The Entanglement and Superposition of Language Particles Under Merge

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ABSTRACT

Merge is a key operation of syntactic computation, which provides an explanation for the two major characteristics of language, namely, recursion and discrete infinity. With Chomsky's continuous revision of the merge operation over the years, a workspace-based merge operation came into being. Under the guidance of the mechanism of this merge operation, this paper finds that Chinese aspect markers are different from the other functional words because of their multiple spatial structures, and further explores that the particles of language merging units are the individuals of the idealized lexical array in the state of the entanglement and superposition of language particles, and concludes that the so-called atoms involved in the merge are the simplest size selected after the entanglement and superposition.

Keywords: *Merge, Entanglement, Superposition, Language particles*

1. INTRODUCTION

Merge is an indispensable grammatical operation that constitutes grammatical components, and even because the features of agree can also be solved through merge, agree may be classified into the merge operation [1]. Fukui (2017) believes that an accurate understanding of merge can bring great benefits to human language theory, and explains the nature of merge, the relationship between merge and the brain, and the interaction between merge and other grammatical components, combining theoretical grammar with neuroscience to understand the nature of merge [2]. Through comparing the linguistic aspects of the minimalist program with the physics of many-body systems, Piattelli-Palmarini and Vitiello (2017) find the two are isomorphic, and the recursive merge has extremely high activity and foundation-like effect in the brain [3]. From the perspective of language evolution, a single-mutation scenario will cause the misunderstanding of pure integer counting, but evolutionary research provides a good reason for half-counting [4]. This argument also lays the groundwork for the volatility characteristics of merge in the following part. Furthermore, compared with animals, human syntax will experience complex merge operations, like 2-merge and 3-merge rather than 0-merge and 1-merge, and the distinctions among them may be limited to the short-term memory [5]. And this argument would upload the relevant more systems dealing with language output except for the widely accepted sensorimotor system, conceptual-intentional system and computational system.

This paper will discuss the characteristics of multi-spatial structure in the process of merge from Chomsky's point of view on merge over the years. And based on this, this paper will use Chinese examples to explore entanglement and superposition in the process of language generation in order to produce more valuable thinking about the syntactic merge operation.

2. THE MULTI-SPATIAL STRUCTURE OF MERGE

Merge is a syntactic operation to explain the discrete infinity and displacement of human language in the period of minimalist program. After entering the period of the minimalist program, the merge operation has gone through many stages of adjustment and improvement. In the early minimalist program, the merge operation together with bare phrase structure and copy theory explained the syntactic generation mechanism. The

merge operation in this period is called "pure merge", that is to say, the movement at this stage is an independent operation parallel to pure merge. With the more in-depth understanding of movement properties (such as agreement and copy), in the recent minimalist program, the parallel compound operation of movement and pure merge has been improved to a single merge operation. In Chomsky (2004), the merge operation can be divided into two types: external merge and internal merge. The two objects of external merge are separate, while the two objects of internal merge have a partial-whole relationship and produce the displacement features that are common in the language in the most concise way[6]. During this period, the consideration of whether syntactic computing generates labels has also received extensive attention and research. The invisibility of labels and the need for interpretation of labels make the magnetic attraction between labels and syntactic computational domain exist but insufficient. Therefore, in Chomsky (2015), the label is no longer output by the computational system through merge, but is decisively influenced by the third factor principle[7]. At this time, the merge operation is called "the simplest merge". According to Chomsky (2019), the object of the simplest merge operation is no longer served by the original specific syntactic object, but is merged based on the workspace, which is called "MERGE"[8]. This adjustment makes the "simplest" match more accurately, gets rid of a series of multi-directional merge operations extended by the simplest merge, follows the strong minimalist thesis, and limits computational resources. In other words, syntactic resources and merge operations are contained in the workspace of the human brain. The concept of workspace can improve the certainty and coherence of operation and fully describe the language facts. In the merge operation, when two syntactic objects enter the workspace, the syntactic objects involved in the merge operation and the workspace where the merge operation is located form a new workspace. The specific process is expressed as: MERGE (X1, X2,..., Xn) = {{X1, X2}, X3,..., Xn}. What's more, Chomsky (2021) puts forward an independent Markovian Merge at different stages of the workspace to better solve the deletion operation[9].

The crux of the question now is: when the members of the lexical array merge, is the size of each member fixed (for example, a word like *le* in Chinese or a word like *went* in English)? Analyzing it from the surface structure of a sentence, no matter which language it is, it is made up of linear addition of language particles per unit, then is this unit a value to form hierarchical structure through merging? Is it a necessary head that participates in the hierarchical structure, which cannot be expanded at will. In other words, is the result of the hierarchical structure of a sentence an unlimited merging from the lowest head unit? For this problem, the author finds a solution from the discussion of aspect and tense. Take the Chinese sentence (1) in "Figure 1" as an example (assuming that *ta* in the example is female):

(1) a. ta chi fan.
She eat meal
'She eats.'
b. ta chi *zhe* fan.
She eat Asp-ZHE meal
'She is eating.'
c. ta chi *le* fan.
She eat Asp-LE meal
'She ate a meal.'
d. ta chi *guo* fan.
She eat Asp-GUO meal
'She has eaten.'

Figure 1 Examples of Chinese aspect.

Aspect markers such as "*zhe*", "*le*" and "*guo*" completely affect the semantics of sentences, so there must be an interpretation of these markers at the interfaces of the computational department and the semantic department. So how do these aspect markers merge in the syntactic computational department? Let's first take (1a) in "Figure 1" as an instance. This sentence does not contain aspect markers and is the simplest SVO sequence sentence. Its syntactic structure is shown in "Figure 2".

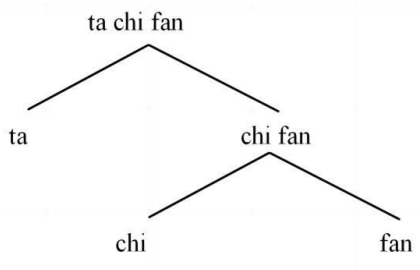

Figure 2 The syntactic structure of "ta chi fan".

In (1a), it can be seen that *fan* has a nominal feature, while *chi* has a verbal feature. With *chi* as a head, *chi fan* has the feature of [+V], and then

together with a nominal *ta*. According to VP-internal hypothesis, *ta* with the feature of [+N] is an adjunct. Therefore, *ta chi fan* has the same feature of [+V] as *chi fan*. Except for grammaticalized parts of speech, other word categories have noun-verb duality, like waves and particles in the quantum world. And then how about (1b-1c)? Those aspect markers are all grammaticalized categories, so they have neither nominal or verbal features. Take (1b) as an instance, if *zhe* is regarded as a component that can participate in the merge independently (that is, it can be used as a single node on the syntactic tree), its syntactic structure is shown in "Figure 3".

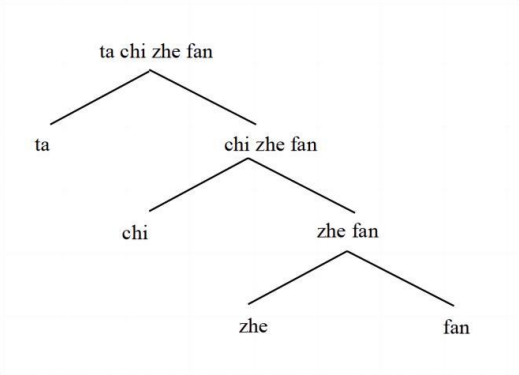

Figure 3 The original syntactic structure of "ta chi zhe fan".

Since *zhe* is a grammaticalized component, it seems that there are three ways to explore the structural expression of *zhe* on the syntactic tree. The first way is to regard *zhe* as a kind of head, which has the [+Aspect] feature, similar to features like [+Tense] and [+Complementizer]. If so, then *zhe fan* has an aspectual feature. However, unlike T and C as heads, Asp does not have stable grammaticalized function, which will influence the verb event structure to make it have a temporal function. In other words, the grammaticalization of "aspect" is not complete, and it still has the function of traction. Therefore, the first road is impassable. The second way is to put *fan* as a nominal head, *zhe* as a complement, and thus *zhe fan* has the feature of [+N]. On the surface, it forms an initial-over-final structure, although not very common, but it still does not violate the Final-over-Final Constraint. But it should be noted that this is in fact [V [Aux O]] order, in which "'Aux' may be either an auxiliary or a verb capable of triggering clause union/restructuring" [10]. Therefore, the structure is also implausible.

Let's focus on the third way. That is, *fan* together with *chi zhe* directly merges into *chi zhe fan*, in which *fan* has a nominal feature and *chi zhe* is the head with the feature of [+V]. In doing so, it not only retains the harmony of the heads, but also ensures the realization of the non-grammaticalization features of the relationship between aspect markers and verbs. Its syntactic structure is shown in "Figure 4".

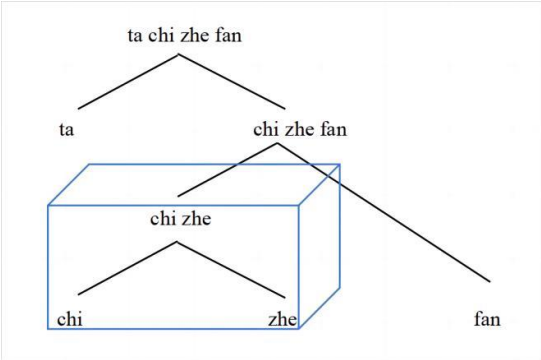

Figure 4 The third way to draw a syntactic tree of "ta chi zhe fan".

Actually, it can be seen that *chi zhe* is composed by merging *chi* and *zhe*, but this process is not a simple merge of two units of a plane, but a merge of two atoms formed after the selection of multiple units in multiple spaces. It can simply graphically show the generation process in the cube of "Figure 4", as shown in "Figure 5".

It can be assumed that the time of speaking in each space is relatively static, so when it comes to the sentence "*ta chi fan.*", it forms an original space, which is called Space 0. Then the Space 1, 2 and 3 in "Figure 5" are the course space of this event (the event is composed of a combination of single or multiple verbs). The process of spatial transformation is similar to the process from the ground state to the excited state. The elements or components in the space are composed of more fine particles and intertwined with time, which can form the continuous event space *chi zhe*, the complete event space *chi le* and the evocative event space *chi guo*. Of course, the quantity of space can produce cross-language differences with the fineness of spatio-temporal cognition.

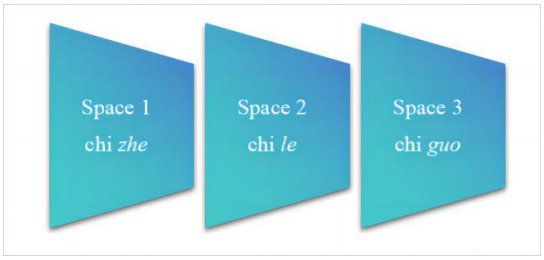

Figure 5 Multi-space selection process of two-unit merged elements in the cube of "Figure 4".

In the same language (for example, Chinese), the spatial number of events is also not fixed, which will lead to spatial transition. The possible answer to the spatial transition is that another merged atom collides with the internal space of the atom, and the two are incompatible. In short, it can now be predicted that the syntax tree is not a plane structure, but a stereoscopic multi-dimensional hierarchical structure. In language output, all will choose the atoms of a single-dimensional interface to be combined.

3. THE ENTANGLEMENT AND SUPERPOSITION OF LANGUAGE PARTICLES

In view of the multi-dimensional selection mechanism when merging aspect markers, the author concludes that the merged objects are selected, that is to say, in the whole lexical array, there is an idealized lexical array to do the final merge operation, and interact with the interfaces for phonetic and semantic conversion. So how does the computational system in the brain select the idealized lexical array from the lexical array? In the quantum world, quantum superposition and entanglement describe the behavior of microscopic particles in quantum mechanics. In the language world, the author also believes that there is the third factor, and some entanglement will occur between the particles, making it form a certain impenetrable phase, and at the same time, there will be some superposition within the language particles, so that the state of the particle is not a simple single dimension. Taking this Chinese sentence (2) in "Figure 6" as an example, it can be explored how language particles are entangled and superposed in the process of merge.

(2) yi zhi hei bai se de mao nao le wo.
one Quantifier-ZHI black white color DE cat scratch Asp-LE me
'A black and white cat scratched me.'

Figure 6 A Chinese sentence entailing entanglement and superposition.

Its syntactic structure is shown in "Figure 7". In this sentence, *nao le wo* and *yi zhi hei bai se de mao* are two main workspaces, two cylinders are used to describe them in "Figure 8". In each workspace, it could be found that there are components entangling each other. More specifically, *yi zhi*, *hei bai se de* and *mao* entangle in purple cylinder, while *nao le* and *wo* entangle in green cylinder. From the bottom of the syntactic tree, it can be seen that the procedure of merge is as follows: *hei* and *bai* merge to form *hei bai*, *hei bai* and *se* merge to form *hei bai se*, *hei bai se* and *de* merge to form *hei bai se de*, *hei bai se de* and *mao* merge to form *hei bai se de mao*, and further *hei bai se de mao* and *yi zhi* merge to form *yi zhi hei bai se de mao*. Likewise, *nao le* and *wo* merge to form *nao le wo*. Finally, *nao le wo* and *yi zhi hei bai se de mao* merge to form a complete sentence. The most important is that the collocation of numeral *yi* and quantifier *zhi* as a kind of entanglement phenomenon is the corresponding processing of the head *mao* in number-quantity space. And more than that, *hei bai* and *se* entangle each other to constitute a color space, and then *hei bai se* and *de* entangle to make up a attributive space, the goal of which is to meet the needs of the head *mao*. What's more, *nao le*, as mentioned earlier, forms a kind of entanglement space of predicate-aspect.

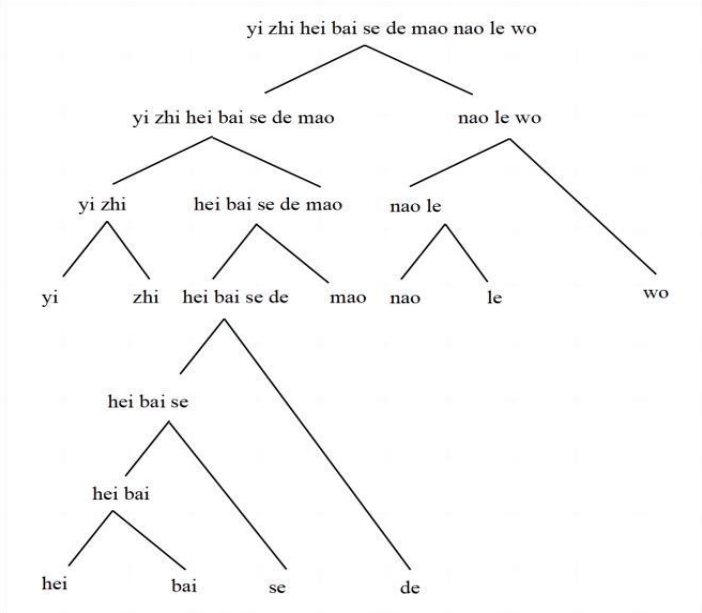

Figure 7 The original syntactic structure of example (2) in "Figure 6".

In addition to the entanglement phenomenon, the superposition phenomenon can not be ignored. In "Figure 7", the most obvious superposition phenomenon comes from the combination of *hei* and *bai* to form *hei bai*. When there is a change of light and shadow in the color space, there will be multiple changes in color, and when the language is output, the speaker will extract a certain color or several colors entangled in the color space. However, when a single color particle cannot find a counterpart in a single language particle, there will be superposition between language particles. For this example, if there is not a single word to describe *hei bai*, then the entangled *hei* and *bai* will be superposed to form *hei bai*. In other words, *hei bai* should be one of the smallest components of this merge. Examples of superposition in language also include the phenomenon of category reduplication, modifier synonym and so on.

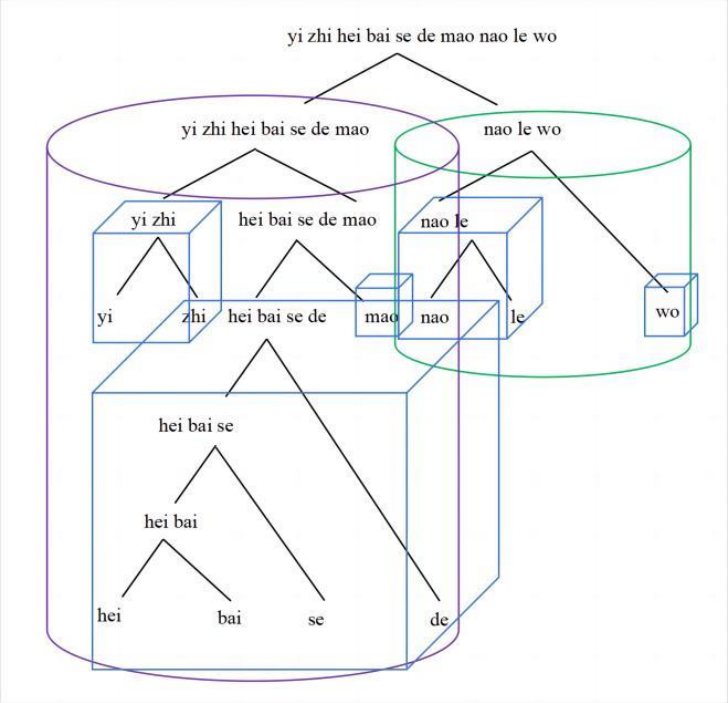

Figure 8 The entanglement and superposition of language particles in "Figure 7".

To sum up the above, the minimalist merge operation of (2) in "Figure 6" should be shown in "Figure 9". The source of the idealized lexical array is extracted through the selection of semantics, memory and cognition in the entanglement and superposition of language particles.

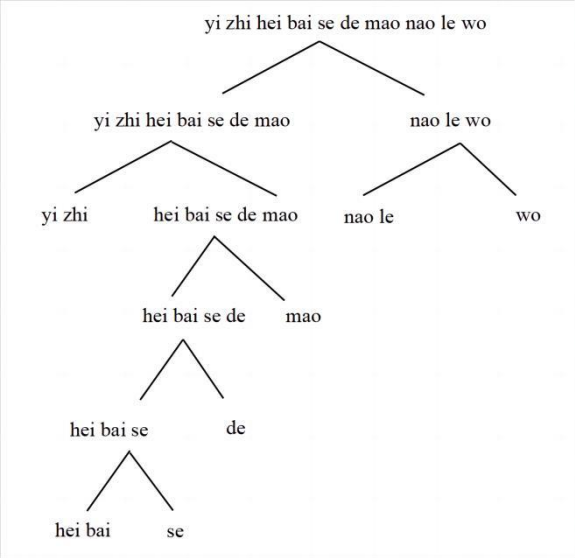

Figure 9 The revised syntactic structure of example (2) in "Figure 6".

4. CONCLUSION

Based on Chomsky's concept of workspace merge operation, this paper focuses on the grammaticalization and non-grammaticalization of Chinese aspect words, and considers that language has more detailed particle components than atomic components from the perspective of multi-space. Taking Chinese as an example, this paper discusses the entanglement and superposition between particles, and draws the conclusion that the particles involved in the merge operation are idealized lexical arrays. The component of the merged unit size (that is, the atom) is the union of the indefinite number of particles. the simplicity of the merge is to extract unique values from multiple spaces to form a two-dimensional plane syntactic tree, so that it can form linear contact with the interfaces. However, the problem of contact at the interfaces is still a concern in the future, how the syntactic computational department connects with the semantic department and the phonetic department, whether there will be other systems involved still needs more medical and brain science experiments to prove the universality of the theory.

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