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The Cognitive Mechanism of the Number Systems

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Abstract: Number is everything and the number systems exist above the number itself. The paper studies the cognitive mechanism of number system from the aspects of embodiment, interactive feature and image schema models. As numbers, number system is also a cognitive tool with unique connotation and abundant extension.

1. Introduction

Number is an universal and relatively stable concept. Pythagoras once said that and Jespersen (1928) states that the number is the simplest natural but linguistic thing. Number is closely related to our daily lives. There are a lot of researches about the number from anthropology, semantics, pragmatics and cultural analysis, and some scholars also discuss it from the cognitive perspective. For example, Du (2014) analyzed the image schema features of number from the part-whole model, balance model and source-path goal model. Furthermore, Liu (2016) discussed the embodiment of the number. Therefore, numbers can not only express quantity, order, scope and size of things, but also be a cognitive tool with unique connotation and abundant extension, which can give vivid metaphorical meaning to language.

It is difficult to imagine how people should deal with large numbers without the number systems. It is clear that the number systems exist above the number itself. However, the researches on the number systems are mainly discussed in the fields of mathematics and computer information, and few scholars have discussed their cognitive mechanism. Therefore, the author mainly discusses the cognitive mechanism of number system from the aspects of embodiment, interactive feature and image schema models. The most common number systems in modern society are decimalism and binary, and of course there are quaternary, octonary, duodecimal, sexagesimalism, and so on. This research focuses on the recognition mechanism of decimalism and binary system.

2. Embodiment

Embodiment is an important philosophical foundation of cognitive linguistics. In different languages, people's understanding of number metaphor shows a great degree of similarity. The reason is that human beings have the convergence of physiological mechanism, that is, brain neural network has similarity, and many human behaviors and activities have considerable similarities themselves. Therefore, the thinking mode of human understanding of number metaphor also has many convergence. According to the etymology of ten, "decimalism" comes from Latin root "dk-", while "finger" comes from the "digitus" with the same root (Blazhij Garczynski, 2014). To count higher than



nine, we need to start combining the digits, using a tens place, a hundreds place, a thousands place, etc. This seems completely natural to us. The decimal system of numbers is our constant companion as we strive to make sense of the world. People count from the fingers to the toes or another person's fingers, so in some districts, such as Denmark, there is the decimal system.

Different from the counting system of human, the electronic computers only understand Binary number system (ones and zeros). Leibniz, the inventor of binary system, once explicitly claimed that his invention was inspired by the theory in *I Ching* (Zhao, 1999), namely “Tai Chi”, which means “Yang” and “Yin”, and the balance of opposition and unification. Nowadays, binary is widely used in computer language, mainly because the bi-stable circuit is expressed by 0 and 1 respectively. The operation is simple and not easy to make mistakes, so binary system is still used today. However, from the perspective of philosophy, its connotation is obtained by people through embodied experience, such as sunrise and sunset, man and woman.

In Indo-European countries, such as UK, there is duodecimal system. It is said that there are three possible sources. One is derived from the twelve phalanges of one hand with the thumb removed; Another is from ten fingers and two feet; And the last source is from the observation of four seasons that the moon would be round twelve times in a cycle (Blazhj Garczynski, 2014). China also has a small number of terms such as the Chinese zodiac. In Denmark, there still is the Mayan vigesimalism, which come from the sum of the fingers and toes. To sum up, the embodiment of the number system is obvious.

3. Interaction

As a computing tool, number is also attached with cultural connotation in language use. Numbers express quantity and order in superficial sense, while when they are endowed with other denotative meanings, they contain metaphorical meanings. Because of the differences in culture, religion, region and nationality, the metaphorical meanings are also different. They reflect the cognitive processes of human beings towards the objective world. For example, seven is considered a lucky number in the west because of the biblical concept of god creating the world for seven days, such as “he is in the seventh heaven”. Why is it seven? There are two explanations. One divides the seven into three and four, three symbolizing the trinity of divinity, namely, the Holy Father, the Son and the Infant, and four symbolizing human nature (the number of four represents the creature from the number three, and it is after three, and the human are specially created by God). Therefore, seven represents the unity of man and God. The second explains seven sources from other cultural origins, symbolizing the universe. For example, in Indian, seven means the four sides (the front, the behind, the left, and the right), the above, the middle and the bottom, which reaches the three-dimensional understanding of seven directions, with infinite metaphors. Thus, “seven” and “heaven” have similar pronunciation. But in China, seven is a mysterious number. Many important events are limited to seven days. For example, the sacrificial activities of the folk funerals in China also take seven days as an anniversary of the death. Every seven days after death, they are called “Touqi” (In the seventh day after death, the ghost will go back home.) On seven-fold days, they are called “Liqi” or “Zuoqi”. On forty-nine days, they are called “Duanqi” or “Zhongqi”. From the perspective of cognitive science, there is a difference between the real world and human cognitive world. Human cognition is the interaction between things and human experience, as well as culture. Therefore, people with different experiences and cultures will naturally give different connotations and explanations.

The same is true of the number system. In the Mayan civilization and ancient Babylon, people had different expressions for the number system. For example, Maya had the vigesimalism, while ancient Babylon had the duodecimal and sexagesimal system. The evolution of the number system is still to be studied by archaeologists, but it is undeniable that the number system is influenced by people's experience and culture. With globalization, the decimalism has become the most common number system, which is also inseparable from people's common cognition.

4. Image Schema

4.1. Container Schema

When we do decimalism, the reason whether we carry the number is “more than ten” or “less than ten”. Then, decimalism is regarded as a container. The number inside the container is under ten and outside needs to be carried to the second container. Binary system is the same thing, but this container is too small to hold only 0 and 1.

4.2. Part-whole Scheme

Ten is regarded as perfect and whole in both Chinese and English because in decimalism ten means perfect. In this case, ten can refer to the whole, such as “Shiquan shimei” (perfect) and “Shie bushe” (unpardonable crimes) in Chinese.

4.3. Balance Scheme

Balance represents symmetry and law. For example, “Kezhi zhe liangchu yishang yixia, yiming yian, yigao yiai, yishan yishui, jingshi teyin wanyue ershe cichu” (It can be seen that these two places, one up and one down, one bright and one dark, one high and one low, one mountain and one water, are specially set here for enjoying the moon.) (*Dream of the Red Chamber*). People often used the two as two “one”s to take its balance. If we take a look at the history of number systems, it is scarce to have singulative number system, because the divisor is few, and inconvenient for people to calculate. The singular will cause imbalance, such as “Qishang baxia” (so anxious), “Luanqi bazao” (in mess), “Diusan lasi” (forgetful) because they represent the imbalance caused by the sense of chaos.

5. Conclusion

To sum up, the number system can be explained and analyzed through cognitive science. As numbers, number system is also a cognitive tool with unique connotation and abundant extension, which can give vivid metaphorical meaning to language too. Moreover, for the same decimal system, whether Chinese and western people have different neural responses or not needs further experimental comparison and analysis.

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References:

- [1] Blazej Garczynski. (2014). A short research in Danish cardinal and ordinal numerals on Indo-european background. *Folia Scandinavica Posnaniensia*, 16 (1): 17-40.
- [2] Chen, Y. (2005). Hanying shuzi wenhua neihan duibi yanjiu. [A contrastive study of the connotations of Chinese and English number culture]. Doctoral Dissertation of Shanghai Jiaotong University.
- [3] Du, Y. (2014). A Comparative Study of Numeral Metaphors in English and Chinese from the Perspectives of Cognitive Linguistics. Master Dissertation of Xi'an International Studies University.
- [4] Liu, P. (2016). Shuci xitong zhong de sheshen xianxiang. [Embodiment in number word system]. *Contemporary Linguistics*. 18 (3): 416-430.
- [5] Schimmel, A. (1993). *The Mystery of Numbers*. New York, Oxford University Press, Oxford.
- [6] Song, Q. (2015). Qi A ba B de fei fanchouhua shuci fenxi. [Research on the decategorization of the numerals of “七 A 八 B”]. Master Dissertation of Changsha University of Science and Technology.
- [7] Wen, Y. (1948). Qishier. [Seventy Two]. SDX Joint Publishing Company.

- [8] Zhang, D. (1999). Shuli qiankun. [Universe in Numbers]. Peking University Press, Beijing.
- [9] Zhao, L. (1999). Yijing: Renlei kexue siwei he shenmei siwei fangshi de jingdian chanshu. [*Book of Changes: A classic model of scientific thinking and aesthetic thinking of TVS*]. (3): 237-240.