

Meta-Operations of Grammatical Analysis: Addition, Deletion, Substitution, Restructuring, and Anchoring

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Abstract

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Full Text

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Abstract: The theoretical divergences among contemporary schools of linguistics obscure the fact that they share a common set of underlying analytical steps. This paper reveals and systematically argues that this set of underlying operational procedures—addition, deletion, substitution, restructuring, and anchoring—constitutes the meta-operations of grammatical analysis, and establishes an evaluative framework of “four admission criteria + three-dimensional feature distinctions.” The argument is based on three independent paths: cross-level full coverage, cross-theoretical convergence, and combinatorial completeness plus thought experiments. The core position of this paper is that the five meta-operations are not “optional” tools of grammatical analysis, but general meta-operations that no grammatical analysis can avoid: any grammatical analysis, regardless of theoretical school, must invoke at least one of these five types of operations. This paper clarifies a three-layer ontological stance: instrumentalist core conclusions, cognitive-isomorphism mid-level hypotheses, and strong ontology as a direction awaiting validation. The five meta-operations possess metalinguistic self-reflexivity, while the proposition of their combinatorial com-

pleteness is clearly falsifiable in cross-linguistic empirical facts.

Keywords: grammatical analysis; meta-operation; operational analysis; cognitive isomorphism; combinatorial completeness

Classification numbers: H04; H0-0

The Five Meta-Operations of Grammatical Analysis: Addition, Deletion, Substitution, Restructuring, and Anchoring

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Abstract: The theoretical divergences among contemporary linguistic schools obscure the fact that they share a common set of underlying analytical operations. This paper explicates and systematically argues for this set of underlying operations—Addition, Deletion, Substitution, Restructuring, and Anchoring—as meta-operations of grammatical analysis, establishing an evaluative framework of “four admission criteria + three-dimensional feature distinction.” The argument is based on three independent paths: cross-level full coverage, cross-theoretical convergence, and combinatory completeness plus thought experiments. The core claim is that the five meta-operations are not optional tools but unavoidable general meta-operations for grammatical analysis: any analysis, regardless of theoretical affiliation, must invoke at least one of these five operation types. This paper clarifies a three-layer ontological stance: instrumentalist core conclusions, cognitive isomorphism middle-level hypotheses, and strong ontological claims reserved for future empirical testing. The five meta-operations possess meta-linguistic self-reflexivity while their completeness proposition is clearly falsifiable in cross-linguistic empirical facts.

Keywords: grammatical analysis; meta-operation; operational analysis; cognitive isomorphism; combinatory completeness

1. Introduction: Blind Spots in Grammatical Analysis

1.1 An Overlooked Fact

Mainstream practice in grammatical analysis—regardless of school or of the language being analyzed—unconsciously relies on a set of underlying operations: adding formal components, removing formal components, substituting formal

components, transforming structural packaging, and anchoring communicative context. These operations permeate every grammatical rule, every sentence analysis, and every teaching exercise, yet they have never been made explicit, systematized, or generalized across levels. Generative grammar uses Merge to introduce syntactic objects, Copy + Delete to remove copies, Agree to substitute feature values, transformations to alter structural packaging, and interface mapping to anchor outputs—yet these operations are dispersed across different modules and have never been uniformly identified as the same set of analytical steps. Systemic Functional Grammar uses the “system of choices” to substitute formal options. Construction Grammar uses constructional variants to transform structural packaging. Structuralist linguistics uses substitution tests to replace phonemes and morphemes. For most people, grammatical analysis is a kind of “tacit knowledge”: they have been performing these operations all along, but without being aware of them and without being able to articulate them.

1.2 The Methodological Gap and the Argument of This Paper

Formal linguistics possesses sophisticated theoretical apparatuses, and pedagogical grammar possesses a wealth of classroom techniques, but a methodological gap exists between the two. The root cause is that neither side has identified the general meta-operations of grammatical analysis. Formal linguistics has unconsciously used these operations in theoretical construction, but has encapsulated them in specialized terminology; pedagogical grammar has unconsciously used these operations in classroom exercises, but has downgraded them to “teaching techniques.” The proposal of meta-operations is intended to bridge this gap, enabling theoretical operations to be carried out in teaching and allowing pedagogical techniques to be explained theoretically.

This paper proposes that addition, deletion, substitution, transformation, and placement are the meta-operations of grammatical analysis. The argument is based on three lines of reasoning: full cross-level coverage (Chapter 2), combinatorial completeness and thought experiments (Chapter 3), and cross-theoretical convergence (Chapter 4).

1.3 The Theoretical Positioning of Meta-Operations

The five meta-operations do not replace existing linguistic theories. The latter answer the question of “how the language system is organized” and belong to ontological explanation; the five meta-operations answer the question of “how researchers operate on linguistic forms in order to derive grammatical regularities” and belong to analytical methodology. The relation between the two is like that between “method of proof” and “content of theorem.”

The core position of this paper is that the five meta-operations are not “optional items” in grammatical analysis, but general meta-operations that no grammat-

ical analysis can avoid. Any grammatical analysis—whether tree operations in generative grammar, distributional analysis in structuralism, or substitution exercises in pedagogical grammar—must rely on at least one of addition, deletion, substitution, transformation, and placement. The four criteria for admission belong to norms of invention at the level of tools, while cross-theoretical convergence belongs to evidence of discovery at the level of regularities. In terms of stratified positions, instrumentalism constitutes the core conclusion; cognitive isomorphism is treated only as a hypothesis explaining the efficiency of the five meta-operations, not as an established fact.

2. The Definition and Functions of the Five Meta-Operations

2.1 Criteria for Identifying Meta-Operations and the Feature Framework

A core distinction must first be clarified: the subject of the five meta-operations is the “analyst/learner,” the object is “existing linguistic forms,” and the direction is “reverse analysis” —that is, starting from existing forms and deriving grammatical regularities by operating on forms. This is fundamentally different from the “forward generative operations” in generative grammar, in which the “language faculty” serves as the subject.

The admissibility criteria for basic meta-operations comprise four conditions, all of which must be satisfied simultaneously. If a given formal-analytic action is to be identified as an indivisible basic meta-operation, it must meet all of the following criteria; failure to satisfy any one of them places it under derivative compound operations.

Criterion 1: irreducibility (the core criterion). The action cannot be equivalently replaced by any finite combination of the other basic meta-operations; it is the smallest atomic unit of syntactic-formal analysis. For example, addition and substitution cannot be mutually interpreted; relying only on the serial superposition of addition and deletion can achieve only constituent displacement, but cannot guarantee propositional equivalence or a systematic correspondence in information structure, and therefore cannot reproduce the distinctive effect of the exchange operation. The traditional notion of “movement” can be decomposed into exchange (reconstructing word order) + placement (verifying legality), and thus belongs to derivative compound operations. The accompanying constraints include: zero-form oppositions at the same level are classified as substitution operations and require evidence of systematic opposition; cross-level additions and deletions may not be ad hoc reduced to substitution operations by positing zero slots; levels are determined according to independently distributed syntactic licensing.

Criterion 2: cross-level universality. The operation has its own independent an-

alytic effects and observable instances across the six major levels of morpheme, word, phrase, clause, sentence, and discourse; it is not merely a special-purpose technique applicable to a single local level. For example, the placement operation can verify verb subcategorization constraints at the word level, and can also test register appropriateness at the discourse level; it has independent functions at all levels.

Criterion 3: independent syntactic effect. Each basic meta-operation corresponds to a unique and irreplaceable analytic target, producing its own syntactic judgment, and cannot be equivalently reproduced by the other operations. The addition operation tests structural extensibility and constituent obligatoriness; the deletion operation identifies formal necessity and communicatively core information; the substitution operation establishes intra-slot formal oppositions and measures gradients of markedness; the exchange operation separates different structural packagings under the same proposition and makes differences in information structure explicit; the placement operation tests formal syntactic legality and pragmatic appropriateness across scenarios. The distinctive effect of the placement operation is to separate a form's inherent meaning from its contextual meaning; this function cannot be achieved through operations that modify form—addition/deletion/substitution/exchange can only change the form itself and cannot generate interpretation differences specific to context.

Criterion 4: operational unidirectionality. The core value of a basic meta-operation lies in producing a specific syntactic judgment; the analytic goals and syntactic effects produced by forward and reverse operations are entirely non-substitutable. The addition operation tests structural extensibility, while the deletion operation tests formal necessity; the syntactic effects produced by the two are entirely distinct, and they are therefore two independent meta-operations.

The three-dimensional feature distinction characterizes the core differences among the five meta-operations through three mutually exclusive dimensions: operation locus (which part of the structure is modified/tested), domain of operation (morphosyntax, semantics, information structure, pragmatics, prosody, and rhetoric), and analytic function (what task the operation undertakes in syntactic derivation). These three dimensions are mutually exclusive and jointly constitute a tool for delimiting the internal boundaries of meta-operations (see Table 1).

Table 1: Correspondence Table of the Three-Dimensional Features of the Five Meta-Operations

Meta-operation	Operation locus	Core domain of operation	Core analytic function	Standard operational instruction
Addition	Constituent embedding; left/right adjunction; addition of an independent structural position	Primarily morphosyntax, extending to discourse cohesion and supplementary prosodic marking	Exposes structurally implicit constituents; tests constituent obligatoriness and the boundary of structural extensibility	What form can be added in this position?
Deletion	Removes an existing structural position; reduces the overall quantity of form	Morphosyntax; information-focus level	Tests the indispensability of form; strips away redundant constituents; distills the communicatively core skeleton	If this form is removed, does the utterance remain legal and semantically complete?
Substitution	Fix the same structural slot; only replace the formal material within the slot, while the total number of positions remains unchanged	Semantic correspondence, prosodic correspondence, rhetorical variants	Construct a system of formal correspondences for the same slot; quantify the gradient of markedness	What alternative forms can still be filled into this slot? What rhetorical effect does repeatedly filling in the same form have?

Restructuring	Without increasing or decreasing the total number of forms, reconstruct the structural relations among components while maintaining propositional equivalence	Information structure, syntactic frames, cross-linguistic sentence-pattern conversion	Compare different structural packagings of the same proposition, and distinguish the binding relation between form and informational focus	For events and participants that are expressed in exactly the same way, what other sentence patterns can be restructured?
Anchoring	Without changing the surface form itself, place the complete form in a syntactic environment or a real communicative scenario to complete the test	Verification of syntactic legitimacy; pragmatic, stylistic, ironic, and other rhetorical contexts	Determine whether the form conforms to syntactic constraints and whether it is appropriate in different scenarios; activate context-specific meanings	In what kind of communicative scenario will placing this sentence pattern change its interpretation and acceptability?

2.2 Addition

The addition operation exposes the boundary between what is “implicitly but necessarily present” and what is “optional” in a structure by supplying implicit components or optional markers. It simultaneously tests extensibility—whether additional components can be added—and obligatoriness—whether the structure becomes more complete and natural after supplementation. The core instruction is: “What else can be added in this position? How does the structure change after it is added?” (see Table 2)

Table 2 Cross-level case table of the addition operation

Level	Example of the addition operation	Distinctions revealed / analytical function
Morpheme level	<i>teach</i> → <i>teacher</i> (+ derivational affix <i>-er</i>) → <i>teachers</i> (+ inflectional affix <i>-s</i>)	Distinguishes lexical-level expansion (derivation changes word class) from grammatical-level obligatoriness (plural marking)
Word level	English: <i>He leave</i> → <i>He leaves</i> (+ tense marker <i>-s</i> , Quirk et al. (1985)); Chinese: <i>shū</i> “book” → <i>yī běn shū</i> “one CL book” (addition of a classifier)	Tests grammatical obligatoriness: English requires <i>-s</i> in the third-person singular present tense; Chinese noun counting requires classifier packaging, reflecting typological differences (Zhao Yanfang (2001))
Phrase level	<i>a book</i> → <i>a new book</i> → <i>a new red book</i>	Modifier extensibility, positional constraints (between determiner and noun), and hierarchical accumulation
Clause level	<i>I know he is honest</i> → <i>I know that he is honest</i> (+ optional subordinator <i>that</i>)	Distinguishes structural obligatoriness from stylistic optimization: <i>that</i> is optional, but insertion in formal or syntactically complex embedded contexts can improve readability
Sentence level	<i>He left</i> → <i>He left, unfortunately</i> (+ evaluative adverb)	Distinguishes the propositional core from the pragmatic periphery: the adverb does not change the truth value, but only makes the speaker’s attitude explicit

Level	Example of the addition operation	Distinctions revealed / analytical function
Discourse level	<i>He left. He was angry.</i> → <i>He left because he was angry.</i> (+ connective <i>because</i>)	Relation explicitation: no conceptual information is added; the causal relation is anchored

2.3 Deletion

Deletion removes an existing form and tests the necessity of that form for the structure. If the structure becomes invalid after deletion, the form is obligatory; if it remains valid, the form is optional. This is the most destructive operation among the five operations, and its core function is to distinguish the core framework of obligatoriness vs. optionality and distillation of communicative information (see Table 3).

Table 3 Cross-level examples of deletion operations

Level	Example of deletion operation	Distinction revealed / analytical function
Morpheme level	<i>teacher</i> → <i>teach</i> (– derivational suffix <i>-er</i>); <i>teachers</i> → <i>teacher</i> (–inflectional suffix <i>-s</i>)	Removal of a derivational suffix causes regression in word class; removal of an inflectional suffix restores the singular; the root core remains unchanged.
Word level	<i>She can swim</i> → <i>She swim.</i> × (–modal auxiliary <i>can</i>)	Closed-class auxiliary structure is obligatory and cannot be omitted.
Phrase level	<i>a new red book</i> → <i>a red book</i> → <i>a book</i> ; <i>a book</i> → <i>book</i> × (deleting the head noun)	Modifiers may be deleted; the head cannot be deleted.

Level	Example of deletion operation	Distinction revealed / analytical function
Clause level	<i>I know that he is honest</i> → <i>I know he is honest.</i> (–subordinating conjunction <i>that</i>); Chinese: “下雨了” (zero subject)	Subordinating conjunctions are optional; Chinese permits zero subjects, whereas English subjects obligatorily form a cross-linguistic contrast (Liu Yuehua et al. (2001)).
Sentence level	<i>He left, and he was angry.</i> → <i>He left.</i> (deleting one clause)	A clause may be deleted as added information; the core verb cannot be deleted.
Discourse level	<i>A man entered. He looked around.</i> → <i>A man entered. Looked around.</i> × (– pronominal subject <i>He</i>)	English does not allow zero subjects, and pronominal chains cannot be broken; Chinese allows them, revealing cross-linguistic structural differences.

Deletion has several special applications. First, it serves as a test of cohesion density. By removing conjunctions, pronouns, and elided elements, one can observe whether discourse coherence is impaired. If coherence breaks after deletion, the form is discourse-obligatory; if coherence is maintained, it functions as discourse optimization. Second, it serves as a test of information recoverability. The news headline *President Visits China* omits the article and the progressive-aspect marking (cf. *The President is visiting China*). In the register of headlines, articles and auxiliaries are discourse-recoverable information and may be deleted without loss of core meaning; if the same omissions occur in the opening sentence of the main text, they appear unnatural. Deletion thus distinguishes the systematic constraints imposed by discourse type on deletable components. Third, it distills communicative information redundancy. Under an extreme prompt (“answer me in one word”), the Chinese “他给了一本书给我” and “他给了我一本书,” as well as the English “He gave a book to me” and “He gave me a book,” all converge on “书” / “book.” Deletion exposes a cross-linguistic common core: the recipient “我” is deletable because it is presupposed, while the thing given, “书,” is the only non-deletable communicative core.

2.4 Substitution

Substitution replaces forms within the same structural slot, constructs a system of formal correspondences, and measures gradients in the strength of marked-

ness. The traditional “substitution test” is the application of substitution at the phoneme-morphology level; the five-operation framework extends it to the phrase level and higher levels (see Table 4).

Table 4 Cross-level examples of substitution operations

Level	Examples of the substitution operation	Distinctions revealed / analytical function
Morpheme level	<i>walks walked walking</i> (tense/aspect marking substituted within the same root)	Systematic correspondence of morphological marking; correspondence between tense and aspect
Word level	<i>Go slowly.</i> (standard adverb) <i>Go slow.</i> (adjective inserted into an adverbial slot); Chinese: <i>a / ma / ne / ba</i> inserted at the end of a sentence	Semantic locking vs. release of morphological marking; the Chinese modal-particle system realizes interpersonal functional correspondences
Phrase level	<i>a book</i> (indefinite reference) <i>the book</i> (definite reference)	Referential correspondence in the determiner system
Clause level	<i>If he is...</i> <i>If he were...</i> <i>If he should be...</i>	Formal distance spectrum of conditional clauses: increasing formal marked distance corresponds to increasing semantic distance of possibility
Sentence level	<i>He is here.</i> (declarative) <i>Is he here?</i> (interrogative) <i>He is here!</i> (exclamative)	Systematic correspondence of illocutionary force
Discourse level	<i>Paupers we are, and paupers we shall remain</i> ... (identical substitution) <i>Beggars we are, and paupers we shall remain...</i> (heterogeneous substitution)	Heterogeneous substitution (A B) displays semantic division of labor; identical substitution (A A) displays discourse cohesion and rhetorical reinforcement.

Identical substitution and heterogeneous substitution share the same logic of

substitution; the difference is activated by the placement operation in context. For example, when *Paupers we are, and paupers we shall remain...* is placed in a Dickensian rhetorical context, the identical substitution functions as emphasis; when placed in everyday conversation, it may become redundant.

2.5 Restructuring

The restructuring operation performs equivalent transformations between different structures, stripping away different structural packagings of the same proposition and making differences in information structure explicit. Its valid conditions are: propositional equivalence (strong equivalence means consistency in truth conditions; weak equivalence allows the core event to remain unchanged while the information structure changes); formal difference; semantic explicitness—that is, after transformation, some formal function is forced into prominence (see Table 5).

Table 5 Cross-level Case Table of the Restructuring Operation

Level	Examples of the restructuring operation	Distinctions revealed / analytical function
Morpheme level	<i>measles</i> / <i>series</i> , etc.; singular packaging plural packaging (reanalysis of internal boundaries)	Same form with different analyses: the interpretation of subject-verb agreement shifts as internal morphemic boundaries are switched
Word level	<i>economics</i> (singular) <i>economics</i> (plural)	A shift in construal leads to a change in structural packaging: the same word form is construed either as an “integral discipline” (singular packaging) or as a “set of multiple factors” (plural packaging), and the subject-verb agreement relation changes accordingly

Level	Examples of the restructuring operation	Distinctions revealed / analytical function
Phrase level	<i>a new book</i> <i>a book that is new</i>	Compactness of preposed modification vs. expansiveness of postposed modification; the correspondence between information density and definability
Clause level	<i>It is likely that he has arrived.</i> <i>He is likely to have arrived.</i>	The transformation between a finite clause and a raising construction highlights the function of the perfect infinitive as “prior to the reference point.”
Sentence level	<i>Give Tom a book.</i> <i>Give a book to Tom.</i> ; Ch.: active “把” (<i>ba</i>) construction, topicalization	Transformations between double-object and dative constructions make the distribution of information focus explicit; the “把” construction and topicalization are both forms of information-structure rearrangement.
Discourse level	Chinese run-on sentences (background first) English SVO compulsory word order (focus first); transformation of narrative perspective: <i>I saw the man with a telescope</i> <i>The man with a telescope was seen</i>	Cross-linguistic differences in information packaging; the problem of micro-propositional equivalence in the reorganization of narrative perspective.

At the discourse level, transformation operations make it difficult to strictly maintain truth-conditional equivalence—for example, changes in narrative perspective introduce different facets of an event. Therefore, “event-sequence equiv-

alence” is used as a supplementary constraint: the core event sequence, principal participants, and macro-level information structure remain unchanged, while re-distribution of micro-propositional details and information focus is permitted. The transformation of narrative perspective in the table above is incorporated into transformation operations under this framework.

2.6 Anchoring

The anchoring operation places a grammatical unit into two or more structural contexts or communicative scenarios. Through comparison, it tests syntactic legality and pragmatic appropriateness, separates the formal/basic meaning from meanings activated by context, and measures gradients of markedness (see Table 6).

Table 6 Cross-level case table of anchoring operations

Level	Examples of anchoring operations	Distinctions revealed / analytical functions
Morpheme level	-s inserted into different roots: <i>walks</i> vs. <i>gos</i> ; -er inserted into a verb root (<i>teacher</i>) vs. an adjective root (<i>happier</i>)	Compatibility of roots with inflectional affixes; selective restrictions imposed by derivational affixes on the lexical category of roots.
Word level	<i>slow</i> inserted into an adverbial slot (<i>Go</i>) vs. an adjectival slot (<i>a car</i>); <i>put</i> inserted into an SVO environment vs. an SVOA environment ; <i>disappear</i> inserted into a transitive environment vs. an intransitive environment	Syntactic distribution and markedness; subcategorization coercion and restrictions on transitivity.
Word level (context)	Traffic sign <i>SLOW</i> vs. coach’ s instruction <i>Go slowly</i> vs. friend’ s advice <i>Go slow</i>	Differences in appropriateness produced by contextual anchoring, which activates directive force, literal guidance, and pragmatic advice.

Level	Examples of anchoring operations	Distinctions revealed / analytical functions
Phrase level	<i>book</i> inserted as a bare-determiner subject vs. a definite subject ; <i>a book</i> inserted into an existential sentence vs. <i>the book</i> inserted into an existential sentence ; <i>a book</i> inserted into a double-object construction vs. a dative construction	Determiner requirement; definiteness restriction in existential sentences; redistribution of information focus.
Clause level	<i>that he is honest</i> inserted into a nominal-clause environment vs. an adverbial-clause environment	Selective restrictions imposed by clause type on the embedding environment.
Sentence layer	Placement of the active/passive voice in the methods section (high frequency of passive) vs. narrative in diaries (high frequency of active); Chinese: placing the second-person forms “你/您” in contexts of different politeness levels	Register appropriateness and choice of politeness level
Discourse layer	<i>Thank you.</i> placed in a normal thanking context vs. a threatening context (<i>Now you can get out. Thank you.</i>)	Significance of contextual choice: the same form changes from thanks to provocation in a thanking context vs. a threatening context

The core criteria for distinguishing the three are: substitution changes the material within the slot, with the total amount unchanged; exchange changes the structural relation, with the total amount unchanged; placement does not

change the form, but only the environment. For any operation, first determine “whether the form is changed”: if not changed $\rightarrow$ placement; if changed $\rightarrow$ then see whether the structural relation is changed: if not changed $\rightarrow$ substitution; if changed $\rightarrow$ exchange.

3. Combinatorial Completeness and Irreducibility

3.1 Systematic Exclusion of Candidate Sixth Elements

The five-element operations are not five isolated actions, but a combinable system. This is one aspect of combinatorial completeness: more complex grammatical analysis actions can be realized through combinations of the basic operations. Another aspect of combinatorial completeness is that all candidate sixth elements can be reduced to combinations of the existing five elements; therefore a sixth element is unnecessary. Below, all candidate sixth-element operations that have been proposed or can reasonably be proposed are examined one by one. Each type of candidate is finally marked with an admission judgment, anchored to the unified criteria in Section 2.1 of Chapter 2. What must be clarified in advance is that the decomposition of all candidate operations in this chapter is strictly confined to the methodological level of syntactic analysis, rather than to the level of the generative mechanisms of language itself.

Candidate 1: Move. In the minimalist program, movement has been reanalyzed as Copy + Delete (copy + deletion). Among the five-element operations, movement = addition (internal merge) + deletion (deletion of the original copy) + placement (verification of the legality of the new word order in the target context). The movement analysis of the English interrogative sentence *What did you see?* can be decomposed into the combination of addition + deletion + placement. Admission judgment: violates Criterion 1 (irreducibility), and belongs to a derived compound operation.

Candidate 2: Conflate. Conflation refers to fusion at the phonological level (e.g., *don't* $\leftarrow$ *do not*) or compounding at the morphological level (e.g., *blackboard* $\leftarrow$ *black* + *board*). Phonological fusion is a deletion operation—removing the phonological boundary; morphological compounding is an addition operation—adding a compound-word structure. Different levels correspond to different element operations, and there is no unified cross-level operational logic. Admission judgment: violates Criterion 2 (cross-level universality), and does not belong to the basic element operations.

Candidate 3: Negate. In the five-element framework, negation analysis can be decomposed as: addition (inserting the negative word *not*) + placement (verifying the legality of the scope of negation and the polarity item). The derivation of English negative sentences involves an addition operation (inserting *not*) and a placement operation (verifying the positional relation between *not* and the auxiliary verb, as well as the legality of the polarity item *anything*), and thus belongs to a derived combination of addition + placement. Admission judgment: violates Criterion 1, and belongs to a derived operation.

Candidate 4: Reduplicate. In the five-element framework, reduplication is an idempotent value of the substitution operation—replacing itself with the same form. Morphological reduplication and inflectional plural marking are likewise applications of substitution operations on the syntagmatic axis, and lexical recurrence at the discourse level follows the same principle. Admission judgment: violates Criterion 1, and belongs to a subclass of substitution.

Candidate 5: Ellipsis. In the five-element framework, ellipsis is already fully covered by deletion operations: deletion (removing recoverable constituents) + placement (verifying contextual recoverability). Admission judgment: violates Criterion 1, and is a deletion operation's

a contextually delimited subclass.

The negative route in the completeness argument is not “no sixth meta-operation can be found,” but rather that “all known candidates fail to meet the admission criteria, and all can be decomposed into combinations of the five meta-operations; therefore there is no need to add a sixth meta-operation.” If an operation can be equivalently decomposed into a combination of the five meta-operations, then it is not an independent primitive meta-operation but a derivative phenomenon of such a combination. From the general properties of discrete symbolic structures, operations in any formal system involve only five kinds of basic actions: adding elements, deleting elements, substituting elements, rearranging relations, and placing items into an environment—corresponding respectively to add, subtract, substitute, permute, and place. If a candidate sixth meta-operation is to break through this framework, it must be shown that it neither belongs to the above five types nor can be composed from them—something no candidate operation has yet satisfied in logic.

3.2 Boundary Stress Tests

While awaiting the emergence of empirical counterexamples, we first subject the most challenging non-canonical forms to stress testing. Because of their atypicality, these forms are most likely to be mistaken as requiring independent operations for their explanation. Below, a dimensional-reduction analysis is conducted one by one, and the characteristic dimensions of each type are located.

First, consider the testing of suprasegmental features (intonation marking interrogativity). In English, rising intonation can turn a declarative sentence into a question: *You are leaving.* (falling tone, declarative) *You are leaving?* (rising tone, interrogative). This is an application of the substitution operation at the suprasegmental level: in English, rising and falling intonation form an opposition in the interrogative/declarative slot. The slot for substitution is not limited to segmental form; suprasegments (intonation, stress, pauses) are also legitimate formal materials. Characteristic dimensional location: the substitution operation is applied within the prosodic domain; the operation point remains the same functional slot, but the formal material is extended from the segmental to the suprasegmental.

Second, consider internal inflection and root alternation (*go* *went*). The past tense of the English verb *go* is not the regular form *goed*, but the suppletive root form *went*. This belongs to block substitution at the lexical level and is a special case of the substitution operation. The operational logic remains unchanged: the same slot (past tense), two forms (*go* and *went*), and a semantic correspondence (present tense vs. past tense). Children often first produce *goed* (regular substitution) and later calibrate it to *went* (block substitution), which shows that the two are applications of the same operation at different levels of form. Characteristic dimensional location: the substitution operation is applied to a block-substitution variant at the lexical level; the operation point remains the same tense slot, but the substitution unit is expanded from a word stem to a word root.

Finally, consider structural ambiguity. The two readings of *I saw the man with a telescope*—“I saw that person using a telescope” and “I saw the person who had a telescope”—arise from the same prepositional phrase *with a telescope* being placed into different structural slots. As an adverbial of manner, it is placed into the manner-adverbial slot inside the verb phrase (modifying *saw*), and the placement operation verifies its legitimacy in the manner-adverbial slot; as a postmodifier, it is placed into the modifier slot inside the noun phrase (modifying *the man*), and the placement operation verifies its legitimacy in the modifier slot of the noun phrase. Here, two legal placement operations produce the same surface form; it is an accidental overlap of different analytic paths. Characteristic dimensional location: the placement operation undergoes multi-path overlap across different structural slots.

The conclusion is that non-canonical forms are not counterexamples, but rather natural extensions of the five meta-operations over non-canonical formal materials. Suprasegments, root alternations, and structural ambiguities—phenomena that appear to require independent operations—are all, after dimensional-reduction analysis, covered by the existing five meta-operations or their combinations.

3.3 Thought Experiment: Syntactic Analysis Without Meta-Operations

The completeness argument above has shown “why it is these five meta-operations.” But to prove that meta-operations are the inescapable underlying logic of syntactic analysis, a stronger demonstration is still needed: is syntactic analysis possible without using meta-operations? This section gives a negative answer through a reductio argument.

Suppose linguist L claims: “My grammatical analysis does not use addition, deletion, substitution, conversion, or placement. I rely only on my linguistic competence (language sense) and pure description.” L is asked to analyze the differences in well-formedness among the following four sentences:

- (1) 我们要好好学习。

“We must study hard.”

- (2) 我们, 要好好学习。
“We, must study hard.”
- (3) 我们要, 好好学习。
“We must, study hard.”
- (4) 我们要好, 好学习。
“We must good, good study.”

L’ s first-order response is a pure description of intuition: “Sentence 1 is the most natural; sentence 4 is completely unacceptable.” But this is not grammatical analysis. It provides no structural knowledge—no definition of “word,” no definition of “well-formed,” no definition of “level.” It is merely a personal aesthetic reaction. The analysis has not yet begun.

If one presses L: “Why is sentence 4 completely unacceptable?” any explanatory path available to L necessarily invokes meta-operations. If L says, “Because 好好 has been split apart,” this introduces a substitution operation: replacing 好好 with 好 + 好 for comparison. If L says, “Because 好 cannot independently modify 学习,” this introduces a deletion operation: deleting one 好 to obtain 好学习, which is ill-formed. If L says, “Because the comma has been inserted into the middle of a word,” this introduces a placement operation: locating the boundary of the “word” and judging that the comma falls on a non-existent boundary. If L says, “Because 我们要好 already constitutes an independent meaning, and what follows can no longer attach to it,” this introduces an addition operation: adding 好 after 要 to form the disyllabic word 要好. If L says, “好, 好学习 is just 好……好学习,” this introduces conversion: converting the comma into prosody. There are five paths, without a single exception.

It is worth noting that L’ s response presupposes such metalinguistic concepts as “word,” “well-formedness,” and “level.” This is the reflexivity of metalanguage: the basic concepts of any foundational formal system cannot be stated outside that system’ s own framework, just as the concept of “set” in set theory cannot be detached from set theory itself.

The argument above does not depend on the five terminological labels addition, deletion, substitution, conversion, and placement, but rather on the operational logics to which those labels refer—adding, removing, replacing, transforming, and inserting. These logics cannot be bypassed in any grammatical analysis, regardless of what terminological system the analyst uses. A grammatical analysis that claims “not to use meta-operations” either degenerates into non-operationalizable intuitive description, incapable of producing reproducible structural knowledge, or in fact has already used meta-operations unconsciously.

The preceding argument takes canonical syntactic forms as its object of analysis, but the scope of meta-operations is not limited to canonical forms. Take the disfluent utterance 我们要好, 好学习 as an example. The speaker intends to produce 我们要好好学习, but a surface rupture appears because of a speech malfunction.

The fact that the listener can ultimately understand the speaker's intention means that the cognitive system has completed a series of mappings from the damaged form to the target form.

To describe the logical structure of this mapping at the level of discrete structure, the five meta-operations constitute a concise and complete set of descriptive primitives. The placement operation places the string into a "malfunction context" rather than a "rhetorical context," determining the overall path of subsequent processing; the deletion operation removes the rupture and redundant components; the substitution operation confirms the structural identity between the surface ruptured form and the baseline form 好好; the conversion operation realizes a cross-level interpretation from a rupture at the phonetic level to an intact unit at the syntactic level; and the addition operation supplies pragmatic information such as prosodic tone. If, through the placement operation, the form is instead placed into an "emphatic context," the same form will trigger a different analytical path: deletion is not performed, substitution leads to a disjunctive interpretation, and conversion turns the comma into a rhetorical pause.

In this respect, the distinction between canonical and damaged forms is not an input premise that the operational framework must presuppose, but rather can be...

...results that are sharpened by differences in operational paths. In the logical order of structural analysis, elementary-operation logic precedes judgments based on specific grammatical rules, and it also has stronger cross-framework generality than the operational primitives presupposed by the concrete grammatical theories of various schools.

Elementary operations have clear boundaries: they do not undertake to explain the physiological mechanisms of language production (such as Broca's area), nor do they undertake to explain real-time psychological processing; they undertake only the analysis of operable procedures implemented on existing linguistic forms.

4. Methodological Dialogue with Formal Linguistics

The five elementary operations are not teaching tools invented out of thin air; rather, they are general underlying operational procedures identified from various linguistic theories. This chapter argues for the following proposition: the core operations of each theory can be mapped onto the five-element framework, and each theory covers only a subset of the five elementary operations.

4.1 Dialogue with Generative Grammar (the Minimalist Program)

Chomsky's (1995, 2000) Minimalist Program reduces syntactic computation to a small number of core operations: Merge, Agree/Select, Copy + Delete, and Interface (see Table 7).

Table 7: Mapping relations between core operations in generative grammar and the five elementary operations**

Generative-grammar operation	Corresponding five-element operation	Mapping relation
Merge (merger)	Add	External Merge = adding an independent object; Internal Merge = adding a copy of an existing object
Agree/Select (agreement/selection)	Substitute	Feature matching and valuation = feature substitution within the same slot
Copy + Delete (copy + deletion)	Subtract	Movement = copy + deletion of the original copy; deletion is subtraction
Transformation (transformation)	Transform	Structural transformations such as active passive and declarative interrogative
Interface (interface)	Place	LF/PF interface mapping to semantics/phonology

The mapping relations have three boundaries. First, Merge, Agree, and the like are innate cognitive operations internal to the human language faculty and belong to the ontological level; the five elementary operations are external operations performed by the analyst on linguistic forms and belong to the epistemological level. The two are functionally isomorphic but differ in ontological status. Second, the core of Agree is probe-goal feature matching, not substitution in the strict sense; from an analytic perspective, feature change can be characterized at the operational level as substitution, but this is the result of external analysis. Third, generative grammar answers “how language can be generated” (a forward direction), whereas the five elementary operations answer “how linguistic regularities are to be analyzed” (a reverse direction); the direction of operation is opposite, and the logical forms a mirror-image correspondence. The above mapping is only functional isomorphism at the methodological level of analysis, not an identity between the ontological mechanism of generative grammar and the elementary operations at the entity level.

4.2 Dialogue with Systemic Functional Grammar

Halliday's (1994) systemic functional grammar takes the "choice system" (system network) as its core mechanism: at each system node, the speaker selects one item from a set of oppositional features. At the operational level, this mechanism is highly isomorphic with substitution. The theoretical system of SFG also implicitly contains ideas related to the other four types of operations: addition corresponds to the insertion and expansion of feature items; subtraction corresponds to ellipsis and cohesive compression; transformation corresponds to rank shifting

and thematization; the placement operation corresponds to the adaptation constraints of register theory and discourse context. The boundary of the mapping lies in the following: SFG drives formal realization through semantic choice and takes meaning as its starting point, whereas the five-element operations take formal modification as their entry point; the two begin from opposite directions. The five-element operations do not supplement SFG with operations it originally lacked; rather, they extract the operations dispersed across the various metafunctional modules into a unified formal language of analysis. The above mapping is only a functional isomorphism at the level of operational logic, and does not alter SFG's theoretical core, which centers on semantic choice.

4.3 Construction Grammar

Goldberg's (1995) construction grammar takes constructions—form—meaning pairings—as the basic unit of analysis. The analysis of constructional variants is, at the functional level, close to the "transformation" operation among the five-element operations: different constructional packagings of the same event semantics. However, construction grammar does not require constructional variants to satisfy strict propositional equivalence, whereas the "transformation" operation in the five-element operations presupposes propositional equivalence. The boundary of the mapping lies in the following: construction grammar aims to reveal the cognitive storage units of language and is a static description of units; the five-element operations aim to provide a general method of analysis and are dynamic analytic actions. The five-element operations provide stricter criteria for judging equivalence in the analysis of constructional variants and supplement it with a dynamic analytic dimension. The above mapping is only a functional isomorphism at the level of analytic operations, and does not alter construction grammar's theoretical goal, which centers on cognitive storage units.

4.4 Structuralist Linguistics

Harris's (1951) structuralist linguistics takes "distributional analysis" as its core method. In phonemic analysis and morphological analysis, substitution tests are essentially substitution operations: holding other variables fixed, substituting different forms in the same slot, and observing changes in meaning or

function. Harris' s distributional analysis is an early methodological source of the substitution operation, but its scope of application is limited to the phonemic and morphological levels. The five-element operations extend Harris' s substitution tests to the levels of phrases, clauses, sentences, and discourse, and supplement them with the complementary functions of addition, deletion, transformation, and placement. The transformational analysis proposed by Zhu Dexi (1982) and its "principle of parallelism" constitute the direct academic source of the transformation operation in Chinese grammatical research; "the basic meaning remains unchanged before and after transformation" is precisely the Chinese-linguistic expression of the propositional-equivalence condition for the transformation operation. The above mapping is only an extension of the operational logic of substitution tests, and does not alter structuralism' s analytic goal, which centers on the classification of units.

4.5 Cognitive Linguistics

Core analytic paths in cognitive linguistics, such as schema-instance analysis (Langacker (1987)), metaphorical mapping (Lakoff & Johnson (1980)), and event salience (Talmy (2000)), can correspond respectively to the paradigmatic substitution function of the substitution operation and the structural reorganization function of the transformation operation. For example, within the same schematic slot, such as the "container" schema, different instance members—cups, boxes, rooms—can be substituted; this is essentially the execution of the substitution operation at the cognitive level. Metaphorical mapping, such as "time is money," places the same semantic base into different structural packagings, corresponding to structural reorganization in the transformation operation. The boundary between the two lies in the following: cognitive linguistics aims to reveal the encoding principles of conceptual structure, whereas the five-element operations aim to provide general steps for formal analysis. The above mapping is only a functional isomorphism between conceptual encoding and formal analysis, and does not alter cognitive linguistics' research goal, which centers on conceptual structure.

4.6 Summary

It is not that the five-element operations have "borrowed" the operations of these theories; rather, within their respective research paradigms, these theories have all, without realizing it, invoked the same underlying logic of analytic operations. The Merge/Agree/Move/Interface of generative grammar, the choice system and rank shift of systemic functional grammar, constructional variants in construction grammar, distributional analysis in structuralist linguistics, and the schema-instance and figure-ground analyses of cognitive linguistics each cover a subset of the five-element operations, and, because their theoretical aims differ, each emphasizes different operational dimensions. The value of the five-element operations lies in uniformly identifying these scattered operations as the same underlying procedure of analytic operations, and in making explicit

as a general methodological framework for cross-level and cross-theory analysis.

5. Conclusion

5.1 Core Conclusions and Main Contributions

The central proposition of this paper is that addition, deletion, substitution, exchange, and positioning are the basic meta-operations of syntactic analysis and constitute a complete, transferable, general methodological meta-language. This proposition is jointly supported by the convergence of three independent lines of argument. First, full cross-level coverage: the five meta-operations apply to all six levels from morphemes to discourse, with the same underlying operational procedure performing corresponding functions at different structural levels. Second, cross-theoretical convergence: the core analytic actions of generative grammar, systemic functional grammar, construction grammar, structuralist linguistics, and cognitive linguistics can all be mapped onto the five-element framework. Third, combinatorial completeness: all known candidates for a sixth meta-operation can be judged to be derived composite operations.

The main contribution of this paper is that it fills a methodological blind spot in grammar research by making implicit syntactic analytic actions explicit, systematic, and cross-level, thereby opening a methodological interface between formal linguistic theory and pedagogical grammar practice. Through four entry criteria and three dimensions of feature differentiation, it provides a unified standard for determining the qualification of basic meta-operations and for delineating their internal boundaries. Through thought experiments, it elevates the five meta-operations from implicit tools to explicit methods.

5.2 Limitations

First, there are limitations in the proof of the theory itself and of combinatorial completeness. The full paper completes only the theoretical-level proof of the five meta-operational tools; the claim that “the five meta-operations are isomorphic with the underlying operational procedures of linguistic cognition” remains only an intermediate-level hypothesis and still lacks support from psychological and neuroscientific experimental data. This hypothesis could be falsified in reverse through children’s acquisition sequences: if children can complete complex structural transformations before they have established the capacity for substitution, then the cognitive-isomorphism hypothesis would be weakened. At present, combinatorial completeness has only completed exclusion tests for known candidates for a sixth meta-operation; rigorous formal proof remains for future research. Metalinguistic reflexivity proves only the foundational status of the five meta-operations at the symbolic level, and does not constitute unfalsifiability at the empirical level.

Second, systematic cross-linguistic validation is lacking. At present, the five meta-operations focus on English and have only begun to touch on Chinese.

Their applicability to isolating languages, agglutinative languages, and polysynthetic languages remains to be tested. Systematic typological verification across languages is one of the core directions for subsequent research.

Third, the definition of propositional equivalence at the discourse level is unclear. Event-sequence equivalence is the current working definition of the exchange operation at the discourse level, but whether changes in narrative perspective constitute changes in proposition remains undecided; a more precise operational definition is needed.

5.3 Future Directions

First, cross-linguistic validation. The five meta-operations should be applied to isolating languages, agglutinative languages, and polysynthetic languages in order to test whether combinatorial completeness holds across languages. For example, addition/substitution operations in Japanese agglutinative forms (the auxiliary system), and addition/deletion operations in Inuit polysynthetic verbs (noun incorporation)—if phenomena of “packaging” that cannot be reduced to the five meta-operations are found in these language types, they will directly constitute counterexamples. The core question is: do the five meta-operations need to be redefined across different language types?

Second, psycholinguistic experiments. Behavioral experiments should be designed to test whether adult native speakers invoke the five meta-operations during real-time syntactic processing. Self-paced reading or eye-tracking can be used to measure differences in processing time when participants process sentences related to addition/deletion/substitution/exchange/positioning operations.

Third, diachronic research on grammaticalization. It should be examined whether grammaticalization pathways follow the analytical hierarchy of the five operations (Hopper & Traugott (2003)). If grammaticalization pathways do follow this analytical hierarchy, then the five operations are not only a tool for synchronic analysis, but also a mechanism of diachronic evolution.

Before the above empirical counterexamples emerge, addition, reduction, substitution, transposition, and arrangement constitute an optimal methodological framework within the current field of grammatical analysis, one that combines combinatorial completeness, operability, and transferability. It not only answers the fundamental question of grammatical analysis— “how to operate on form in order to discover meaning” —but also provides an explicit methodological perspective for understanding the laws governing the formal operation of human language.

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Author Contribution Statement

Shi Wei: proposed the research ideas and designed the research plan; was responsible for the literature review, construction of the theoretical framework, and methodological innovation; completed the drafting, revision, and final version revision of the paper.

Note: Figure translations are in progress. See original paper for figures.

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