A single probe or a composite probe?

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This paper compares the traditional single probe (cf. Chomsky 1995, Rizzi 1997, Cinque 1999) with a *composite* probe (cf. van Urk 2015). Assuming a composite probe, we predict i) that the functional features located in a functional head can probe different items independently of each other; and ii) that since those features are located in the same functional head, they produce an interpretation for the items they probe by interacting with each other, i.e., the items probed and raised by them are interpreted in pairs. Our predictions are borne out by the Japanese data, in which a scrambled nominal and the following subject that are adjacent to each other are interpreted as double contrastive. On the assumption of a composite probe, we propose i) that T(e)ns(e), the primary feature of T, firstly probes and raises a DP to the position closest to T, and then C(on)tr(astive), an additional feature of T, probes and raises another DP to the position next to the DP raised by Tns, and ii) that two raised items compose a unit and located in [Spec,TP] together (cf. sideward movement, Nunes 2004). We also point out that the derivation on the assumption of the single probe contains many problems. Finally, we discuss how to account for operations such as sideward movement within Chomsky's (2021) latest framework of *workspaces*, which restricts Merge to external and internal merge only. We propose that among the conditions that restrict Merge, Minimal Yield and Minimal Search, the latter is slightly modified.

Keywords: Composite/single probe, double contrastive, sideward movement, workspaces, Minimal Yield, Minimal Search.

1 Introduction, theoretical background, and predictions

It has been traditionally assumed that a functional head has one functional feature that characterizes its property, and that the interpretation of the nominal located in its Spec is determined by that functional feature (cf. Chomsky 1995, Rizzi 1997, Cinque 1999). This indicates that a *single* probe is assumed: the only one feature located on a functional head selects an item and raises it to its Spec. In (1a), the *wh*-object *what* moves to sentence-initial position. The derivation proceeds as illustrated in (1b). The verbal functional head v* has φ-features, which assign an Acc(usative) Case to the *wh*-object *what*. The functional head T has unvalued φ-features, which are valued by the subject *you*. The subject is then raised to [Spec,TP] and assigned a Nom(inative) Case by T. The C head has [Q] and attracts the *wh*-object that has [wh/Q] to its Spec. The relationship between a functional head and a relevant nominal is called *Agree* by Chomsky (2000) and *Criterion* by Rizzi (1997).

(1) a. What did you eat?

b. [$_{CP}$ what$_{[wh/Q]}$ [(did+)C$_{[Q]}$ [$_{TP}$ you$_{[Nom]}$ [T$_{[\varphi]}$ [$_{v*P}$ you [v*$_{[\varphi]}$+eat [$_{VP}$ eat(=V) what]]]]]]]

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Φ-features, however, are decomposed into several functional features such as person, number and gender, which can be separate probes (cf. Anagnostopoulou 2003, Béjar and Rezac 2003). Sigurðsson and Holmberg (2008) claim that in the Icelandic Dat(ive)-Nom construction, person and number can probe separately from each other. In (2a), where the expletive *það* 'there' is present in sentence-initial position and the Dat noun *(einhverri) konu* 'some woman' is located in its original position, the Dat noun intervenes between the finite verb and the Nom noun *myndirnar* 'the paintings', and the finite verb agrees with the Dat noun, i.e. *virðist* 'seem-3SG'. When the Dat noun *henni* 'her' moves to sentence-initial position as illustrated in (2b), the finite verb agrees with the Nom noun, i.e. *virðast* 'seem-3PL'.

(2) a. Það virðist/*virðast einhverri konu myndirnar vera ljótar. [Ice.]
EXPL seem-3SG/3PL some woman-DAT paintings-the-NOM be ugly
'The paintings seem to a woman to be ugly.'

b. Henni virðast myndirnar vera ljótar.
her-DAT seem-3PL paintings-the-NOM be ugly
'The paintings seem to her to be ugly.'
(Sigurðsson and Holmberg 2008: 252, (4a,b))

It is only the third person Nom noun that the finite verb agrees with. When the Nom noun is either the first person *við* 'we-NOM' as in (3a) or the second person *þið* 'you-NOM-PL' as in (3b), the finite verb can appear only with the third person singular form, i.e. *mundi* 'would-3SG'. When the Nom noun is the third person *þeir* 'they-NOM' as in (3c), the finite verb either agrees with the Nom noun, i.e. *mundu* 'would-3PL' or appears with the third person singular form. Interestingly, a verbal form that is syncretic between the third person plural and the second person plural, e.g. *virtust* 'seemed-2-3PL', can appear with the Nom second person plural form *þið* 'you-NOM-PL'; see (3d). The last data illustrates a partial agreement in which the verb agrees with the Nom noun only in number, but not in person.

(3) a. Honum mundi/*mundum virðast við (vera) hæfir. [Ice.]
him-DAT would-3SG/1PL seem we-NOM (be) competent
'We would seem to him to be competent.'

b. Honum mundi/*munduð virðast þið (vera) hæfir.
him-DAT would-3SG/2PL seem you-NOM-PL (be) competent
'You (pl) would seem to him to be competent.'

c. Honum mundi/mundu virðast þeir (vera) hæfir.
him-DAT would-3SG/3PL seem they-NOM (be) competent
'They would seem to him to be competent.'
(Sigurðsson and Holmberg 2008: 255, (10-11))

d. Henni virtust þið eitthvað einkennilegir.
her-DAT seemed-2-3PL you-NOM-PL somewhat strange
'You seemed to her to be somewhat strange.'
(Sigurðsson and Holmberg 2008: 270, (53a))

On the assumption of the single probe, i.e., that *P(erso)n* and *N(umbe)r* are independent clausal heads in the same way as, e.g. T, and that they are subject to a roll-up head movement, the derivation proceeds as illustrated in (4), according to Sigurðsson and Holmberg (2008). When an expletive occupies sentence-initial position as illustrated in (2a), T moves to Nr, and the amalgam further moves up to Pn; the Dat noun also moves to the position closest to the T+Nr+Pn amalgam, and the latter probes the former; see (4a). When the Dat noun moves to sentence-initial position as illustrated in (2b)/(3c), nothing intervenes between the Nom noun and the T+Nr+Pn, and the latter can probe the former; see (4b). In the case of partial agreement as illustrated in (3d), it is argued that (T+)Nr probes the Nom noun, which results in the plural agreement. Then, (T+Nr+)Pn probes both the Dat and Nom nouns, which results in the form compatible

with both the third and second persons; see (4c).

(4) a. ⋯ [EXPL [T+Nr+Pn [DAT [~~T+Nr~~ [~~T~~ [$_{vP}$ ~~DAT~~ [V [$_{TP}$ NOM …

b. ⋯ [DAT [T+Nr+Pn [~~DAT~~ [~~T+Nr~~ [~~T~~ [$_{vP}$ ~~DAT~~ [V [$_{TP}$ NOM …

c. ⋯ [DAT$_{[3]}$ [T+Nr+Pn$_{[2\text{-}3]}$ [~~DAT~~ [T+Nr$_{[PL]}$ [T [$_{vP}$ ~~DAT~~ [V [$_{TP}$ NOM$_{[PL/3]}$ …

Contrary to the traditional single probe, it has been proposed that features such as person and number are fused and simultaneously probe an item; in other words, a probe is *composite* (cf. Coon and Bale 2014). On the basis of the data from Dinka, van Urk (2015) claims that φ-features and an information-structural feature can compose a composite probe and simultaneously probe an item, which causes agreement in Ā-movement. Dinka is a V2 language, and the verb agrees with the item located in [Spec,CP]. Agreement is realized by a prefix, which is attached to the verb located in the second position and changes its form depending on tense. In (5a), the subject *ròoor* 'the men' appears in [Spec,CP].[1] The *áa-* form, which expresses the third person plural and the present tense, is prefixed to the perfect Aux(iliary verb) *cé* located in the second position. In (5b), the object *miɛɛr* 'giraffes' is located in [Spec,CP]. The *áa-* form is prefixed to the perfect Aux *càa* located in the second position.[2]

(5) a. Ròoor **áa**-cé yîin tîiŋ. [Dinka]
men **3PL.PRES-PERF** you see-INF
'The men have seen you.'
(Van Urk 2015: 102, (19c))

b. Miɛɛr **áa**-càa ké tîiŋ.
giraffes **3PL.PRES-PERF**+1SG 3PL see-INF
'Giraffes, I have seen.'
(Van Urk 2015: 103, (20c))

Not only φ-agreement but also Case assignment occurs between the verb in the second position and the item located in [Spec,CP]. All nominals that appear in [Spec,CP] have an absolutive Case. In (6a), the subject *Ayen* is located in [Spec,CP] and has an absolutive Case. When the object *cuîin* 'food' is located in [Spec,CP], it has an absolutive Case there, and the subject *Ayen* has a genitive Case in a lower position; see (6b).

(6) a. **Àyén** à-cé cuîin câam nè păal. [Dinka]
Ayen-**ABS** 3SG-PERF food eat-INF PREP knife
'Ayen has eaten food with a knife.'

b. **Cuîin** à-cíi **Áyèn** căam nè păal.
food-**ABS** 3SG-PERF Ayen-**GEN** eat-INF PREP knife
'Food, Ayen has eaten with a knife.'
(Van Urk 2015: 105, (26))

Agreement between the verb and the item located in [Spec,CP] occurs not only in declarative but also in interrogative clauses. (7) represents *wh*-cleft constructions. In (7a), the third person plural *kɔɔc-kó* 'which people' is the subject and raised from inside a lower CP. The prefix *é-kè-*, which represents the past tense and the third person plural, is attached to the verb *thɛt* 'cook' located in the second position of the lower CP.

[1] The characters to describe Dinka used by van Urk (2015) are so specific that they are notated by approximate characters here. The notations made by van Urk are slightly modified in some cases to be easily recognized.
[2] The first person singular subject is dropped and cliticized onto the perfect Aux, which results in the *càa* form. This process is not relevant to the agreement between the verb and the item located in [Spec,CP], according to van Urk. The third person plural *ké* is a pronominal copy and left at the v*P edge in (5b), as well as in (7b) below.

In (7b), the same nominal acts as the object and is raised from inside a lower CP; the prefix *é-kè-* is attached to the perfect Aux *cíi* located in the second position of the lower CP.[3]

(7) a. Yè kɔɔc-kó [$_{CP}$ *Op* **é-kè**-thɛt]? [Dinka]
be people-which.PL **PAST-3PL**-cook
'Which people were cooking?'

b. Yè kɔɔc-kó [$_{CP}$ *Op* **é-kè**-cíi Áyèn ké gàam gàlàm]?
be people-which.PL **PAST-3PL**-PERF Ayen-GEN 3PL give-INF pen
'Which people had Ayen given a pen to?'
(Van Urk 2015: 104, (23))

Van Urk (2015) proposes that contrary to languages such as English in which φ-features are located in T and an Ā-feature is located in C, they are both located in C and compose a composite probe in Dinka. The φ-features and Ā-feature located in C probe an item together. They only target the item that has both φ-features and an Ā-feature that match those of the probe and ignore the item that has φ-features only, even if the latter is closer to the probe, as illustrated in (8). It is claimed that on the assumption of the composite probe, the facts in Dinka that only one item can occupy [Spec,CP] and that the verb in the second position agrees with any of the items located in [Spec,CP] are coherently accounted for.

(8) [$_{CP}$ $C_{[\bar{A}, \varphi]}$ … [$DP_{[\varphi]}$ … [$DP_{[\bar{A}, \varphi]}$ …

We have important predictions on the assumption of a composite probe. First, the functional features located in a functional head will, in principle, be able to probe different items independently of each other: one of the functional features probes and raises an item, whereas the other functional feature probes and raises another item. This possibility is suggested by van Urk (2015: 107, ft. 9), but it is implied there that when φ-features and an Ā-feature probe separately, they are not fused and do not compose a composite probe. The functional features located in the same head do not always need to be fused in that head, however. It has been proposed by the literature (Richards 2007; Ouali 2008; Chomsky 2008, 2013, 2015, 2020) that functional features located in a phase head, e.g. C, are inherited by its complement head, T. According to this idea, functional features are located in C independently of each other and inherited by T also independently of each other. Thus, the functional features located in the same head should be able to act as a composite probe even if they are not fused, and simultaneously probe different items independently of each other. Secondly, since the functional features are located in the same functional head, those features will together produce an interpretation for the items they probe. It is claimed by van Urk (2015) that φ-features and an Ā-feature, both of which are located in C, probe an item together, which causes φ-agreement on the verb located in the second position on one hand, and an information-structural interpretation on the item located in [Spec,CP] on the other. If the functional features located in the same head each probe an item, however, two items are raised separately from each other. They will be interpreted in the interaction between the functional features that probe them: they will be interpreted in pairs in the raised position.

2 Data from Japanese (an OV language)

In this section, we present data from Japanese, an OV language, that confirm our prediction. In (9), the subject is *sensei* 'teacher', to which the Nom marker *-ga* is attached. The object is *heikin-zyumyoo* 'average life span', to which the Acc(usative) marker *-o* is attached. The two nominals, *bunmeikoku* 'civilized country' and *dansei* 'male', to both of which the Gen(itive) marker *-no* is attached, modify the object. The entire object phrase means 'males' average life span in civilized countries'. Note that the two modifiers, *bunmeikoku* 'civilized country' and *dansei* 'male', are base-generated DP-internally (cf. Kuno 1973,

[3] The *cíi* form of the perfect Aux in (7b) is *object voice*, whereas the *cé* form in (5a) is *subject voice* (cf. van Urk 2015), which issue I leave aside here.

Tateishi 1994).

(9) Sensei-**ga** [$_{DP}$ bunmeikoku-**no** dansei-**no** heikin-zyumyoo-**o**] keisanshi-ta.
teacher-NOM civilized-country-GEN male-GEN average-life span-ACC calculate-PAST
'The teacher calculated males' average life span in civilized countries.'

Nominals marked by the same Case marker can be scrambled (cf. Tateishi 1994). When scrambled, they are marked by the topic marker *-wa*, which is also used to express contrastiveness (cf. Kuroda 1965, Kuno 1973). As illustrated in (10), the three nominals that compose the object phrase, i.e. *bunmeikoku* 'civilized country', *dansei* 'male', and *heikin-zyumyoo* 'average life span', can all be scrambled and marked by *-wa*. Hereafter, *-wa* is notated as TOP regardless of its interpretation. That the three nominals are scrambled is confirmed by the fact that the subject *sensei* 'teacher' can appear in any of the indicated positions. That is, it can either precede or follow all the *-wa*-marked nominals; it can also intervene between the highest and intermediate *-wa*-marked nominals, and between the intermediate and lowest *-wa*-marked nominals.

(10) (^{OK}Sensei-**ga**) bunmeikoku-**wa** (^{OK}sensei-**ga**) dansei-**wa** (^{OK}sensei-**ga**)
teacher-NOM civilized-country-TOP male-TOP
heikin-zyumyoo-**wa** (^{OK}sensei-**ga**) keisanshi-ta.
average-life span-TOP calculate-PAST
'The teacher calculated males' average life span in civilized countries.'

2.1 *Observation 1* Whereas *-wa*-marked nominals located in higher positions are all interpreted as non-contrastive, i.e. as topics (cf. Hosono 2023), the lowest *-wa*-marked nominal can be (with some additional emphasis on it) interpreted in pairs with the following subject: they are interpreted as double contrastive. In (11), the first two nominals marked by *-wa* that are located in higher positions, i.e. *bunmeikoku* 'civilized country' and *dansei* 'male', are interpreted as non-contrastive, i.e. as topics. On the contrary, the lowest *-wa*-marked nominal, i.e. *heikin-zyumyoo* 'average life span', is interpreted as double contrastive in pairs with the following subject *sensei* 'teacher'.

(11) Bunmeikoku-**wa** dansei-**wa** heikin-zyumyoo-^{CONT}**wa** sensei-**ga** keisanshi-ta.
civilized-country-TOP male-TOP average-life span-TOP teacher-NOM calculate-PAST
'Regarding civilized countries, as for males, (their) **AVERAGE LIFE SPAN**, the **TEACHER** calculated it (, but their cancer mortality rate, her student calculated it).'

The observation above holds, no matter in which order *-wa*-marked nominals appear. In (12), for instance, one of the modifiers, *dansei* 'male', is followed by the object *heikin-zyumyoo* 'average life span', which is followed by the other modifier, *bunmeikoku* 'civilized country', which is followed by the subject *sensei* 'teacher'. The first two nominals marked by *-wa* that are located in higher positions, i.e. *dansei* 'male' and *heikin-zyumyoo* 'average life span', are interpreted as non-contrastive, i.e. as topics. On the contrary, the lowest *-wa*-marked nominal, i.e. *bunmeikoku* 'civilized country', is interpreted in pairs with the following subject *sensei* 'teacher': the two nominals are interpreted as double contrastive.

(12) Dansei-**wa** heikin-zyumyoo-**wa** bunmeikoku-^{CONT}**wa** sensei-**ga** keisanshi-ta.
male-TOP average-life span-TOP civilized-country-TOP teacher-NOM calculate-PAST
'As for males, regarding (their) average life span, about **CIVILIZED COUNTRIES**, the **TEATHER** calculated (, but about their cancer mortality rate, her student calculated).'

2.2 *Observation 2* The relevant subject and *-wa*-marked nominals must be adjacent to each other to be interpreted in pairs. (The acceptability of judgments is for intended readings.) In (13), the *-wa*-marked nominal, *bunmeikoku* 'civilized country', which is intended to be interpreted in pairs with the subject *sensei* 'teacher', is located in sentence-initial position. It is very difficult to interpret it in pairs with the subject. To interpret the relevant two nominals as double contrastive, an excessive focal accent would be needed on the *-wa*-marked nominal located in sentence-initial position.

(13) ??Bunmeikoku-**wa** dansei-**wa** heikin-zyumyoo-**wa** sensei-**ga** keisanshi-ta.
civilized-country-TOP male-TOP average-life span-TOP teacher-NOM calculate-PAST
(Intended reading: 'Regarding **CIVILIZED COUNTRIES**, as for males, the **TEACHER** calculated (their) average life span.')

Actually, the subject and the *-wa*-marked nominal must be adjacent in the lowest position to be interpreted in pairs. (The acceptability of judgments is for intended readings.) In (14), the nominals intended to be interpreted in pairs are *bunmeikoku* 'civilized country' and the subject *sensei* 'teacher'. They appear adjacent to each other in sentence-initial position in (14a) and in intermediate positions in (14b). The two nominals cannot be interpreted as double contrastive in either of these cases.

(14) a. *Bunmeikoku-**wa** sensei-**ga** dansei-**wa** heikin-zyumyoo-**wa** keisanshi-ta.
civilized-country-TOP teacher-NOM male-TOP average-life span-TOP calculate-PAST
(Intended reading: 'Regarding **CIVILIZED COUNTRIES**, as for males, the **TEACHER** calculated (their) average life span.')

b. *Dansei-**wa** bunmeikoku-**wa** sensei-**ga** heikin-zyumyoo-**wa** keisanshi-ta.
male-TOP civilized-country-TOP teacher-NOM average-life span-TOP calculate-PAST
(Intended reading: 'Regarding **CIVILIZED COUNTRIES**, as for males, the **TEACHER** calculated (their) average life span.')

2.3 *Observation 3* The subject must follow the relevant *-wa*-marked nominal to be interpreted in pairs. In (15), in which the subject *sensei* 'teacher' precedes the *-wa*-marked nominal, *heikin-zyumyoo* 'average life span', the two nominals cannot be interpreted as double contrastive. In this case, only the *-wa*-marked nominal, *heikin-zyumyoo* 'average life span', is interpreted as contrastive. Compare with (11), in which the subject *sensei* 'teacher' follows the *-wa*-marked nominal, *heikin-zyumyoo* 'average life span', and they are interpreted in pairs.

(15) Bunmeikoku-**wa** dansei-**wa** sensei-**ga** heikin-zyumyoo-**wa** keisanshi-ta.
civilized-country-TOP male-TOP teacher-NOM average-life span-TOP calculate-PAST
'Regarding civilized countries, as for males, the teacher calculated (their) **AVERAGE LIFE SPAN** (, but not their cancer mortality rate).'

In sum, we have shown the followings: i) whereas *-wa*-marked nominals located in higher positions are all interpreted as non-contrastive, i.e. as topics, the lowest *-wa*-marked nominal can be interpreted in pairs with the following subject, i.e., the two nominals are interpreted as double contrastive; ii) the subject and the *-wa*-marked nominal must be adjacent to each other in the lowest position to be interpreted in pairs; and iii) the subject must follow the relevant *-wa*-marked nominal to be interpreted in pairs.

3 Analyses

3.1 *Analysis on the assumption of a composite probe* In this section, we present an analysis of our data on the assumption of a composite probe. We propose the following way of derivation: i) the functional head T has *T(e)ns(e)* as the primary functional feature and can additionally have *C(on)tr(astive)*, which brings about a contrastive interpretation (cf. Hosono 2023); ii) Tns probes one DP and raises it, whereas Ctr probes another DP and raises it; and iii) two raised items compose a unit and located in [Spec,TP] together (cf. *sideward movement*; Nunes 2004; also Takano 2020 for a recent analysis of this operation).[4] Specifically, (11), which is repeated in (16), is derived as represented in (17). Tns located in T probes the subject located in [Spec,v*P] and raises it to the position closest to itself. Ctr, which is also located in T, probes an object (or part of it) and raises it to the position adjacent to the subject. The subject raised by Tns

[4] In Chomsky's (2021) recent work, it is claimed that only external merge and internal merge are allowed, eliminating other operations such as late marge, parallel merge and sideward merge. We discuss how to derive those merging operations within Chomsky's framework in section 4.2.

and the object raised by Ctr compose a unit, which is indicated by '+', and are located in [Spec,TP]; see (17a). Tns licenses the Nom *-ga* form on the raised subject, whereas Ctr licenses the *-wa* form on the raised object; the other nominals also move and adjoin to TP (cf. Hosono 2023); see (17b).

(16) Bunmeikoku-**wa** dansei-**wa** heikin-zyumyoo-$^{\text{CONT}}$**wa** sensei-**ga** keisanshi-ta.
civilized-country-TOP male-TOP average-life span-TOP teacher-NOM calculate-PAST
'Regarding civilized countries, as for males, (their) **AVERAGE LIFE SPAN**, the **TEACHER** calculated it (, but their cancer mortality rate, her student calculated it).'
(=11)

(17) a. $[_{TP}$ [DP-TOP$_{(CONT\text{-}wa)}$ + DP-NOM$_{(-ga)}$] [$T_{[Tns,\ Ctr]}$ $[_{v*P}$ DP $[_{VP}$ $[_{DP}$ DP … DP … DP] …

b. [DP-TOP$_{(-wa)}$ [DP-TOP$_{(-wa)}$ $[_{TP}$ [DP-TOP$_{(CONT\text{-}wa)}$ + DP-NOM$_{(-ga)}$] [$T_{[Tns,\ Ctr]}$ $[_{v*P}$ DP $[_{VP}$ $[_{DP}$ DP … DP … DP] …

In the derivation illustrated above, the nominal probed by Tns and the nominal probed by Ctr must both be located in [Spec,TP] since the features that probe them, i.e. Tns and Ctr, are both located in T; two nominals to be interpreted in pairs must thus be adjacent to each other, which accounts for (13). Tns raises an item to the position as close to itself as possible; Ctr also raises an item to the position as close to itself as possible. Targeted nominals must thus be located in the lowest position, which accounts for (14). Tns is the primary functional feature of T, whereas Ctr is an additional feature. Tns firstly probes a nominal and raises it to the position closest to itself, and then, Ctr probes another nominal and raises it to the position adjacent to the nominal raised by Tns. Therefore, the relevant two nominals must be adjacent to each other to be interpreted as double contrastive, but the nominal probed by Tns is located in the position closest to T, i.e., it must follow the *-wa*-marked nominal probed by Ctr, which accounts for (15).

3.2 *Analysis on the assumption of a single probe* In this section, we present an alternative analysis on the assumption of a single probe. A possible derivation of (16) above would proceed as illustrated in (18): i) T projects TP, and the nominal located in the lowest position, i.e. the subject *sensei* 'teacher', and only that nominal, is located in [Spec,TP]; ii) for the nominals marked by *-wa*, the functional head, e.g. *Top(ic)*, projects TopP, and each of the nominals is located in [Spec,TopP].

(18) $[_{TopP}$ DP-TOP$_{(-wa)}$ [Top $[_{TopP}$ DP-TOP$_{(-wa)}$ [Top $[_{TopP}$ DP-TOP$_{(CONT\text{-}wa)}$ [Top $[_{TP}$ DP-NOM$_{(-ga)}$ [$T_{[Tns]}$ $[_{v*P}$ DP $[_{VP}$ $[_{DP}$ DP … DP … DP] …

In this derivation, there is no interaction between T and the lowest Top: the interpretation of the nominal located in [Spec,TP] is determined by T, whereas that of the nominal located in the lowest [Spec,TopP] is determined by Top. The fact that the two nominals are interpreted as double contrastive is not accounted for. To ensure that two nominals are interpreted in pairs, we could assume that an interpretive rule, which associates T with Top and enables the nominals located in each of the Specs of those heads to be interpreted in pairs, works in the interface component. It cannot be ensured, however, that it applies to T and the lowest Top only. If it applied to T and a higher Top head, the nominals located in each of the Specs of those heads could be interpreted in pairs even if they are not adjacent to each other, contrary to the fact illustrated in (13). In addition, this system allows the Top head to project below TP. (More than one) *-wa*-marked nominal could appear below the two nominals interpreted in pairs, contrary to the fact illustrated in (14). We could also assume that i) T and Top are introduced at the same time, ii) they are fused and compose a head, Top/T, and iii) this head probes and raises a nominal, which process repeats twice: … $[_{Top/TP}$ DP-TOP$_{(CONT\text{-}wa)}$ [Top/T $[_{Top/TP}$ DP-NOM$_{(-ga)}$ [Top/T … . Though T and Top could produce an interpretation for the nominals they probe together, there is no priority between T and Top, contrary to the case illustrated in (17) in which T has Tns as the primary feature and Ctr as an additional feature; it is possible that Top/T firstly probes and raises a *-wa*-marked item and then probes and raises a *-ga*-marked item. The two items could be interpreted in pairs even if the *-wa*-marked item follows the *-ga*-marked item, contrary to the fact illustrated in (15). The way of derivation on the assumption of a single probe thus

contains many problems and lacks a principled, coherent account, contrary to the account on the assumption of a composite probe.

4 Some remaining issues

4.1 *Validity of assuming a composite probe* In this section, we discuss some remaining issues. Sigurðsson and Holmberg (2008: 274, ft.11) give several concerns about assuming a composite probe. First of all, they are doubtful whether a complex head in which some functional features are located can be part of grammar, saying that it is necessary to account for how such a head can be produced as well as why a head can be complex in some languages but not in others. It is not the case that an object such as a complex head is newly created as a grammatical item as they say, but that several features can simply be located in a head together (but independently of each other) as claimed by the literature given in section 1 (cf. Richards 2007; Ouali 2008; Chomsky 2008, 2013, 2015, 2020). A functional head of some languages will host more features than its counterpart of other languages depending on, e.g., to what extent the agreement system is complicated. Sigurðsson and Holmberg also cast doubt on assuming i) that each of the features located in a head can act as a probe independently of each other, ii) that those features can probe in some order, and iii) that the result of their probing is affected in a different manner by movement of arguments to the positions near or around a complex head. These points are not assumptions, but corollaries of several features being located in a head together. Nothing prevents those features from acting as a probe independently of each other; nothing prevents one of them from probing an item earlier than the other, either. The result of their probing is simply reflected by the positions to which targeted nominals are raised; for instance, Tns firstly raises a nominal to the position nearest to T, and then Ctr raises another nominal to the position next to the nominal raised by T, as illustrated in (17). Finally, Sigurðsson and Holmberg point out that we would have to assume the functional features located in a head should be able to c-command out of that complex head. It is not clear whether a c-command relation exists between the functional features located in a head together: in $T_{[Tns,\ Ctr]}$, it is not clear whether a sister relation, i.e. a structural relationship, exists between Tns and Ctr inside T. This point is not clarified at this moment since the internal structure of a composite head is still unclear, which I leave for future research.

4.2 *Restricting Merge* In his recent framework, Chomsky (2021) introduces new theoretical assumptions and syntactic devices, claiming that merging operations should be restricted to external merge and internal merge only. It is claimed that Merge does not apply to individual items, but applies to a *workspace*, i.e. a working memory which is assumed to be part of syntactic computation and defined as the place where items that can be involved in a syntactic derivation are stocked. The derivation proceeds as follows:

(19) a. WS = $[X_1, \dots X_n]$
b. WS' = $[\{P, Q\}, X_1, \dots X_n]$
c. WS" = $[\{R\ \{P, Q\}\}, X_1, \dots X_n]$
d. WS"' = $[\{Q, \{R, \{P, Q\}\}\}, X_1, \dots X_n]$

(19a) illustrates a workspace WS, which contains *members*, $X_1, \dots X_n$, which are items to be involved in the following derivation. Two items in a workspace are searched and form a set (*Form Set*). We can select P and Q among $X_1, \dots X_n$ in WS, merge them, and make a set, which results in a new workspace, WS', as illustrated in (19b). This new workspace contains a new member, {P, Q}, i.e. the set formed by P and Q, as well as any other items that are already contained in the former workspace WS. A built set is kept in new workspaces throughout a derivation. We can further take another item R from originally stocked items, $X_1, \dots X_n$, and merge it to the set {P, Q}, which results in a new workspace, WS", as illustrated in (19c). This new workspace contains a new member, {R {P, Q}}, and other items kept from WS'. The operations from WS to WS' and from WS' to WS" that take members in a workspace and merge them are called *external merge*. Then, Q, which is a *term* of the already built set {R {P, Q}}, can be taken and merged to the set {R {P, Q}} itself, which results in a new workspace, WS"', as illustrated in (19d). This new workspace contains a new member, {Q, {R, {P, Q}}, and other items kept from WS". The operation from WS" to WS"' that takes a term of a member and merges it to that member itself is called *internal merge*.

Merge is restricted to external merge and internal merge by a newly introduced condition, *Minimal Yield*, supplemented by another condition, *Minimal Search*. Roughly speaking, the former states that Merge

must result in adding only one candidate that can be accessed in the following derivation, and the latter that when there are several identical copies, the structurally highest one that c-commands others must be searched.[5] As we can see in (19a-d), the derivation that proceeds with external merge and internal merge adds only one new member to a new workspace. More specifically, see below:

(20) a. WS = [a, b, c]
b. WS' = [{a, b}, c]
c. WS" = [{c, {a, b}}]
d. WS"' = [{b, {c, {a, b}}}]

In (20a), the workspace WS contains three accessible members, a, b, and c. We can take a and b, and merge them, which results in external merge, as illustrated in (20b). The new workspace WS' contains four members that can be accessed in the following derivation: a, b, c, and {a, b}. Since external merge adds only one accessible member to those contained in the former workspace, this is a licit operation. With the same process, c is externally merged to the set {a, b}; see (20c). The new workspace WS" contains five accessible members, a, b, c, {a, b}, and {c, {a, b}}; the number of accessible members increases from four in WS' to five in WS". Then, we can take b and merge it to the set {c, {a, b}}, which results in internal merge, as illustrated in (20d). Among the two copies, only the highest one, b, can be, but the lower one, b, cannot be, searched and accessed in the following derivation, since the former c-commands the latter. The new workspace WS"' thus contains six accessible members, a, b (the highest copy), c, {a, b}, {c, {a, b}}, and {b, {c, {a, b}}}. Since only one accessible member is added after Merge applies to WS" and produces WS"', internal merge is a licit operation.

On the other hand, other merging operations such as Late Merge, Parallel Merge and Sideward Movement are claimed to yield more than one accessible member. In Sideward Movement, for instance, Merge applies to the workspace at the stage of (20b), repeated in (21a), in which WS' contains four accessible members: a, b, c, and {a, b}. Then, a and c are taken and merged, which yields a new workspace WS"; see (21b). The copy, a, which is merged with c, does not c-command the lower copy, a, and the latter is still accessible. WS" thus contains six accessible members: a (merged with c), b, c, a (the lower copy), {a, c}, and {a, b}. Since the number of accessible members increases from four in WS' to six in WS", this kind of operation is not licit.[6]

(21) a. WS' = [{a, b}, c]
b. WS" = [{a, c}, {a, b}]

With merging operations other than external merge and internal merge simply rejected, no account is provided for a vast amount of data that have been accounted for by making use of those merging operations. It is desirable to work out a way to allow those operations but keep the minimal generation at the same time. Note that Minimal Yield says only one candidate accessible in the following derivation can be generated by Merge. It should be possible that Merge does not increase the number of accessible members; even if a new accessible member is not added, the result of a merging operation should be licit. I pursue this possibility by slightly modifying the supplementing condition, Minimal Search. Ke (2024) presents a formulation of Minimal Search, which, roughly speaking, proceeds in such a way that search terminates immediately after a target is found and also when its search domain is exhausted; otherwise, search continues in a parallel manner until when a target is found. Recall that in the workspace WS" illustrated in (21b), neither of the two copies, a and a, c-commands the other, so they can both be targets of Minimal Search in the following derivation. I propose to add a condition of terminating search to Ke's formulation:

[5] Besides, two conditions that restrict Merge are assumed: i) *Binarity*, which restricts the number of merged members to 2, and ii) the *Phase Impenetrability Condition*, which states that Merge does not access into the complement of a phase (cf. Chomsky 2001). These four conditions are claimed to compose *Resource Restriction*.

[6] As a basis of his thought on restricting Merge, Chomsky cites Fong (2021), who claims that the human brain receives such a vast amount of input information that the former must discard much of the latter. Citing Georgiou (2014), who shows that dozens of neural processes proceed independently in a parallel manner, Fong claims that if several binary merging operations proceed simultaneously, they must obey non-interference, i.e., the inputs of those operations must not be overlapped. Merging operations such as Late Merge, etc., in which generated two workspaces share the same item, are thus incomputable (Fong 2021: 6).

(22) Search fails and terminates when two identical copies that are not in a c-command relation are found.

When two identical copies that are not in a c-command relation are found, search cannot determine which one is a target, so, search fails. This indicates that among six members contained in WS" in (21b), i.e. a (merged with c), b, c, a (the lower copy), {a, c}, and {a, b}, neither a nor a is targeted by search in the following derivation. In other words, WS" contains four members accessible in the following derivation, i.e. b, c, {a, c}, and {a, b}. The number of accessible members does not increase from WS' in (21a) to WS" in (21b): both workspaces contain four accessible members. The copy, a, is accessible in the following derivation only as part of the set, {a, c}. This is desirable since the item raised by merging operations other than external merge and internal merge is not expected to leave the set and move further independently of the other member of the set.

5 Conclusion

In this paper, we have compared the traditional single probe with a *composite* probe. On the assumption of the composite probe, we predicted i) that the functional features located in a functional head can probe different items independently of each other, and ii) that since those features are located in the same functional head, they produce an interpretation for the items they probe by interacting with each other, i.e., the items probed and raised by them are interpreted in pairs. Our predictions have been borne out by the following Japanese data: i) whereas *-wa*-marked nominals located in higher positions are all interpreted as non-contrastive, i.e. as topics, the lowest *-wa*-marked nominal can be interpreted in pairs with the following subject as double contrastive; and ii) to be interpreted in pairs, the subject and the *-wa*-marked nominal must be adjacent to each other in the lowest position, and the subject must follow the relevant *-wa*-marked nominal. On the assumption of the composite probe, the following derivational way has been proposed: i) Tns, the primary feature of T, firstly probes and raises a DP to the position closest to T, and then Ctr, an additional feature of T, probes and raises another DP to the position next to the DP raised by Tns; and ii) two raised items compose a unit and located in [Spec,TP] together (cf. sideward movement). We have also presented several ways of derivation on the assumption of the single probe, claiming that many problems arise, compared with a principled, coherent account provided on the assumption of the composite probe. Finally, we have discussed the validity of assuming a composite probe as well as how to account for merging operations such as sideward movement within Chomsky's (2021) latest framework of workspaces, which restricts Merge to external merge and internal merge only. We have proposed that among the conditions that restrict Merge, Minimal Yield and Minimal Search, the latter condition is slightly modified to allow other merging operations.

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