cannot dispense with Pair-MERGE as an independent operation. Needless to say, a question remains as to whether or how Pair-MERGE is incorporated into the theory of syntax which satisfies the conditions of learnability as well as evolvability. There are other important questions that deserves our attention (e.g., whether Form Sequence replaces Pair-MERGE (Chomsky 2021)), but we leave such issues for future research.

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[7] Note that the derivation does not get into such self-contradiction when the syntactic objects are rendered inaccessible owing to c-commanding configurations or PIC.