Non-Referentialist C_{HL} as Error Minimization:
Toward a Valuation-Free Agree Model

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Abstract

What are uninterpretable features (uFs, or morpho-syntactic features such as ϕ and case)? What exactly is Agree? Where do they originate from? Two assumptions are utilized: the converse of the referentialist doctrine for the computational procedures of human natural language (C_{HL}) (i.e., words do not refer; axiom one) and the error minimization hypothesis (EMH) for nature, which contains EMH for C_{HL}, resulting in a valuation-free Agree model. The axiom one and EMH state that (a) both the conceptual-intentional system (CI) and sensory-motor system (SM) are disconnected in the human brain, (b) as a result, the human brain must connect two systems that are fundamentally different, namely, geometry-building narrow syntax (NS) and sound-wave-computing SM, and (c) uFs are errors that emerge in our brain as a result of the mutated disconnection. C_{HL} (NS) is a system that strives to offset errors in order to approach a perfect computational system, deducing the strong minimalist thesis (SMT). The valuation-free Agree model is based on the grammatical feature hypothesis (consequent upon axiom one) and the error-minimization algorithm (EMA) (a subset of EMH). The grammatical feature hypothesis holds that all morpho-syntactic features are NS-computable and SM/CI-uncomputable. The valuation-free Agree model is supported by evidence from languages such as English, French, Hindi, and Japanese, being as it is that there are two types of EMA: error elimination under matching (EMA ①) and error neutralization (EMA ②). EMA ① eliminates probe-goal uF (case and ϕ) under the matching, where two Agree types exist in terms of feature inheritance timing. EMA ② neutralizes uF: it eliminates ϕ as a reflex of case elimination, forcing the predicate ϕ to default. The control issue (i.e., null case elimination of infinitive) and the seeming lack of ϕ-agree in east Asian languages are incorporated in EMA ②.

Keywords : error minimization algorithm (EMA), error minimization hypothesis (EMH), referentialist doctrine, seeming lack of ϕ-agreement, valuation-free Agree model

1 A problem

Chomsky (2001a, 16) posed a question about the computational procedures of human natural language (C_{HL}), where uF = uninterpretable feature.[1)]

(1) *A fundamental question*

A fundamental problem is why uF and Agree exist.

In considering Chomsky's question, I propose a plausible solution. Specifically, I am looking for a pointer to answering fundamental questions, as shown in (2).

(2) *Fundamental questions*

a. What exactly is uF? What exactly is Agree? (Identification)

b. When, how, and why did they both emerge in the human brain? (Evolution)

According to a popular consensus, the minimalist program (MP) has already answered (2) in Chomsky (2000a) and Chomsky (2001b), as shown in (3).[2)]

(3) *What is the function of uF?—The standard answers.*

a. The uFs are the driving force of the internal merge (IM; movement), in which case-feature elimination is a consequence (side effect) of phi-feature matching and elimination. The EPP-feature attracts the goal to the probe's edge.

b. Chomsky (2001b) and Chomsky (2008) hypothesized that "the size of phases is in part determined by uninterpretable features," which are "a striking phenomenon of language that was not recognized to be significant, or even particularly noticed, prior to Vergnaud's original ideas about the role of structural Case."[3)]

Is there a uF because C_{HL} requires IM to function? Where is the origin of uF? Why does an IM exist in the first place? Is uF present because C_{HL} needs to execute phase-cyclic computation? Previous attempts to answer the aforementioned questions about uF and also the discussions as a consequence on why it exists in the human language system are lacking

1) The uF is redefined as SM/CI-uncomputable features in Subsection 3.1.1.

2) Epstein et al. (2013) examines how MP has approached and developed the uF accounts.

3) A personal letter by Jean-Roger Vergnaud to Noam Chomsky and Howard Lasnik in 1977 (Vergnaud (1977, 22–23)). Vergnaud first pointed out that UG (i.e., C_{HL} theory) consists of invariant principles and variable parameters. Chomsky (2022) states that (3b) is inaccurate.

in detail. Therefore, unanswered is the underlying problem of uF.

The remainder of the paper is organized as follows. Section 2 introduces the two assumptions adopted in this study. The first assumption is a converse of the referentialist doctrine of C_{HL} (i.e., words do not refer) as axiom one (Subsection 2.1). As a result, CI and SM are unconnected in the human brain, forcing the association of two fundamentally different systems, namely, the geometry-creating narrow syntax (NS) and sound-wave-computing SM.[4] The NS–SM connection generates errors, which are morpho-syntactic features (case and ϕ). The second assumption is the error minimization hypothesis (EMH) for nature, which includes the EMH for C_{HL} (Subsection 2.2). As a result, uF is reconsidered as an error that emerged in the mutated human brain, and the strong minimalist thesis (SMT) is deduced from EMH.

Section 3 proposes a valuation-free Agree model that simplifies the conventional Agree. The axiom one contradicts valuation, necessitating the grammatical feature hypothesis: all formal features are NS-computable and CI/SM uncomputable (Subsection 3.1). The EMH guarantees two types of error-minimizing algorithms (EMA): uF elimination via feature matching (EMA ①) and uF neutralization (counteraction) (EMA ②) (Subsection 3.2). Furthermore, in terms of feature-inheritance timing, EMA ① employs two patterns of Agree.

Section 4 addresses the empirical implications of the current proposals. EMA ① and ② simplify and unify seemingly unrelated data analyses. More notably, EMA ② allows us to combine two challenging problems: the PRO-infinitive (Subsubsection 4.2.1) and the seeming lack of ϕ-agreement in east Asian languages (Subsubsection 4.2.2). Section 5 (conclusion) closes the paper by highlighting the outstanding issues. Figure 1 illustrates paper's organization.

Figure 1 depicts the concept of the current investigation, which comprises fundamental questions: What is uF? What is Agree? And Where do they originate from? The study adopts two assumptions: an alternative to the referentialist doctrine (axiom one) and the EMH for nature, a subset of which is EMH for C_{HL}. Axiom one conflicts with valuation, leading to the grammatical feature hypothesis: all morpho-syntactic features are NS-computable and CI/SM-uncomputable. The EMH redefines uF as a human brain error, deduces SMT, and guarantees EMA. Based on the grammatical feature hypothesis and

4) I choose to narrow definition of NS (LF computation, where LF = logical form: C_{HL}–CI interface), which is equivalent to C_{HL}. For each sentence, NS = C_{HL} builds a binary-branching structure using a lexical array containing specific features and words selected once from the Lexicon (Adapted from Chomsky (2000a, 100–101)).

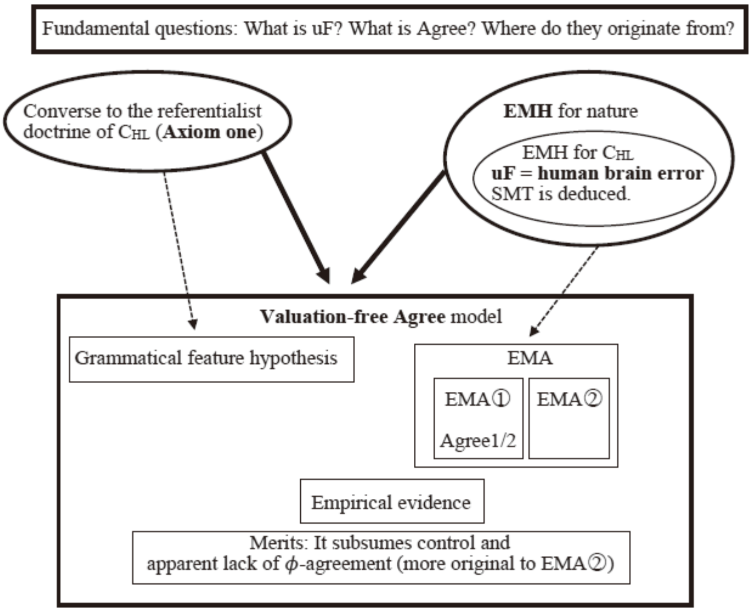

Figure 1: Paper's organization illustrated

EMA, a valuation-free Agree model was proposed, supported by a consistent analysis of seemingly unrelated data, including the PRO-infinitive and the apparent lack of ϕ-agreement in east Asian languages.

2 Assumptions

2.1 Axiom one: Converse to the referentialist doctrine of C_{HL}

As explained in Chomsky (2000b, 37–42) and Chomsky (2015c, 44–45), I assume to be inaccurate the referentialist doctrine regarding human language, i.e., the direct reference theory of human natural language, in which CI and SM are inexorably connected. For non-human animals' externalization relates to a certain internal state or external object, i.e., what they externalize corresponds to what they "think." By adopting a basic principle proposed in Gallistel (1990), Chomsky stated that: "Animal [non-human] communication is based on the principle that internal symbols have a one-to-one relation to some external event or internal state. But that is simply false for human language – totally" (Chomsky and McGilvray (2012)).[5] Given that the referentialist doctrine is false for C_{HL}, its converse is true, as demonstrated in (4), which I consider as axiom one.

5) For a related discussion, see Dobler (2013, 295).

(4) *Axiom one (converse to the referentialist doctrine)*

Words do not refer to external objects.

As Chomsky asserts, humans perform referring actions with words composed of meanings with sounds, but words themselves do not refer to anything: meaning and externalization do not refer to a specific internal state or external object/phenomenon (Figure 3). I quote a critical claim by Chomsky (5) in Chomsky and McGilvray (2012, 29) discussing the logical implication of axiom one.

(5) [Given the axiom one, there is] "no semantics at all—that is, no reference relation—just syntactic instructions to the conceptual apparatus which then acts" (ibid).

Where a related topic is seen in Subsection 3.1.1, in which the grammatical feature hypothesis is proposed. What is important are syntactic instructions based on phonemic, phonetic, formal, and conceptual features that do not have a one-to-one relationship with any mental or external state.[6)]

I assume Figure 2 as a corollary of axiom one that in the human brain, CI is disconnected from SM, but the two external systems are linked in non-human brains. In non-human brains, SM and CI are reflexes that combine to generate instinct. A mutant C_{HL} (NS) evolved in the human brain, resulting in SM and CI becoming disconnected, which is the reason why we, Homo sapiens, (can) lie and act. The formation of mutant C_{HL} triggered the SM–CI disconnection, which required the association of two separate systems (NS–SM/NS–CI), resulting in an error, i.e., morpho-syntactic features.

In Figure 2, CI, SM, and C_{HL} form loops, as illustrated by the facts that a speaker's thought is a starting point and input to C_{HL}, any universal-phonetical-sound set can be computed as a sentence, and a speaker computes the sound and meaning that she externalizes while saying and comprehending it simultaneously. Loops help to maintain a steady flow of information,[7)] while being graph-theoretical solutions to Kirchhoff's current law, which is the balance equation expressing system equilibrium (Strang (2016, 455)).

6) A caution is necessary here to distinguish the use of terminology "refer" in the referentialist doctrine and that in anaphoric relation within a sentence, e.g., in a sentence such as *John believes that Bill hates himself*, the anaphor *himself* "refers" to *Bill*, not *John*, within this particular example. More strictly, *Bill,* not *John*, is the antecedent of the anaphor *himself*. Axiom one states that the words in this sentence do not refer to any external object.

7) A complex system such as C_{HL} is characterized by feedback loops (Krivochen (2018, iii)). For a graph-theoretic approach to C_{HL}, see Arikawa (2019) and Arikawa (2020).

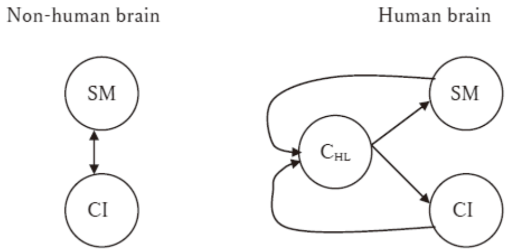

Figure 2: Axiom one: CI and SM are linked in non-human brains; they are unconnected in human brain

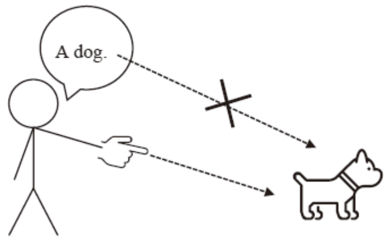

Figure 3: We refer but words do not

2.2 The error minimization hypothesis (EMH) for C_{HL}

“Nature distributes the currents to minimize the heat loss [error] (Strang (2009, 428)).” A natural object (order) inevitably produces heat (entropy or disorder). Nature tends to offset errors.

(6) *The error minimization hypothesis (EMH) for nature*

Nature tends to minimize errors.

In the presence of EMH, C_{HL} tends to become a “perfect system” by meeting the interface criteria in the most computationally efficient way. Chomsky compares C_{HL} to a snowflake: the basic attribute of C_{HL} evolves by obeying natural laws such as the principle of least action and minimal computation (MC). “In the absence of external pressures, the Basic Property should be optimal, as determined by laws of nature, notably MC, satisfying SMT (7), rather as a snowflake takes its intricate shape” (Chomsky (2016, 23)).[8)]

(7) *SMT*

Language [C_{HL}] is an optimal [computationally efficient] solution to legibility conditions [posed by CI and SM] (Chomsky (2000a)).

The logical form (LF) and phonetic form (PF) are interfaces connecting C_{HL}–CI and C_{HL}–SM, respectively. CI and SM force C_{HL} to produce optimal information at LF and PF, which is subsequently transmitted to and exploited by CI and SM. The legibility conditions are requirements that C_{HL} must meet by supplying CI/SM-legible (readable) information to LF

8) Regarding MC, see Chomsky (2015a), Chomsky (2015b), Chomsky (2016). See Fukui (1996) for more information on how and why the principle of least action applies to C_{HL}.

and PF.

A "perfect system" can be the most computationally efficient. However, an error (morpho-syntactic feature) enables the computational system to "become a perfect system." A "perfect" system does not necessarily imply an error-free system. A system cannot completely eliminate errors. To live in a superior system (human brain), a new subsystem (C_{HL}) attempts to interact with surrounding old-timers (SM and CI) and achieve efficient computing by eliminating errors. I propose a hypothesis that C_{HL} is an error-minimizing system. The language system (an ordered natural object) inevitably produces morpho-syntactic features (disordered "heat" or errors) and attempts to eliminate the errors.[9]

(8) *The EMH for* C_{HL}

C_{HL} has evolved into an error-minimizing system that seeks to eradicate error (uF), aspiring to perfection (computational efficiency).

Language errors are morpho-syntactic traits that evolved in our ancestral brain when CI and SM were severed (Subsection 2.1; Human brain in Figure 2).[10]

Why did the errors emerge after CI and SM were disconnected? Chomsky (2021b, 12) offers a convincing explanation: it was because externalization relates "two systems that are entirely independent, both in character and evolutionary history: language proper [NS] and SM." The geometry (binary branching structure)-creating NS, which is limited to humans, appeared very suddenly (Chomsky and McGilvray (2012, 23)) within a very small window of 50,000 to 100,000 years ago (Chomsky (2015c, 3)), whereas the sound-wave computing SM, with which we share core processes with other animals, first appeared 60 million years ago.[11] C_{HL} had to contend with "the mismatch [incompatibility] between narrow syntax, a system of pure structure, and SM, which imposes a requirement of linear order for reasons that have nothing to do with language."[12] Thus, morpho-syntactic features are errors caused

9) Strang (2009, 428) stated in its graph theory section that "nature distributes the currents to minimize heat loss." In this context, "currents" refer to information flow, and "heat loss" refers to error. Thus, nature strives to minimize errors.

10) Piattelli-Palmarini and Uriagereka (2004) proposed that morpho-syntactic features are viruses emerged in the human brain, consistent with this study assuming that viruses are errors inevitable to any system. The language-system virus is not merely "an elegant metaphor," as mentioned in Lasnik (2002, 435).

11) "Take, say, the bone of the middle ear. They happen to be beautifully designed for interpreting language, but apparently, they got to the ear from the reptilian jaw by some mechanical process of skull expansion that happened [about] 60 million years ago" (Chomsky and McGilvray (2012, 25)).

12) The "reasons that have nothing to do with language" refers to the fact that PF and SM are constrained by a physical law that states that a single articulator cannot order two sounds linearly

by the emergence of a “mismatch” between SM and NS. C_{HL} (NS) and errors (morpho-syntactic features) are identical pairs. C_{HL} originated as a system that seeks to minimize errors caused by NS and SM incompatibilities. However, it would have been impossible for C_{HL} to generate infinite discrete structures with semantic and phonetic features, which are inputs to CI and SM without the errors (i.e., morpho-syntactic features). An error-containing system (e.g., DNA, C_{HL}) is resilient, flexible and productive, whereas an error-free system (if such a system existed) would be rigid and inefficient. With the SMT (Chomsky (2001a)) being a generative syntactic guideline, and, more specifically, the optimal scenario being that UG (C_{HL} theory) reduces to the simplest computational principles that work in compliance with computational efficiency conditions (Berwick and Chomsky (2015, 94)), the EMH explains why SMT is correct and valid. The EMH is more general than the SMT in that it holds for error minimization (optimal computation) in general for natural objects. The SMT is deduced by the general EMH.

3 Valuation-free Agree model

3.1 Grammatical feature hypothesis

3.1.1 DP ϕ is uninterpretable (CI-uncomputable)

Let us go through the first axiom again (4), which is renumbered as (9).

(9) *Axiom one (converse of the referentialist doctrine)*

Words do not refer to external objects. (Chomsky (2000b, 37–42) and Chomsky (2015c, 44–45))

A word is comprised of two parts: sound and meaning. According to axiom one, human linguistic sound and meaning do not relate to (i.e., do not have a one-to-one relationship with) any mind-internal states or external objects. Humans, not the words, employ sound and meaning to perform a referring action (Figure 3).

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at the same time, i.e., it cannot externalize both sounds at the same time. One might wonder why SM and CI connect perfectly in the non-human brain. In this case, I employ a testing *Hypothesis 3* that was mentioned by Hauser et al. (2002): *Only FLN* [faculty of language-narrow sense; C_{HL}] *is uniquely human*. Humans and non-humans share the fundamental CI and SM properties. However, unlike in non-human, human CI and SM are no longer reflexes or instincts. Phototaxis, I believe, is an example of a primitive SM–CI connection. A euglena exhibits positive phototaxis, and showing that more photons are safe and fewer photons are dangerous. An earthworm exhibits negative phototaxis, where we consider that an earthworm's brain (its SM) detects information (several photons) and sends it to the CI, which computes its meaning, i.e., its survival instinct tells it to choose fewer photons. The CI orders SM to relocate to a less photon-intense position. There is no room for errors when CI and SM communicate as reflexes and instincts.

Consider the difference between interpretable/uninterpretable. Pesetsky and Torrego (2007, 264) stated the difference as shown in (10).

(10) A feature F is interpretable iff F of a certain lexical item contributes semantically to its interpretation. Otherwise, F is uninterpretable. (Adapted from Pesetsky and Torrego (2007, 264)).

The phrase "semantic contribution" indicates that interpretability is specified for CI rather than SM here. However, interpretability must be defined for both CI and SM. The term "interpretable" is misleading because it usually refers exclusively to CI-interpretability. It is necessary to include not just semantic contribution but also phonemic/phonetic contribution. I propose that the term "interpretability" be replaced with a more generic term "computability." Assume that the conceptual features can only be computed and used in CI, and that phonemic/phonetic features can be computed and used in SM.

Consider grammatical (morpho-syntactic; formal) features such as case and ϕ. The prevailing opinion is that ϕ-features are interpretable in relation to DPs but not in relation to predicates; for example, Chomsky (1995, 278) claimed that "the Interpretable features are categorial features generally and ϕ-features of nouns." In this context, "interpretable" refers to CI-computable.[13)] For example, ϕ (plural) morpheme "s" in "books" is CI-computable, whereas ϕ (third person, singular) morpheme "s" on a verb is CI-uncomputable, e.g., "s" on "reads" in a sentence "She reads books." The conventional logic is as follows: the plural "s" on DP is CI-computable because "a book" and "books" have different references, i.e., one book vs. more than one book; the singular "s" on the verb "read" is CI-uncomputable since it does not relate to a singular reading event. However, axiom one prevents us from claiming that "s" on "books" is CI-computable because it refers to a collection of numerous books that exist in the external world. To begin with, the idea of "semantic contribution" based on the referentialist doctrine is false. Nothing is referred to by a CI-computable feature (meaning). As a result, the CI-computable/noncomputable distinction for ϕ based on the referentialist doctrine is untenable, causing the conventional analysis to collapse: ϕ on a noun is CI-computable (interpretable), but ϕ on a verb is CI-uncomputable (uninterpretable).

In this section, I propose a simplified model: The grammatical feature hypothesis holds that all grammatical (i.e., morpho-syntactic; formal) features, such as case and ϕ, are NS-computable but SM/CI-uncomputable (11).

13) Bobaljik (2006, 1) admits that "[t]he issue is not as simple as saying that ϕ-features are interpreted on nouns but not on verbs (to roughly paraphrase Chomsky (1995, 278))."

(11) *The grammatical feature hypothesis*

All grammatical features are NS-computable but are SM/CI-uncomputable.

Consider the valuation/interpretability biconditional (Chomsky (2001b, 5)), which is adopted from Pesetsky and Torrego (2007, 266).

(12) *Valuation/Interpretability Biconditional*

A grammatical feature F is uninterpretable iff F is unvalued.

Although the condition (12) is ambiguous as to which system F is uninterpretable, given the biconditional logic (12), a grammatical feature F is interpretable iff F is valued. Let us assume that "interpretability" here refers to "CI-computability." As a result, a grammatical feature F is CI-uncomputable iff F is unvalued, and F is CI-computable iff F is valued. Chomsky's purpose for postulating valuation, as stated in Pesetsky and Torrego (2007, 266), was to make the model reflect that NS cannot check F's CI-computability, which is what CI does, but it can inspect F's value (Chomsky (2001b), Chomsky (2008)). However, valuation creates a contradiction. If a probe's case values a matching goal's case, the case is valued and interpretable (CI-computable). As a result, case is CI-computable as meaning. Case, however, lacks intrinsic meaning: a contradiction. Therefore, valuation must be avoided. If all grammatical features F is CI-uncomputable and unvalued, then no grammatical feature F is CI-computable and valued. It is sufficient to postulate that a grammatical feature F is NS-computable and SM/CI-uncomputable (11). C_{HL} (NS) is a "blind merge machine" (D'Alessandro (2020)) that focuses solely on NS-computable features. NS not only ignores word order and sound computed in SM, but it also ignores meaning processed and is employed in CI.

After stating that interpretable (CI-computable) features include tense, aspect and modal for T, and ϕ for nominal, and uninterpretable (CI-uncomputable) features include ϕ for T, and case for nominal, Radford (2009, 287–288) concedes that the analysis leaves complexities, as demonstrated in (13).

(13) There are a number of potential complications which cloud the picture. For example, ϕ on expletives appear to be uninterpretable, as do the gender on nouns, e.g., feminine gender [FEM] of the French noun *table* 'table'). Tense determined by sequence of tense may be uninterpretable. However, we set aside such complications here. (Adapted from Radford (2009, 287–288))

However, I maintain that we reconsider the very complications (13) seriously, rather than ignoring them. Where the apparently challenging grammatical features in (13) are NS-computable and SM/CI-uncomputable, the axiom one (9) and the grammatical feature hypothesis (11) resolve these complications.

3.1.2 More evidence for the grammatical feature hypothesis

This section provides evidence for the grammatical feature hypothesis (11). It is generally assumed that the gender feature [FEM] of a Hindi word such as *laṛkī* 'girl' is interpretable (CI-computable) since the word has a conceptual (meaning) feature [feminine].[14] A good example to demonstrate that morpho-syntactic features such as ϕ-features are independent of DP meaning is the word *boireannach*, which means "woman" in Scottish Gaelic (Indo-European, Celtic; VSO), whereas, as proven by transgender facts, grammatical gender differentiation lacks biological basis and strong predictability. Furthermore, according to axiom one, the meaning [feminine] relates to nothing. It is not apparent what it means to say that ϕ is CI-computable in terms of DPs. How is ϕ [FEM] interpretable (CI-computable) in relation to the Hindi word *kitāb* 'book'?[15] As shown in (14) (adapted from Adger (2003, 40)), this word has a morpho-syntactic feature [MASC] (grammatical gender feature masculine) and a conceptual (meaning) feature [fem].

(14) Thàinig am boireannach mòr agus shuidhe i sios.
arrive [past] the woman [MASC] big [MASC] and sat she [fem] down
'The big woman arrived and she sat down.'

In the Scottish Gaelic example (14), the adjective mòr 'big' agrees with the noun *boireannach* 'woman' according to the grammatical feature ϕ [MASC]. The feminine form of the pronoun *i* 'she' has the meaning feature [fem]. The masculine pronominal form is *e* 'he,' which is grammatically incorrect in the sentence (14) (ibid. 41). In the same language, the word *chaileag* 'girl' has the morpho-syntactic feature [FEM]. With it being plausible to argue that grammatical gender (morpho-syntactic feature) is independent of meaning feature, in modern spoken Dutch (Indo-European, Germanic; SOV), the word *meisje* 'girl' has a neuter gender ϕ ([NEUT]), occurs as it does with the neuter article and triggering

14) Hindi: Indo-European, Indo-Aryan; basic word order SOV.
15) Regarding Hindi DP gender, Agnihotri (2007) states that "the assignment of gender is often arbitrary" and that "[b]asically, one has to learn the gender of each noun," implying that Hindi DP gender is uF (CI-uncomputable).

neuter agreement on relative pronouns (ibid. 41). Despite denoting a feminine entity, the German noun *Mädchen* ‘girl’ is intrinsically neuter in gender (Radford (2004, 8.4)).

Furthermore, it is wrong to conclude that T’s tense feature is interpretable (CI-computable) (Chomsky (2001b), Chomsky (2008)). A temporal morpheme *ta* in Japanese, for example, can carry future/present/past tenses, perfect aspect, and modality (Teramura (1971)), suggesting that the morpheme *ta* lacks a fixed intrinsic meaning, i.e., it is uF (CI-uncomputable). Consider (15); inf = infinitive, acc = accusative, dat = dative.

(15) a. $[_{DP}$ $[_{CP}$ ichiban haya-ku kimono-o ki-ta] hito]-ni age-ru
most fast-inf kimono-acc wear-future person-dat give-future
‘I will give it to a person who will wear the kimono the fastest.’

b. $[_{DP}[_{CP}$ kimono-o ki-ta] hito]
kimono-acc wear-present/perfective person
‘a person with a kimono’/‘a person who has worn kimono’

c. kinoo kimono-o ki-ta
yesterday kimono-acc wear-past
‘I wore kimono yesterday.’

d. haya-ku ki-ta ki-ta
fast-inf wear-imperative wear-imperative
‘Wear it quick.’

T morpheme *ta* means future tense (15a), present tense/perfective aspect (15b), past tense (15c), and imperative modal (15d). The morpheme *ta* lacks a fixed intrinsic meaning. T’s tense feature is a uF, i.e., CI-uncomputable.[16] According to the current method, DP ϕ-features are uninterpretable (CI-uncomputable) as DP case and ϕ on predicates. Valuation (Chomsky (2000a), Chomsky (2001b)) is untenable because it assumes that a

16) Chomsky (2021a, 33–34) states that “tense is a feature of v, not of INFL,” based on (ia) with the structure (ib).
(i) a. John arrives every day at noon and met Bill yesterday.
b. C, { $John_3$, { INFL, 〈&, { $_1$ v, { arrive, $John_1$ }}, { $_2$ $John_2$, { v*, { meet, Bill }}}〉}}
In (ib), INFL has ϕ-features that are fixed for conjuncts, but tense is not fixed. Chomsky’s proposal is similar to the current proposal that tense is uninterpretable (CI-uncomputable): v is the location of typical grammatical features like uCase and uϕ. We equate T with INFL.

goal (DP) bears interpretable (CI-computable) ϕ, erroneously presuming that such ϕ on a noun corresponds to an outer-world distinction.[17] The current study employs a simplified approach (the grammatical feature hypothesis (11)): all case and ϕ (morpho-syntactic) features are NS-computable and SM/CI-uncomputable; they are errors or viruses that cause SM and CI to freeze unless they are eradicated within the NS.

3.2 Two types of error-minimizing algorithm (EMA)

3.2.1 EMA ① and EMA ②

I propose two versions of EMA (Table 1): error elimination via feature matching (EMA ①) and error neutralization (counteraction) without matching (EMA ②), where error is uF: uCase and uϕ (SM/CI-uncomputable case and ϕ). EMA ① eliminates uF by matching; valuation is unnecessary (Subsection 3.1.1). As a result, EMA ① is less complicated than the conventional Agree.

	Error elimination via matching (EMA ①)	Error neutralization (EMA ②)
uCase	uCase elimination via matching	uCase (null) neutralization by infinitive
uϕ	uϕ elimination via matching	uϕ neutralization by case markers

Table 1: Two types of error minimization: EMA ① and ②

Furthermore, in terms of feature-inheritance time, EMA ① employs two logically necessary Agree patterns (Agree 1 and 2) (Subsection 3.2.2). Both EMA ① and EMA ② search errors minimally (minimal search (MS)) to reduce them (i.e., morpho-syntactic features). To eliminate uF, EMA ① leverages feature matching between probe (head) and goal (DP) uFs (uCase and uϕ). To neutralize uF, EMA ② uses infinitival T and case markers.[18] In EMA ②, MS detects case markers before heads, and those case markers are the ones which encapsulate nouns containing uϕs, and these are eliminated as a reflex of uCase elimination via feature matching in EMA ①.[19] Thus, "reflex" here means "neutralization"

17) Thus, a presupposition in Chomsky (2000a, 124) that "ϕ-features are interpretable (CI-computable) only for N" is false.

18) The current proposal in terms of EMA ① is compatible with Mark Baker's intuition: "The intuition here is that both members [probe and goal] of the Agree relation must have some deficiency that gives them a motive for participating in Agree" (Baker (2013, 615)). "Deficiency" means an error that must be eliminated. The uF-neutralization (EMA ②) deals with a deficiency in a broad sense in that probe-ϕ becomes neutral (default) because goal-ϕ is eliminated as a reflex of uCase elimination and probes do not require uϕ for Agree.

19) The current analysis postulates that uϕ is eliminated as a reflex of uCase-elimination in EMA ②, which is the opposite to the standard analysis where uCase is eliminated as a reflex of ϕ-elimination (Chomsky (2000a, 122)). Regarding EMA ②, uCase-elimination is a prerequisite to ϕ-elimination.

or "counteraction" (Subsection 4.2.2). EMA ② employs non-externalization to neutralize the PRO case, as a result of the infinitive necessitating PRO, which is not externalized. As a result, PRO does not require any specific agreement form in control structures, resulting in default agreement. The infinitival T relates to case markers and forces PRO to be devoid of phonetic content and neutralize case, i.e., making the PRO case to be null (Subsection 4.2.1).[20]

My proposal has the following merits: (a) it integrates uF elimination with uF neutralization, (b) it subsumes control structures under uF neutralization, and (c) it subsumes a long-standing problem of apparent lack of ϕ-agreement in east Asian languages such as Japanese and Korean under uϕ neutralization (EMA ②), which is a reflex of uCase elimination (EMA ①).[21] The fact that EMA① and ② are UG (C_{HL} theory) principles rather than parameters, implies that a language exhibits both EMA ① and ②.

3.2.2 Two logically required EMA ① Agree patterns

Assume that feature inheritance (phase head → nonphase head: v → V, C → T; Chomsky (2008)) is feature-transfer, not feature-copying. As shown in (16), there are two uF-elimination patterns that are logically essential.

(16) *Two logically necessary Agree patterns*

a. Feature inheritance → Error elimination (Agree-1)

b. Error elimination → Feature inheritance (Agree-2)

In Agree-1, the error elimination is postponed (16a). Critically, the two patterns are analogous to two distinct types of theorem proof, namely, the basic-property-forming UG axioms that may lead to external variation. The two Agree patterns are schematically represented in Figure 4, where H is a phase head, *x* is an error, and dotted arrow shows feature inheritance, and solid arrow signifies IM.

In Figure 4(a) (Agree-1), a probe uF [X] in a phase head H is transferred to its complement head Y, therefore removing [*x*] contained in Y's complement XP. Figure 4 (b) (Agree-2) shows that probe uF [X] minimally detects a viral [*x*] in the c-commanding domain (MS) prior to feature inheritance, internally merging XP containing [*x*] to the HP edge, and thus eliminating the error [*x*]. A probe uF [X] is relatively excited from the

20) The Case Filter is proposed in Chomsky (1981, 49): *NP if NP has phonetic content and has no Case. A neutralized case is not equal to no case. This paper adopts a hypothesis that PRO bears a null case (Chomsky and Lasnik (1993)).

21) Non-externalized implementation of error neutralization can be seen in languages like Chinese where all uFs are neutralized.

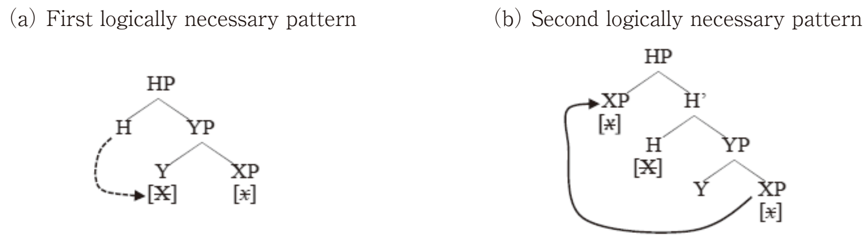


Figure 4: Two logically necessary patterns of error elimination:
(a) feature inheritance first (Agree-1) (b) error elimination first (Agree-2)

outset. As a result, feature inheritance is utilized only sparingly in Agree-2. Figure 4(b) attempts to distribute uF features, but there is nothing to spread on the non-phase head, Y.

4 Discussion

4.1 EMA ① issues

4.1.1 Evidence for Agree 1/2: English-French asymmetry

The Agree-1/2 model allows for an external variation, i.e., differences in V-movement between languages. The new approach makes it easier to analyze a well-known English-French contrast (17) (Pollock (1989, 367), Chomsky (1991); nom = nominative case).

(17) a. John often kisses Mary.
  b. Jean embrasse souvent Marie (French)
   Jean-nom kiss.3.sg.masc often Marie
   'Jean often kisses Marie.'

Figure 5 illustrates the geometry of the English example (17a), while Figure 6 illustrates the geometry of the French example (17b). I presume that temporal adverbs such as "often" and "souvent" adjoin within a TP system with T (tense) as the head.[22] English employs Agree-1, which means "feature inheritance precedes error elimination," whereas French uses Agree-2, which means "error elimination precedes feature inheritance." To use standard terminology, the French C is "strong" in that it avoids procrastination when it comes to error elimination. Unlike the standard analysis, the relevant phenomenon is determined by C's

22) The adverbs "often" and "souvent" are treated as VP-adverbs in Chomsky (1991), a view of which is followed by an article (Epstein et al. (2013)) in a handbook of cutting-edge generative syntax. However, we believe that these adverbs are TP-adverbs as stated in Jackendoff (1972) (a seminal work on the related area), Potsdam (1998), and Alexiadou (2013); these adverbs express the frequency of events in time, not a property of the events.

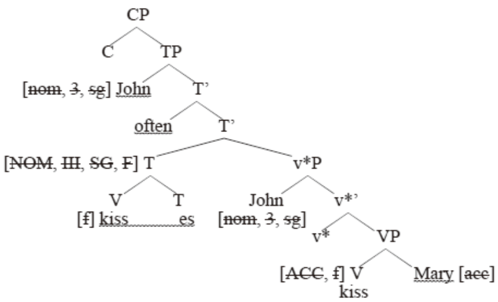


Figure 5: English: feature inheritance precedes error elimination

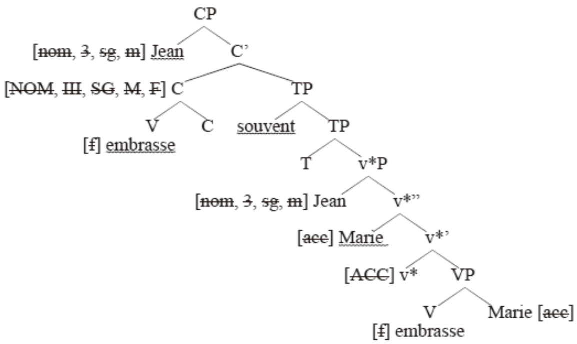


Figure 6: French: error elimination precedes feature inheritance

property rather than T's. Because error elimination is delayed, the English C is "weak." As a result, C, rather than T, exhibits UG-based logically required potential patterns. In assuming that the CP phase heads (C and T) are equipped with a probe uF [F] that seeks an error [f] in V, the two logically essential Agree patterns are not parameters; rather, they are built in as UG principles. I ignored sequential head adjunction.[23]

If we consider feature inheritance as an axiom, the two error elimination patterns are the two logically essential potential consequences available in C_{HL}. The current analysis does not require T parametrization (i.e., French T attracts V before Spell-Out, whereas English T attracts V after Spell-Out), as proposed in Chomsky (1991). Both attractions take place before Spell-Out in Figures 5 and 6. The current model, which is based on logical necessity within the UG, is less complicated than language-specific parameter proliferation within a head. Importantly, Agree 1 and 2 are not language-dependent fixed parametric options. Therefore, the English-French contrast is caused by the logically necessary computations provided in the set of UG principles.

4.1.2 Evidence for Agree 1/2: Hindi ERG-ABS vs. ERG-DAT

How do Agree-1/2 accommodate for a language-internal variance? In Hindi data adapted from Mahajan (1990, 73), ERG-ABS (ergative-absolutive) (18a) exhibits Agree-2, whereas ERG-DAT (ergative-dative) (18b) exhibits Agree 1.

23) Incidentally, Pollock (1989, 397, (77)) proposed a consecutive head movement (i.e., V to v, {V + v} to T, and {V + v + T} to C, as in Figure 6) for an English sentence.

(18) a. raam-ne roTii khaa-yii th-ii
Ram (3.sg.masc)-erg bread (3.sg.fem) eat-perf.part.3.sg.fem be.past-3.sg.fem
'Ram had eaten bread.'

b. baccoN-ne siitaa-ko dekh-aa th-aa
children (3.pl.masc)-erg Sita-dat (3.sg.fem) see-perf.part.3.sg.masc be.past-3.sg.masc
'The children had seen Sita.'

Figures 7 and 8 show the geometries of (18a) and (18b), respectively. The example (18b) demonstrates uϕ neutralization; the geometry (Figure 8) further elaborated in Subsection 4.2.2. Figure 7 is a geometry generated by Agree-2: the v probe uFs are excited that they forbid procrastination. Prior to feature inheritance, the v-probe uFs minimally detect viral features in the patient DP, compute that the probe uFs and errors are remote (i.e., separated by a VP), instigate IM of the DP, destroy viruses, and vanish.
Figure 8 depicts a geometry generated by Agree-1: the v probe uF [ACC] travels to V, and the viral [acc] is eliminated in situ.

In the instance of a patient DP agree, I adopt Legate (2008, 56–57), i.e., Hindi belongs to "a class of ergative-absolutive languages as *absolutive as a morphological default* (ABS = DEF) (ibid. 56)," where "T assigns [nom] to the intransitive subject (S) and v assigns [acc] to the transitive object (O) (ibid. 57)." "In this class of ergative-absolutive languages, [nom] and [acc] morphology is lacking (ibid)," a situation "entirely parallel to that of English nouns, for which [nom] on the subject and [acc] on the object are both morphologically realized by a (null) default [i.e., no phonetic feature] (ibid. 55–56)." I do not follow Woolford (2006) here, in which T skips an agree-inactive ergative agent DP to assign [nom] to the agreeing patient DP, because this violates MC and is more computationally complex than

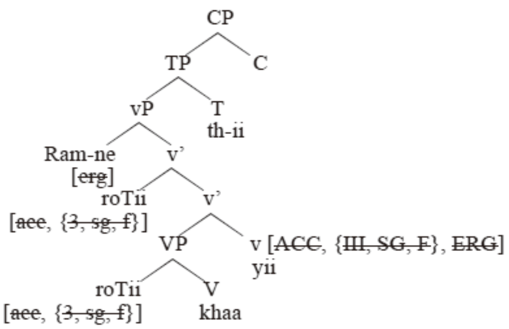


Figure 7: Hindi ERG–ABS; Agree-2

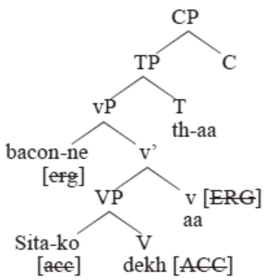


Figure 8: Hindi ERG–DAT; Agree-1

Legate's system. I agree with Woolford (2006) on [erg]: v assigns [erg] to DP at the vP edge (the vP-internal ergative subject hypothesis).[24] The geometrical contrast between Figures 7 and 8 is verified by a specificity consideration. A VP-external agreeing DP is interpreted as specific, while a VP-internal non-agreeing DP is interpreted as non-specific (Mahajan (1990, 103–106)). Deleting the [dat] case marker *ko* makes the object specific (19a), and a non-agreeing VP-internal DP is non-specific (19b).

(19) a. baccoN-ne laRkii dekh-ii th-ii
children (3.pl.masc)-erg girl (3.sg.fem) see-perf.part.3.sg.fem be.past-3.sg.fem
'The children had seen the girl.'

b. baccoN-ne laRkii-ko dekh-aa th-aa
children (3.pl.masc)-erg girl-dat (3.sg.fem) see-perf.part.3.sg.masc be.past-3.sg.masc
'The children had seen a girl.'

See Enç (1991), Diesing (1992), and Woolford (2015) for a correspondence between semantics (e.g., specificity) and geometry (VP-externality).

4.1.3 Evidence for Agree-1: Cancerous suffix in direct passive

Consider how the EMA ① and the Agree 1 deal with grammatical direct passive examples (English (20) and Japanese (21)), whose geometries are depicted in Figures 9 and 10, respectively. The derivation is the same.

(20) He was beaten by her.

(21) kare-ga kanojo-ni nagur-are-ta (Japanese)
he-nom her-by beat-passive-past
'He was beatn by her.'

Assume Agree-1: the v probe uF [ACC] is transmitted to V (feature inheritance), and assume that the cancerous [**ACC**] (in boldface type) in the direct-passive morpheme

24) According to Anand and Nevins (2006), the vP-internal ergative subject hypothesis was proposed by Nash (1995) and Woolford (1997): [erg] is not a structural case assigned by T, but rather a lexical case due to thematic role, and Ura (2000): [erg] is a structural case assigned in theta position.

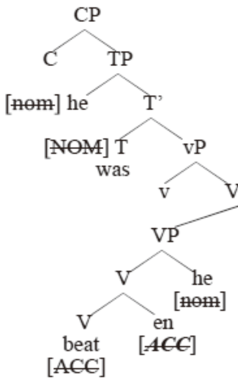


Figure 9: English passive geometry

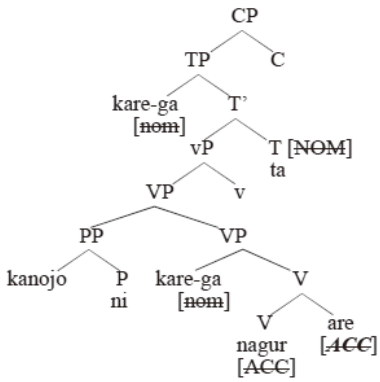


Figure 10: Japanese direct passive geometry

destroys the inherited probe uF [ACC] (virus buster) in V. Then assume Agree-2 is realized, i.e., virus detection and elimination precede feature inheritance. Henceforth, the v probe uF [ACC] cannot finish its task because there is no viral [acc], and the probe uF [ACC] remains in v, and spreads to V. With the cancerous [**ACC**] eliminating [ACC], and it vanishing, a viral [nom] is subsequently removed. All errors are eliminated, and CI and SM converge. As a result, both Agree 1 and 2 make accurate predictions. Agree-1 is clearly simpler than Agree-2. Is there another reason why Agree-1 is chosen here? I propose that Agree-1 is chosen here because the phase head v in a passive/unaccusative structure differs from a v* with full transitivity (Chomsky (2008, 147)), precisely, a non-transitive v must spread probe uF [ACC] to V as soon as possible, which generates Agree-1.

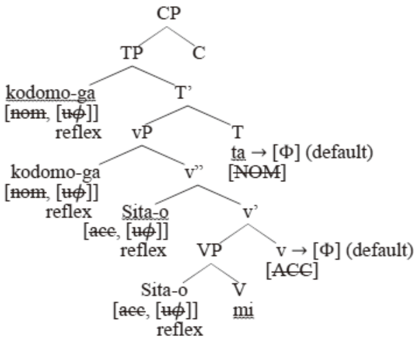
4.2 EMA ② issues

4.2.1 Null case elimination as uCase neutralization

Due to non-externalization, PRO is neutralized by the EMA ②, rendering it a null case. As a result of uCase elimination, C_{HL} uses EMA ① to eliminate PRO uϕ. C_{HL} generates the geometry shown in Figure 12 for an English subject-control example (22) (Chomsky (1982)).

(22) The police$_1$ tried [PRO$_1$ to uphold the rules]

According to Figure 12, EMA ② neutralizes PRO, i.e., PRO is constrained against externalization and exhibits a null case. By matching with [NULL] in the infinitival *to* with EMA ① eliminates [null]. Finally, EMA ② eliminates uϕ because of uCase elimination. Since uϕ elimination is unnecessary, V's ϕ becomes the default (neutral); V is the bare infinitive form.



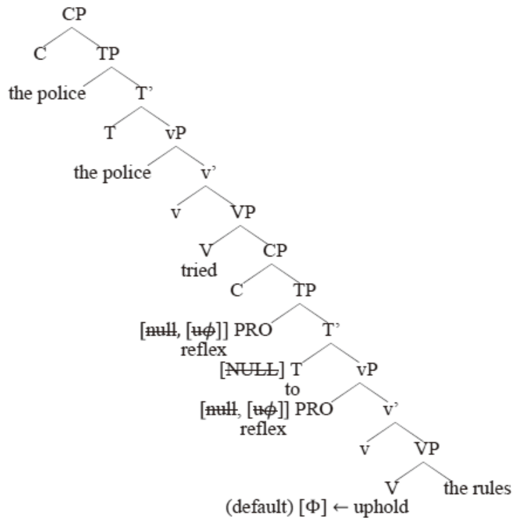


Figure 11: EMA ① and ② working in Japanese　　　　Figure 12: English PRO neutralization

4.2.2 Apparent lack of ϕ-agreement as uϕ neutralization

East Asian languages, such as Japanese and Korean, have long been considered to lack ϕ-agreement, which means that their predicate inflections do not agree with DP forms in terms of person, number, and gender. Proposing a hypothesis (23), I contend that these languages exhibit systematic uϕ neutralization.[25] Therefore, I propose a neutralized ϕ agreement hypothesis (23).

(23) *Neutralized ϕ agreement hypothesis*

A language without overt ϕ-agreement has a default ϕ-agreement.

Hindi is a good example for investigating the relationship between EMA ① and ②, and how the latter evolves. The examples (18) are repeated here as (24), where the boxes in gloss indicate relevant uϕs. When at least one DP-case ending is not externalized (not pronounced), C_{HL} uses EMA ①, as shown in (24a) and Figure 13. However, when DP-case endings are externalized, C_{HL} invokes EMA ②, i.e., the predicate agreement is neutralized and fixed as default [3, sg, masc] (i.e., third person, singular, masculine) (Mahajan (1990,

25) According to Fukui (1986), there are no characteristics of agreement features in Japanese. Kuroda (1988) states that a set of typological distinctions emerge from a single parametric distinction, i.e., agreement is forced in English but not in Japanese. Dissimilar to Fukui, Kuroda did not claim that Japanese is devoid of agreement, which is consistent with the current paper's claim: Japanese has a case agreement and neutralized ϕ-agreement.

73)), as demonstrated in (24b) and Figure 14.[26] In more detail, in (24a) the patient DP agrees with V in uϕ including [fem], and in (24b) DP shows no ϕ-agreement, i.e., V's agreement is neutralized and the default ϕs [3, sg, masc] are shown systematically. In (24b), no feature matching is observed. How does C_{HL} eliminate uϕs in (24b)?

(24) a. raam-ne roTii khaa-yii th-ii
Ram (3.sg.masc)-erg bread (3.sg. fem) eat-perf.part.3.sg. fem be.past-3.sg. fem
'Ram had eaten bread.'

b. baccoN-ne siitaa-ko dekh-aa th-aa
children (3. pl.masc)-erg Sita-dat (3. sg.fem) see-perf.part.3. sg.masc be.past-3. sg.masc
'The children had seen Sita.'

Figure 7, renumbered here as Figure 13, is the geometry of (24a). Figure 8, renumbered as Figure 14, is an elaborate geometry of (24b).

For (24a), C_{HL} generates a geometry as demonstrated in Figure 13, where EMA ① eliminates errors (uCase and uϕ) through feature matching. The viral buster [ACC, III, SG, FEM] in the phase head v draws (internally merges) the patient DP *roTii* 'bread' bearing matching viruses [acc, 3, sg, fem] to the vP edge. When the agent DP *Ram-ne* externally merges at the vP edge, a virus [erg] in the ergative case marker *ne* is removed by a virus buster [ERG] in v. In a later step, the phase head v internally merges with T, causing T to exhibit an identical ϕ pattern that is ignored here.

For (24b), C_{HL} generates a geometry as shown in Figure 14, where EMA ① eliminates uCase via matching and EMA ② neutralizes uϕ, which are eliminated because of uCase

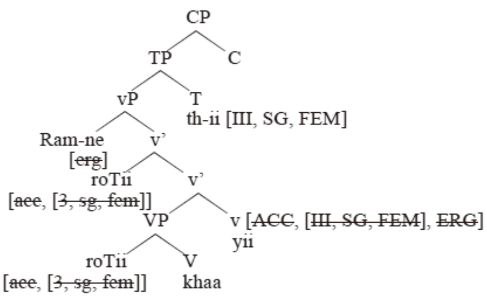


Figure 13: Hindi ERG-ABS; Agree-2; EMA ①

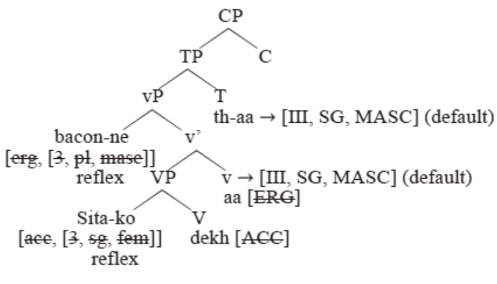


Figure 14: Hindi ERG-DAT; Agree-1; EMA ②

26) Agnihotri (2007) called non-agreeing [3, sg, masc] as "default."

elimination. Because uϕs disappear as a result of uCase elimination, the heads v and T do not need to have matching viral busters, resulting in default (neutralized) agreement [III, SG, MASC].

Languages that appear to lack ϕ-agreement systematically, such as Japanese and Korean, use neutral (fixed; default) ϕ-agreement (EMA ②). These languages have case markers and a somewhat flexible word order. The nominative and accusative case markers systematically block ϕ-agreement in a Japanese example (25); the geometry illustrated in Figure 11, that this language has neutral ϕ-agreement (i.e., uϕ neutralization), as seen in the Hindi example (24b).

(25) kodomo-ga siitaa-o mi-ta (Japanese)
child(ren) (3)-nom Sita-acc (3.sg.fem) see-past
'The child(ren) saw Sita.'

In the Japanese example (25), a neutralized ϕ-agreement exists, forced by the existence of case markers. In its original form, a neutralized-ϕ agreement exhibits no externalization, as in Japanese and Korean, which is more efficient than selecting a fixed ϕ-set {3, sg, masc}, as in Hindi.[27)]

Based on Chomsky's notion that case elimination is a reflex (side effect) of ϕ elimination, Preminger (2015, 67–68) drew a similar conclusion as the current proposal. If "case is seen as a result of phi-agreement," it follows that "there is a phonologically covert agreement in phi-features between the putative case assigner and the case-marked DP (ibid.)" even if the ϕ-agreement is not heard. As a result, if case is a side effect of ϕ-agreement, then every language has ϕ-agreement and this is because all languages contain cases, where, even if ϕ-agreement is not audible in a language, the language contains silent ϕ-agreement. Contrary to Preminger's opinion where he adopted the popular perspective that case is a side effect of ϕ-agreement, the current paper contends that ϕ-agreement (uϕ-elimination) is a side effect (result) of case-agreement (uCase-elimination) (EMA ②), implying that case is a more fundamental uF than ϕ in C_{HL}.

27) I leave an open question as to what the morpho-syntactic status of the case markers is. They are not projecting postpositions, according to evidence from anaphor binding and floating numeral quantifiers. However, it is uncertain whether we can conclude that they are non-projecting suffixes. Another challenge is determining how to investigate a language lacking both ϕ-agreement and case markers, such as Chinese. Chinese and English are similar, but the former has a worsening poverty of uF-agreement externalization (EMA ② dominance).

5 Conclusion

This paper posed two questions: (a) What exactly is uF/Agree? (identification), and (b) Where is its origin? (evolution). I adopted two assumptions: the failure of the referentialist doctrine (axiom one: words do not refer) and the EMH for nature, comprising EMH for C_{HL} as its subset. These assumptions are the basis for the valuation-free Agree model, resulting in (a) SM–CI disconnection, (b) the human brain's last resort to associate two heterogeneous systems: C_{HL} (NS) and SM, and (c) emergence of uF as errors due to the unnatural NS–SM association. C_{HL} is a common error-minimizing system found in nature that aims to offset errors. The SMT is deduced from EMH.

A valuation-free Agree model is ensured by axiom one and EMH for C_{HL}. From the axiom one, we obtained the grammatical feature hypothesis, which states that all morpho-syntactic features are NS-computable but SM/CI-uncomputable, eliminating the need for a valuation. The EMH for C_{HL} allows for two types of error-minimization algorithms (EMA): error elimination under matching (EMA ①) and error neutralization (EMA ②). Under matching (EMA ①), where two types Agree in terms of feature inheritance timing, EMA ① eliminates probe-goal uF (case and ϕ). EMA ② neutralizes uF by eliminating ϕ as a reflex of case elimination, causing the predicate ϕ to default.

The merits of valuation-free Agree model are that (a) EMA combines uF elimination and uF neutralization, (b) it subsumes control structures under uF neutralization, and (c) it resolves a long-standing issue of apparent lack of ϕ-agreement in east Asian languages such as Japanese and Korean. The proposal is supported by various empirical evidence.

Finally, we highlight two outstanding issues for future research: (a) how strong is the case for a hypothesis that DP ϕ is uninterpretable? (Subsection 3.1.1), and (b) how strong is the case for a hypothesis that languages apparently lacking ϕ-agreement have neutral (default) ϕ-agreement? (Subsection 4.2.2) Problem (a) requires further investigation to determine if valuation is truly based on the referentialist doctrine (Subsection 2.1). Concerning problem (b), a minute comparative study is necessary between default ϕ-agreement in a language like Hindi and an apparent lack of ϕ-agreement in languages like Japanese and Korean.

Acknowledgement

This work was supported by JSPS KAKENHI Grant Number JP21K00491 (Research projects: Essence and ontology of structure-building mechanisms of natural language system: a graph-theoretical approach; 2021–2023) and the Momoyama Gakuin (St. Andrew's) University Fund for Research Support. The author wants to thank Enago (www.enago.jp) for the English language review.

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(Accepted on 21 November, 2022)