Language Shapes Thought: Rethinking on Linguistic Relativity

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Abstract—We reviewed the researches on linguistic relativity in color, space and time domains, and rethink the relationship between language and perception to support the idea that language interact with other cognitive processes and shape the perception and thought of human. Language, perception and action are not separated systems, but are closely interconnected and highly interacted to some extent. And language plays a constructive role in object affordances, which do not only require low-level processes of action and motor control, but depend on the language knowledge as well.

Index Terms—color, space, time, linguistic relativity, OBJECT affordances

I. INTRODUCTION

The existence of Whorf effect, which supports that one’s native language shape one’s ways of cognition and perception, has been debated for many years. The relationship between language and perception is also the classic debate in linguistics. The side of linguistic relativity holds that our perception is shaped by the semantic categories in our language. The questions underpinning the linguistic relativity debate are questions such as: does language shape thought? And does language modulate perception? In this review, we will investigate the recent researches on linguistic relativity in color and spatiotemporal domains, and rethink the relationship between language, thought and cognition.

II. COLOR DOMAIN

The hotly debated question in color domain is if the color categories defined by languages may affect the process and perception of color categories. Regier & Kay (2009) suggested the debate may conflate two distinct questions: Do color terms affect color perception? Are color categories determined by largely arbitrary linguistic convention [1]? The responds of linguistic relativists would be affirmative to both questions, and along with the arisen of new studies and evidences, linguistic relativity was proved to be partly right. With regard to the first question, color terms affect color perception primarily in the right visual field. With regard to the second question, color categories naming reflects both universal tendencies and some degree of linguistic convention.

A number of findings show that there exists “categorical perception” (CP) for color, and the differences of color categories in languages may predict where CP will occur [2], [3]. For example, there are different color terms to distinguish light blue (goluboy) and dark blue (siniy) in Russian, but not in English. And this difference results in the different discriminations in this color category [3]. Examples of CP have been reported for many different stimuli, and some studies reported CP effects in the reaction times. Participants were faster at discriminating target from distractors if the colors of target and distractors fall into different linguistic color categories than into the same category [3]-[7]. In addition, color CP would disappear with a concurrent verbal interference task, and this finding implied that color CP is language based [6]. Previous studies also examined CP effects by testing color discrimination under conditions in which response time and memory requirements are reduced [8], [9]. However, it is not easy to explain the results of these studies, because the interaction between language and color could arise at many different levels and could depend on the task to a large extent. Furthermore, many studies measured the speed of the response or the ability of memory. This raised the possibility that language only affects the ability to store or react to it.

Furthermore, language affects perception primarily in the right visual field (RVF), because the left brain hemisphere is dominant for language. Given the hemispheric specialization, our perception might be influenced by our native language in the right visual field than the left visual field [2], [10]. This effect means language might shape color processing and could support Whorf hypothesis in color domain. Gilbert, Regier, Kay & Ivry (2006) tested this hypothesis using a lateralized visual search task [6]. They found that cross category targets were identified faster than same category targets in RVF and when RVF color CP is found, it has a verbal basis. Roberson, Pak & Hanley (2008) also reported color CP in the RVF in Korean, reinforcing that cross category targets were identified faster than same category targets in RVF [7]. Given this aspect of hemispheric specialization and the universal Whorf effect in language, the asymmetric effect might reflect a general influence of language on perception, this effect would not limited
within color domain. So, Gilbert et al. (2008) employed visual search task, but replaced the colors with pictures of cats or dogs. The results of their experiments supported previous findings of a lateralized Whorf effect to non-color stimuli. So this effect might have a general influence on perception and reflect the interaction between language and perception.

However, the findings of pre-linguistic CP in infants and that color terms do not affect color CP in toddlers call the hypothesis of language-driven CP in the RVF in question. This also raised the question about the relation between pre-linguistic CP and the language-driven RVF-lateralized color CP in adults. Franklin et al. (2006) compared infants and adults performance on a visual search task and found that pre-linguistic infants showed no CP in the RVF, and clear CP in the LVF [6]. This study suggested that the acquisition of color terms cause the shift of color CP from RH to LH. But what is the nature of this shift? Where did the CP effects come from? These are still open questions.

Besides the evidence from behavior studies, some ERP and fMRI studies have raised a number of related evidences. For example, Siok et al. (2009) found that discriminating colors of different lexical categories elicited faster and stronger response in the left hemisphere language regions and suggested that the language areas might act as a top-down control source on the visual areas in color perception [11]. Holmes et al. (2009) founded that shorter latencies for early components to cross-category differences than for within-category differences providing evidence for an early role for categorical differences in color perception and suggesting influence of color categories on post-perceptual processing [12]. Liu et al. (2010) employed a “same-different” judgment task and their results suggested that the categorical perception of color stimuli presented in the RVF might result from an effect of language-related processes suppressing the capacity to discriminate two shades of color within the same color category [13]. Although many recent electrophysiological and imaging studies support that linguistic category affect color discrimination via involvement of left hemisphere language regions, there are still uncertain and opened questions, such as the influence of color categories is post-perceptual or pre-perceptual processing, the nature of hemispheric specialization and CP effect. Lu, Hodeges, Zhang & Wang (2012) tried to answer these questions by employing color naming task. Their result showed that linguistic effects on color discrimination cannot be restricted to the left hemisphere, and linguistic effects on color cognition are more robust and distributed than previously acknowledged [14].

To summarize, it appears uncontroversial that once language is learned, its lexical categories shape perceptual discrimination primarily in the left hemisphere and right visual field. The Whorf hypothesis would be partly right which implies the relation between language and perception in color domain might be deliberated more broadly.

III. SPACE AND TIME DOMAIN

There are many different ways to describe spatial relation in different languages and there has been a great deal of thoughts about spatial frames of reference. Most of literature privileges.

Egocentric coordinates, two other distinct types based on object-centered coordinates, and absolute coordinates, which may be called the Relative (egocentric), the Intrinsic (object-centered) and the Absolute (like north, south) system [15].

Languages have specialized expressions for one, two or all the three spatial frames of reference, and the application of these spatial frames of reference differ across languages. The computations required in different spatial frames of reference are different, such as absolute spatial frames of reference in all situations are of a quite different from the other two frames. There are two viewpoints about if the different spatial frames of reference need different deeper cognitive consequences. According to one view, spatial cognition is inherently ‘dynamic, egocentric and primitive’ [16]. The other viewpoint is that spatial cognition requires multiple spatial frames of reference, and that languages recruit from these systems [17]. A lot of experiments have shown that people do use different non-linguistic spatial frames of reference to do the same tasks, and that these non-linguistic spatial frames of reference align with the preferred spatial frame of reference of their language [18], [19]. And Dehaene et al. (2006) reported the data from Munduruku tribe [20]. They evaluated spatial thinking among Munduruku children and adults, and tested American children and adults as a comparison group for their Amazonian sample. They found that American adults did better than Munduruku of any age, and better than American children. Their results supported that there are universal tendencies in space cognition and language affect space cognition as well. Thereby, culture and language are crucial for full development of geometric and spatial potential.

In general, time representation relies on space representation in most diverse languages. But the representation way differs across languages and cultures, depending on the spatial representations, spatio-temporal metaphors, culture, age and experience [21]-[23]. English speakers use the horizontal spatial metaphors primarily to express time, whereas Chinese speakers also use the vertical metaphors. Both English and Mandarin use horizontal spatial terms to talk about time, but in Mandarin, spatial metaphors for time are also common. Unlike English speakers, Mandarin speakers also use vertical metaphors frequently [24], [25]. Will the use of different spatial metaphors affect the way of conceptualize time? In consideration of this linguistic difference, some argued that Mandarin speakers think about time vertically more than English speakers do.

Many studies have demonstrated that English speakers construct representations of time that are horizontal and people spatialize time naturally and automatically [21], [23], [26], [27]. While a number of similar studies found that vertical representations of time in English speakers
were non-existent or very rare. [23], [28], [29]. And studies comparing English and Mandarin speakers found that Mandarin speakers do construct vertical representations for time, and so more often than English speakers [23], [27].

One experimental paradigm used to test English and Mandarin speakers’ representations of time produced mixed results and evoked many disputes [25], [26], [30], [31]. At first, Boroditsky (2001) used this paradigm and argued for the point that the use of spatial metaphors could change the way speakers think about time. But the later studies used this paradigm produced inconsistent results, such as January & Kako (2007) and Chen (2007) could not replicate her experimental findings. So they argued that Chinese speakers do not conceptualize time differently than English speakers. Replying to their disputes, Boroditsky, Fuhrman & McCormick (2011) suggested this type of design can only be used to test for interactions between groups but not relied exclusively or almost exclusively on data from only one language group, such as 73 Mandarin speakers but only 14 English speakers [32]. Furthermore, she stated that they used different stimuli and experimental procedures from her original study. Because the original paradigm tested only for effects of axis, Boroditsky, Fuhrman & McCormick (2011) presented a new paradigm to extend the early studies. The task separated the directions within the axes, the task was non-linguistic, the task relied on reaction-time, and the task tested temporal reasoning across a wide range of temporal progressions and durations. And the results of this study extended and supported her previous work.

In summary, this study together with previous other studies might prove that Mandarin speakers use vertical terms to talk about time more than English speakers do and Mandarin speakers think about time vertically more than English speakers do as well. Speaker across different languages might activate different space representation with cultural specialties and their different time representation might produce diverse emotional and behavioral consequences [22], [33].

IV. DISCUSSION

From the review above about linguistic relativity in color and spatiotemporal domains, it appears that language do indeed play an important role in the perception, cognition and then in thought and communication of human. This discussion briefly addresses the relation between language, perception and cognition.

The dynamic, distributed characters of language and perception point to the possibility that both are far more diverse and complicated than linguistic relativity theorists and universalists have assumed. It appears that the more we learn about languages and perception, the more complex they become. We now move to the object affordances: because, overall, more and more evidence suggests that people perceive object affordances rather than a set of separate dimensions, such as color, time and space. Object affordances can be defined as the specific possibilities that objects offer for bodily interaction. Objects typically elicit multiple affordance representations, and a number of behavioral studies have shown that different affordances can be activated depending on linguistic context [34], [35]. These studies proposed that object affordance strongly depends on context and intention. This view predicts that there is no context-neutral description of object features and object is defined by the set of possible actions that can be performed on it.

Object affordances do not only require low-level processes of action and perception control, but depend on the specific language knowledge as well. The evidences in color and spatiotemporal domain support that language play a key role in the perception, cognition and then in thought and communication of human. Moreover, there is a growing body of evidence that speakers of different languages, whose terminology or grammatical structure differ, influence the processing of conceptualization, object affordances i.e., in different ways. Besides semantic knowledge reviewed about color, space and time terms, Boroditsky, Schmidt, & Philips (2003) have suggested that the interaction grammatical patterns in words do affect our representation of the outside world [36]. Studies investigating the influence of grammatical categories on perception, have essentially focused on potential links between grammatical gender and object categorization. Cubelli et al. (2011) employed non verbal semantic task on pictures and offered strong evidence to support that grammatical gender can affect conceptualization [37]. Boutonnet, Anthanasopoulos & Thierry (2012) tested Spanish-English bilinguals and control native speakers of English in a semantic categorization task on triplets of pictures in an all-in-English context while measuring event-related brain potentials (ERPs) [38]. Pulvermüller, Cook & Hauk (2012) examined the effects on event-related brain responses of action-related semantics, lexical category, and words inflection and their results demonstrated that intrinsic properties of semantic and grammatical, including morphophonological, analysis of action-related language are manifest in motor systems activation [39]. These experimental results demonstrated that this kind of unconscious effect play a part in representation and conceptualization. Their results provided evidence for spontaneous and unconscious access to grammatical knowledge, thereby provided support for linguistic relativity effects in the grammatical domain. Consequently, language knowledge including semantic and grammatical information might intact with cognition substantially, and modulate perception and action spontaneously. Many studies argued, perception, action and language have common representational resources and cognitive processes including perception and language are closely intertwined and consist of a set of processes that determine possible actions. That is, we tend to say what we do and tend to do what we say to some extent [40], [41]. In this sense, language is highly interconnected with other cognitive processes such as
action and perception to support object affordances, thereby influences other functional networks.

To date, more and more new aroused evidences support the linguistic relativity hypothesis, by showing that both action-perception features and semantic or grammatical features of objects are spontaneously retrieved which likely contribute to objects affordances and mental representations of these objects. That is, both action-perception systems and language systems serve thinking and communication of human. As thus, perceptual systems and natural language statistic systems might be interconnected together, just as Boroditsky & Prinz (2008) have supposed [42]. Only perception or language is not enough for human cognition. On the one hand, perception and action systems may store and utilize representation off line and reactivate the similar pattern when applying to thinking. But this type of representation has some limits such as integration problems and non-efficiency. On the other hand, structured language inputs include a lot of special statistical rules only existing in language such as phonetic, lexical and syntactic patterns. A number of studies have shown, human may make use of the special co-occurrence information of new words in context and judge the meaning by statistic information [43], [44]. Connecting with natural language systems might resolve the above problems by integrating human experience through language knowledge along with action-perception information.

The mechanism of object affordances in this discussion shares the insight that the brain is organized along two major neural pathways, one encoding affordances and actions and the other one, involving a number of mechanisms that allow the selection of affordances and actions on the basis of high-level goals [45], [46]. Therefore, we prescribe possible actions, rather than describing states of the world. Knowing what an object is does not mean to possess descriptions of this object, but to master sets of sensomotor skills and possible actions to utilize the object in concrete context [47]. A number of studies showed, that the processing of objects affordances for action is to a strong extent determined by top-down influences related to one’s action intention and the context [48], [49]. That is, object affordances are not automatically activated every time but depend on the context. And when the processing of objects affordances is determined by top-down influences, there displayed universal aspects of event perception and cognition but not linguistic effects, especially in action and event perception [50]. Nonetheless, the hierarchical, goal-directed mechanisms of object affordances and action control might serve the function of varied linguistic relativity.

From the viewpoint of contemporary cognitive neuroscience, meaning is the result of our interactions with the outside world. Language connects all the possible actions in a network thereby expanding individual action experiences. Language’s nature is in this view not only epistemic, but also action-based primarily, and the solution of contextually appropriate action might extend to contextually-appropriate language through evolution. The main reason of focusing on the relation between language and objects affordances of action in our discussion is that the basic function of cognition is the control of action. Based on evolution, multi-cellular creatures need nervous system to express active movement, and systems evolution demands action and the knowledge of objects affordances which serve linguistic relativity and shape human thought at last. Nevertheless, just as effective action requires coordination with other systems in the brain, besides action and perception systems, language needs coordination with other systems such as emotional systems throughout the brain.

V. CONCLUSION

From the review above about researches on linguistic relativity in color, space and time domains, we might move to rethink and discuss the relationship between language and perception to support the idea that language interact with other cognitive processes and shape the perception and thought of human.

To be concluded, language do plays a constructive role in object affordances, perception and representation. Language, perception and action are not separated systems, but are closely interconnected and highly interacted to some extent. Language plays a constructive role in object affordances, which do not only require low-level processes of action and motor control, but depend on the specific language knowledge as well. Thereby the hierarchical, goal-directed mechanisms of object affordances and action control might serve the function of varied linguistic relativity.

And accepted the suggestion of Jeannerod [40, 41] about arguing for a representational approach to action and the idea that the organization of action derives from the organization of its representational underpinnings, we might propose that action language may affect overt execution and motor expertise may affect action language processing, thus, action control and execution need language semantic and action procedural knowledge at the same time and might draw on a common representational resource. The same coding and representational resource of language, perception and action might put the resource of joint attention which distinguished human from other animals and opened the door of social cognition.

REFERENCES


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