Review of the Relationship Between Space, Time and Number in the West

Yancheng Yang1,2,3

1School of Foreign Languages/Institute of Language and Cognition, Hunan University, Changsha, China
2School of Foreign Languages/Culture Study Center, Luoyang Institute of Technology and Science, Luoyang, China
3CRLAO, INALCO, Paris, France
yangyancheng1234@163.com

Keywords: space, time, number, relationship, review

Abstract: Recently in the west, the relationship between space, time, and number have become a hot topic in cognitive science, which rouse a lot interests. In this paper, we mainly review the relationship between them, including time and space studies, time and number studies, number and space studies, and the relationship between space, time, and number in the past researches in the west. Finally, taking the west literature review as reference, I propose my view of the relationship between them in the YiChing.

“Space, time and number study” is a hot issue in recent growing literature. For the current cognitive linguistics research trend, there are two new turns. One is about the quantitative turn in methodology, the other one is about the social turn in theory. It is no exception for time and space study, about my topic I will focus on interdisciplinary approaches (Cognitive semiotics, Cultural semiotics and Cognitive cultural linguistics, historical linguistics, cognitive social linguistics etc) to probe into temporal, spatial and numeral concept and representation in ancient China.

1. Time and space studies

Heidegger’s view of time is more emphasis on the “future”, biased towards the possibility of the future, focusing on the inevitable death in the future. The conceptions of time can be affected by a lot of factors, including the metaphorical representations of particular language, the relevant linguistic context, and the particular metaphors in a given situation (Boroditsky, 2011). A number of studies on cross-linguistic differences can provide evidence for the conceptions of time, including numerous cognitive linguistic studies (e.g. Lakoff & Johnson, 1980; 1999; Lakoff & Turner, 1989; Radden, 2004), and empirical psycholinguistic researches (e.g. Boroditsky, 2000; Gentner, 2001; Boroditsky & Ramscar, 2002).

Using space to express time is very common for people around the world (Clark, 1973; Traugott, 1978; Alverson, 1994; Haspelmath, 1997). Space and time are the two most important basic conceptual domains of human thinking. However, it is perhaps not evident for a naive philosophical observer to show a peculiar relatedness between space and time, that is, “Human languages again and again express temporal and spatial notions in a similar way.” (Haspelmath, 1997, p. 1)

In human thinking, people always link space and time as well. Temporal expressions basing on spatial ones is one common way of conceiving of this relationship, which can be also considered as a kind of conceptual metaphor (e.g. Lakoff & Johnson, 1980, Claudi & Heine, 1986).
Any theory of a metaphorical relation between space and time has to take into consideration, space and time are not distinguished at the perceptual level, and distinguishing conceptualizations of time and space at some cognitive levels seems possible.

Temporal expressions are identical with spatial expressions (e.g., Wierzbicka, Clark, Jackendoff); Temporal expressions depended on spatial expressions (e.g., Meyer-Lübke, Gamillscheg, Lyons, Langacker, Wunderlich); In terms of spatial concepts, time can be conceived by the speakers (e.g., Gamillscheg, Langacker). Wierzbicka contrasts this explication with one proposed by some philosophers according to which the world is four-dimensional, and a period of time span can be thought of as a part of this world.

Claudi & Heine (1986) place time right after space on their universal schema of their grammaticalization paths—“PERSON > OBJECT > ACTIVITY > SPACE > TIME > QUALITY” (Heine, Claudi & Hunnemeyer, 1991, p. 157). Space is more concrete and can therefore be renewed and reinforced more easily.

Nowadays, many scholarly did a lot of various aspects studies relative to space and time. (Marija, et.al., 2009) However, for researches in the two domains and the acknowledgement of cross-domain transfers, a lot of challenges affect the mapping a taxonomy of spatial representations onto the domain of time, which can make the conceptual relations of space and time more complex (e.g., Núñez & Cooperrider, 2013).

Asymmetrical space-time interactions have been shown by previous studies. Spatial cognition has a larger effect on temporal cognition. (Casasanto and Boroditsky, 2008; Merritt et al., 2010; Clark, 1973; Gentner 2001; Boroditsky, 2000.) The idea that the ways in which we experience, space play a role in structuring the semantics of time, this idea was supported by the different experimental studies (Boroditsky, 2000, 2001; Boroditsky & Ramscar, 2002; Núñez & Sweetser, 2006; Casasanto & Boroditsky, 2008; Matlock, Ramscar, & Boroditsky, 2005). In a recent study of space–time (dis)analogies in language, Langacker (2012) summarizes certain linguistic parallelisms closely tied to time and space.

Conceptualization of space and time is another hot topic. The concept of space is the source domain for time. Space is an abstract (non-material, in fact it is a ‘vacuum’) entity, it would be interesting to examine through language expressions how it is conceptualized by human beings.

Up to now, all studies on metaphors have focused on the source domain of many concepts such as time, thought, love, fear, etc. pointing at space as the ultimate source domain. But nobody so far has attempted to investigate the concept of space as a target domain and ask a question of what might be the source domain of space.

Boroditsky & Ramscar (2002) showed that understanding time is facilitated and directed by conceptualizations of space, including thinking about physical motion. ATOM theory (A Theory of Magnitude) proposed by Walsh (2003) and TMS (transcranial magnetic stimulation) studies are two major views on the relationship between space and time in cognition (Bueti & Walsh, 2009). Time can be processed in terms of space (Clark, 1973; Lakoff & Johnson, 1980, 1999; Boroditsky, 2000; Gentner, Imai, & Boroditsky, 2002 ).

Cognitive studies using non-linguistic stimuli and responses conducted with adults (Casasanto & Boroditsky, 2008) and young children (Casasanto, Fotakopoulou, & Boroditsky, 2010) can support the asymmetric view on the relationship between space and time.
2. Time and number studies

Lu, et. al. (2009) researched the contextual effects on the number–time interaction. Representations of time and number in particular have long been hypothesized to originate from a common representational system. Since the Meck and Church study (1983), a great deal of work has revealed parallel sensitivity for time and number discrimination in non-human animals and adult humans. (Cantlon, et.al., 2009; Dormal, V. et al. 2006; Roitman, J. D. et al. , 2007)

Links between number and time or between space and time, on the other hand, are rarely discussed and the shared properties of all three systems have not been considered.

3. Number and space studies

Number can be represented spatially, it is well accepted and forms a basis for research into spatial aspects of numerical processing. Number is deceptively simple, and is the most underestimated of the grammatical categories. (Corbett, 2000) This was recognized by Jespersen, he held that number might appear to be one of the simplest natural categories, as simple as “two and two are four.” But on closer inspection, it presents a great many difficulties, both logical and linguistic (Jespersen, 1924, p. 188). Lyons also pointed out its interest: “The analysis of the category of number in particular languages may be a very complex matter” (Lyons, 1968, p.283).

Numbers are words (and symbols) that we use to describe patterns. The numbers we write down and speak are words in a language, and that language is called mathematics. We are the only creatures on Earth to make use of language, so it is not terribly surprising that we are the only ones to “speak numbers” (Bentley, 2008).

4. Space-time-number relationship

A lot of evidences in the past researches showed that time (and numbers) are represented in space. (Bueti & Walsh, 2009; Walsh, 2003; Lakoff & Johnson, 1980, 1999; Winter, Marghetis & Matlock, 2015) Winter, et.al., (2015) held that cross-domain interactions are manifestations of asymmetric mappings that use representations of space to structure the domains of number and time.

On the classical and ancient concepts of time, space and number, even Aristotle claims that time is inseparable from movement, not only a change in the position, but the change in general. Time and space are intimately related, the real nature of this relationship is very difficult. Time and Space are also related to a new use of mathematics. Freud did not deal directly with numbers, he did make important comments on the mathematics and Dimensions of time and space. (Stadter & Scharff, 2006, p. 183)

Dehaene, S., & Brannon, E. M. (2010) proved that space, time, and number are connected in the world and the human mind. Quantities of cross-dimensional interactions and metaphors among space, time and number are computational issues for cognitive neuroscience.

The past researches show that time, space and quantity are part of a generalized magnitude system. A Theory Of Magnitude (ATOM) can be treated as a conceptually new framework within which to re-interpret the cortical processing of these elements of the environment. (Walsh, 2003) Walsh also synthesized the behavioral and neurobiological evidence that time, space and number share are common processing mechanisms and proposed that they are linked to guide action.
Talking about time in terms of space or motion has received much attention in linguistics and psychology, and many scholars researched about the broader question of how people can talk about and conceptualize one domain using concepts from another (e.g. Boroditsky & Ramscar, 2002; Gentner et al., 2001; Lakoff & Johnson, 1999).

It is the physical objects (both animate and inanimate) that are the only entities accessible to our senses and it is the physical object that is the ultimate source domain of Space, time and other concepts, e.g., number. (Szwedek, 2009, p. 331)

5. Conclusion

From the above review, we can find the past researches of the west related to space, time and number studies are lack of evidence from ancient language, especially few of them explore the ancient text. Taking our Chinese language for an example, this kind of relationship is different from the west, e.g. space, time and number in the YiChing are not separated, but a wholeness, they can be considered as one single domain. In Chinese culture, we cannot separate them, we should put them together, or integrated them into the growth experience, which is life metaphor (time, space and magnitude) and motion metaphor.

Acknowledgement

In this paper, the research was sponsored by The General supported project of Hunan Provincial Social Science Achievements Review Committee in 2019(XSP19YBZ080)—A Study of Time and Space Language Representation in Ancient China-Taking ShiJing and YiJing as an Example; Humanities and Social Science Fund of Ministry of Education of China, (Project No. 17YJCZH221).

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