Polymeaning-Word Congruency and Memory Division Support the Semantic/Syntactic/Episodic Model of Native Language

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Abstract

Background: Recently, it was proposed by Cai the semantic/syntactic/episodic model of native language to improve the common word/grammar model, supplementing the episodic association of words in clause or sentence by meanings. **Purpose:** In this article, it is aimed to support the semantic/syntactic/episodic model with diverse evidences. **Method:** It was the best and most convincing method by integrative review of literatures in various related fields to support the semantic/syntactic/episodic model. **Results and Discussions:** It is first adopted such various linguistic progressions as linguistic fluency, word congruency, and so on, to support the semantic/syntactic/episodic model. Then, it is demonstrated as necessary to use the episodic association of word meanings to determine one congruent meaning for some polymeaning words in sentence and paragraph, thus supporting the indispensability of "episodic" as the third linguistic component. Finally, it is divided the memories into the declarative remote memory, procedural memory and declarative immediate/recent episodic memory, corresponding to the three semantic/syntactic/episodic components of language, respectively, supporting the semantic/syntactic/episodic division of language. **Conclusion:** It is evident that the supports to the simple and intuitive semantic/syntactic/episodic model of language are diverse and could enhance its propagation and applications.

Keywords

Semantic/Syntactic/Episodic Model, Word Congruency, Polymeaning Word, Arabic Vowels, Declarative Remote Memory, Episodic Immediate/Recent Memory

1. Introduction

The adult humans organize their native language from word to sentence to story, combining various word meanings into diverse sentences, paragraphs and situations, while depicting and expressing a variety of feelings, intentions and stories at will. With the acquisition of language, the humans have become much more competent than animals in integrative comprehension, logical meditation, situation description, procedural instruction, story depiction, reciprocal communication, and so on.

It has certainly been interesting to reveal the general principles and mechanisms of language, while making them convenient for applications. The most common classification of linguistic functions are the word/grammar division of language (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997).

The humans acquire their native language through learning and memory after birth. Memory can be divided into the declarative memory and procedural memory, with the former encoding facts, knowledges or episodes, and the latter storing skills or habits (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997).

Pinker, Ullman and so on formulated a declarative/procedural model of language to account for the common word/grammar components of language with neuropsychology. They proposed that the semantics and grammar of language should belong to the declarative memories and procedural rules respectively (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997). They even tried to locate the different brain circuits responsible for the two different components of language, in that the words and phrases should be encoded in the temporal-lobe as declarative memory (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997), while the grammar should be stored in the frontal, parietal, basal-ganglia and cerebellar circuits as procedural memory (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997).

This declarative/procedural model of language has acquired support from some evidences (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997). 1) Different subtypes of aphasia have different cortical impairments (Yang et al., 2008). The alexia with lesion in fusiform gyrus or nearby cortical regions manifests impairment in word comprehension during reading (Kleinschmidt & Cohen, 2006; Leśniak et al., 2014; Turkeltaub et al., 2014), whereas the anomic aphasia with lesion in anterior temporal lobe manifests impairment in correct naming (Hanley, 2014; Ives-Deliperi & Butler, 2012; Semenza, 2011). 2) Poor in grammar, the non-fluent/agrammatic aphasia (Grossman, 2012), different from the logopenic aphasia (Graff-Radford et al., 2012; Thompson et al., 2012), is simultaneously unable to learn the artificial grammar as procedural memory (Christiansen et al., 2010).

The disadvantage of the word/grammar or declarative/procedural model of language lies in that, besides grammar, it does not consider how to directly associate or comprehend the word meanings to form sentential meaning (Cai, 2017).

In recent years, Cai improved the word/grammar model or declarative/procedural model of language to a perspective semantic/syntactic/episodic model, and suggested that the episodic association of word meanings into sentence should also be necessary for the formation of sentence (Cai, 2015, 2017), and even indispensable for the sentence and paragraph containing polymeaning words (one word of multiple different meanings) (Cai, 2018a).

In this article, because of the very importance of the semantic/syntactic/episodic model of native language, it is attempted to support this semantic/syntactic/episodic model with diverse evidences, consolidating the scientific basis of this simple and intuitive model, while promoting its propagation and prospective applications.

2. Method

For this diverse and interdisciplinary subject, the integrative review of progressions in related subfields was the best and most convincing method. Herein, it is necessary to mention that, because the meta-analysis specially examines the progressions in a specific subfield, it is not suitable for interdisciplinary research.

Paper search was mainly performed on Pubmed and Baidu Xueshu. The first preference was given to relevant updated reviews. If there was no appropriate updated review, then the relevant reviews published at more than 10 years ago were allowed for citation. If there was neither appropriate old review, then the research articles with repeated experimental results were collected for citation. Above all of these, the preference for citation was highest for the published papers of the author, in order to indicate the author's expertise for writing the article.

3. Linguistic Evidence Supporting the Semantic/Syntactic/Episodic Model of Language

As mentioned in Introduction, Cai recently improved the common word/grammar components of native language to a better semantic/syntactic/episodic three components of language (Cai, 2015, 2017). It was supplemented that, besides the word/grammar components of language, the episodic association of word meanings in clause or sentence or even paragraph was likewise indispensable for language comprehension and communication (Cai, 2015, 2017), completing the language from word to sentence to story (Cai, 2015, 2017, 2018a).

Diverse evidences can support the third linguistic component (Cai, 2015, 2017) in addition to the word/grammar components (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997). For the linguistic or neurolinguistic progressions till now, it has been demonstrated that: 1) The linguistic fluency can be manipulated independently of word/grammar pharmacologically because stuttering is related to the reticular dopaminergic system (Lan et al., 2009; Maguire et al., 2004; Stager et al., 2005). 2) Word congruency and sentential construction in clause or sentence have been evidenced to be associated with various gamma

bands of brain (Lewis & Bastiaansen, 2015; Nelson et al., 2017; Peña & Melloni, 2012). 3) It is utilized the episodic associations of polymeaning words (the words with multiple meanings) with others in sentence and paragraph to determine one congruent meaning for the polymeaning words (Cai, 2016, 2018a). In consistence, it has been reported that the low and middle gamma bands represented the congruency of linguistic prediction with linguistic input (Lewis & Bastiaansen, 2015), obviously helpful to match the congruent meaning of polymeaning words. Accordingly, it is indispensable for the episodic linguistic component to work out the congruent meaning of polymeaning words in sentence and complete the language from word to sentence to story. 4) In Arabic reading, many vowels of words are omitted while short vowels are sometimes added in words for improving comprehension (Abu-Rabia, 2019; Saiegh-Haddad, 2018), which obviously indicates that a portion of omitted vowels of words in Arabic reading require episodic congruency to determine word-meanings in sentence while the added short vowels can directly indicate the meanings of these words for improvement of clarity.

At the higher level of paragraphs and stories, it is also necessary to episodically coordinate the words and sentences by meaning congruency for organization. Disorders of language for story organization have been demonstrated in various patients of different pathologies (Ash et al., 2014; Miniscalco et al., 2007; Youse & Coelho, 2009).

In all, diverse evidences, especially the meaning congruency of polymeaning words to clause or sentence or even paragraph, can support the episodic linguistic component in addition to the word/grammar components.

4. Memory Division Supporting the Semantic/Syntactic/Episodic Model of Native Language

4.1. Further Division of Memories

There are two kinds of memories known as the declarative memories and procedural memories (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997). The declarative memories store the facts, knowledges or episodes, while the procedural memories store the skills or habits (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997). This division of memories has helped establish the declarative/procedural model as the psychological basis of word/grammar components of language (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997).

This division of memories is still rough and can further be improved in accuracy. Declarative memories can still be divided by time into 1) short-term memory or immediate memory lasting only for minutes or seconds, and 2) long-term memory encoded in brain for more than hours or days. In further, recent memory is the long term memory having lasted for several hours to several years, so that it is also called as time-limited long term memory, while remote (retrograde) memory is the long term memory having been memorized for decades of

years. With regard to the classification of memories in more details, it is suggested to refer to some reviews (Cai, 1990, 2018b) and early books (Squire, 1987).

4.2. The Memory Correspondents of Semantic/Syntactic/Episodic Components of Native Language

Just as Pinker, Ullman and so on using the declarative/procedural division of memories in psychology to differentiate the word/grammar components of language (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997), herein it is analogously adopted the further detailed division of memories to differentiate the semantic/syntactic/episodic components of native language.

Most common words in native language are initially learned and memorized as declarative memories in childhood (Cai, 2015), and then they are consolidated to become the stable declarative remote memories in adults upon frequent usage (Cai, 2015). Many common words have one or several common meanings for use (Cai, 2016), therefore they are the declarative remote associative memories in association with one or several meanings. Even though some words are acquired as the result of linguistic derivative rules rather than from learning (Pinker, 1991; Ullman et al., 1997), as present in derivative forms of original words, they are accordingly also present as stable word memory associations. In all, the common words in native language are actually the stable associative memories as one kind of declarative remote memories, more accurate than simply the declarative memories in the declarative/procedural model for word/grammar language (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997).

The declarative/procedural model of language has successfully demonstrated that the linguistic grammar should associate the declarative semantic words or phrases by procedural rules into clauses and sentences (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997), and share the same brain structures of artificial learning of procedural sequence (Christiansen et al., 2010). In this regard, with the division of declarative memory and procedural memory, it is easy to differ the declarative common words from the procedural grammar in native language.

Different from the common words as the declarative remote memories, the episodic association of words by meanings into clause or sentence can be remembered in short term immediately for understanding or expressing the sentential meaning. Whereas, the limited ability in both memory and recall of word list (Cai, 1990, 2018b; Squire, 1987) demonstrates that it would be difficult to recall accurately all words and sentences in story after long time even though the subjects can reorganize the language to tell the story in his own words, different in the sentences when hearing the story. In this regard, the episodic component of language belongs to the declarative episodic memories lasting from immediately short term to recently long term limited in time, rather than the common words as the declarative remote memories. Division of declarative remote memory and declarative immediate/recent episodic memory can differ the common

semantic words from their episodic formation of sentence in native language.

If the episodically associative component of language belongs to the immediately short term memories, it would predict that language comprehension would require the short term memory. This is exactly really the situation. Many evidences have recently shown that short term memory is involved in language comprehension (Harris et al., 2014; Papagno & Cecchetto, 2019).

In all, the semantic/syntactic/episodic components of native language correspond to the declarative remote memory, procedural memory and declarative immediate/recent episodic memory, respectively. Division of memories supports the perspective semantic/syntactic/episodic model of native language.

It is interesting to mention that, when Cai formulating the semantic/syntactic/episodic model of language in 2015, it was exactly the difference between the word cortices storing the remote memory and the reticular formation regulating the time-limited long term episodic memory that made the author decide to extend the declarative/procedural model to the semantic/syntactic/episodic model of language (Cai, 2018c). However, the hypothetic paper about the model mainly demonstrated the more-important real existence of the third episodic component of language by the linguistic fluency/congruency, pharmacology and so on (Cai, 2015, 2017), while herein the detailed memory division is utilized again to distinguish the three semantic/syntactic/episodic components of native language. Integration of diverse evidences is important to comprehensively support the semantic/syntactic/episodic model of language.

5. Discussions

5.1. Traditional Supports to the Semantic/Syntactic Components of Native Language

It is certainly very important to reveal and support the general principles and mechanisms of language, so as to make them convenient for propagation and applications. The most common classification of linguistic components are the word/grammar division of language (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997). Pinker, Ullman and so on tried to adopt the declarative/procedural division of memories in psychology to differentiate the common word/grammar components of language, with the semantics and grammar of language belonging to the declarative memories and procedural rules respectively (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997).

Traditionally, it is well supported the word/grammar or declarative/procedural components of language, which are just the semantic/syntactic components for the semantic/syntactic/episodic model. As mentioned in section Introduction, some evidences have supported these two components of language. For the semantic component as declarative memory, lesion in fusiform gyrus or nearby cortical regions results in alexia (Kleinschmidt & Cohen, 2006; Leśniak et al., 2014; Turkeltaub et al., 2014), while lesion in anterior temporal lobe results in anomic aphasia (Hanley, 2014; Ives-Deliperi & Butler, 2012; Semenza, 2011). For

the syntactic component as procedural memory, the non-fluent/agrammatic aphasic patients are impaired on both linguistic and artificial procedural learning (Christiansen et al., 2010; Grossman, 2012).

5.2. Polymeaning-Word Congruency Supports the Semantic/Syntactic/Episodic Model of Native Language

However, the word/grammar or declarative/procedural model of language (Ardila, 2012; Pinker, 1991; Ullman, 2004; Ullman et al., 1997) has not considered the direct episodic association of words and phrases by meanings in clauses and sentences. This defect makes this model as an incomplete one, and also limits the influence and application of this model.

The new semantic/syntactic/episodic model of native language is perspective as simple, intuitive and able to organize the words to complete the sentence (Cai, 2015, 2017, 2018a). Especially, it is even able to determine one congruent meaning of some polymeaning words by episodic associations with others in sentence and paragraph (Cai, 2016, 2018a), thus making the third linguistic component indispensable to complete the linguistic sentence and paragraph. Furthermore, some linguistic authors even pointed out that the majority of English words possessed two/more unrelated meanings (homonyms) or multiple related senses (polysemes) (Eddington & Tokowicz, 2015), further emphasizing the importance of linguistic congruency of words with sentence and paragraph.

For other linguistic evidences from the episodic congruent associations of polymeaning words in sentence to support the "episodic" component of language, it is demonstrated in this article as: 1) The word congruency and sentential construction may be related to the various gamma bands (Lewis & Bastiaansen, 2015; Nelson et al., 2017; Peña & Melloni, 2012), while the low and middle gamma bands may represent the congruency of linguistic prediction with linguistic input (Lewis & Bastiaansen, 2015), obviously helpful to match the congruent meaning of polymeaning words. 2) In Arabic reading, some omitted vowels of words require episodic congruency to determine their meaning in sentence while the added short vowels can directly indicate the meanings of the words (Abu-Rabia, 2019; Saiegh-Haddad, 2018).

5.3. Memory Division Supports the Semantic/Syntactic/Episodic Model of Native Language

In this article, it is moreover adopted the further division of memories to distinguish the three semantic/syntactic/episodic components of native language. The semantic/syntactic/episodic components of native language correspond to the declarative remote memory, procedural memory and declarative immediate/recent episodic memory, respectively. Such division of memories is easy to be distinguished in psychological experiments (Cai, 1990, 2018b; Squire, 1987). Division of memories helps establish the semantic/syntactic/episodic model of native language.

In all, Table 1 summarizes the three semantic/syntactic/episodic components

of native language, and their relations with linguistic functions and division of memories.

5.4. Brief Perspectives

The language makes the humans able to depict and express a variety of feelings, intentions and stories at will. Therefore, with diverse evidences to support the simple and intuitive model of native language of three semantic/syntactic/episodic components (Cai, 2015, 2017, 2018a), it is easier to understand how the humans can perform and complete many complex functions by language, such as integrative comprehension, logical meditation, situation description, procedural instruction, story depiction, reciprocal communication, and so on (Cai, 2018a).

The brain thinking of humans further requires the supplementation of assumption, inference and memory, which are all performed or expressed by language (Cai, 2018a), making the language likewise useful to assist human meditation (Cai, 2018a). Accordingly, the human meditation based on language would further extend the usage and influence of the semantic/syntactic/episodic model of native language.

Along with the determination of one congruent meaning for some polymeaning words in sentence and paragraph, the simplicity and indispensability of semantic/syntactic/episodic components of native language would make it possible to apply the full linguistic functions to the automated machines and artificial intelligence as learned in humans (Cai, 2018a). Besides, the semantic/syntactic/episodic model is likewise very suitable for improving the translation machines (Cai, 2016, 2018a).

Table 1. The three semantic/syntactic/episodic components of language.

Linguistic components	Memory division	Linguistic manifestations
Semantic words	Declarative remote memory	Alexia from lesion in fusiform gyrus, and anomic aphasia from lesion in anterior temporal lobe.
Syntactic grammar	Procedural memory	Agrammatic aphasia poor in comprehending and expressing grammar, and poor in learning artificial grammar.
Episodic coordination by meanings	Immediate or recent declarative episodic memory	Fluency disorder as stuttering, word congruency/sentential construction by various gamma waves of brain, determination of one congruent meaning for some polymeaning words in sentence and paragraph.

5.5. Limitations of the Study

One limitation of the study lies in that only the common words are declarative

remote memories for the native language utilized in human adults, but not for second language under learning. For those rarely utilized words, or those difficult words necessary to resort to dictionary to use, it is not appropriate to use the memory division to match the semantic/syntactic/episodic components of language.

6. Conclusion

Because the word/grammar or declarative/procedural model of language neglects the direct association of word meanings in clause or sentence, the perspective semantic/syntactic/episodic model of native language supplements the third component as episodic association of word meanings in clause or sentence. In this paper, it is supported this third component of language with diverse evidences, mainly as: 1) the progressions on studies of linguistic fluency, word congruency, and so on. 2) It is supported the indispensability of the "episodic" component of language because it is necessary to use the episodic association of word meanings to help determine one congruent meaning for some words of multiple meanings (polymeaning words) in sentence and paragraph. 3) The detailed division of memories supports the semantic/syntactic/episodic model of language, in that the semantic/syntactic/episodic components of language correspond to the declarative remote memory, procedural memory and declarative immediate/recent episodic memory, respectively. With the simple and intuitive semantic/syntactic/episodic model of language well supported by diverse evidences, it would benefit to its propagation and applications.

Conflict of Interest Statement

The author declares no conflict of interest for this work.

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