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The Influence of Our Native language on Cognitive Representations of Colour, Spatial Relations and Time

Nicholas P. Sarantakis*

The current literature review offers a critical evaluation of the extent to which our native language determines the ways in which we conceptualise the external world. Experimental studies regarding colour perception, spatial cognition and spatial representation of events in time are examined. It is argued that the available evidence supports the hypothesis of (a flexible) linguistic relativity, instead of the linguistic determinism hypothesis. Moreover, it is suggested that the impact of language on thought is mediated by three pathways: (i) the intention of an individual to express their thoughts; (ii) the environmental and cultural context; and (iii) the ability of an individual to learn different modes of reasoning.

Language and other cognitive capabilities of the human brain have traditionally been seen as the hallmark of what it is to be human. Empiricist philosophers argue that our experiences determine our thoughts and what we become. On the other hand, Kant acknowledges the significance of our experiences, but claims that they are organised in terms of innate fundamental concepts (i.e., concepts that are present in humans regardless of their particular experiences and perceptions), which are related to our language capabilities. It is not surprising then that the relationship between language and thought has attracted significant attention in psychology. The interaction of language and thought has previously been explored bilaterally. However, in the current literature review we shall focus only on the influence of language on thought.

The Whorfian Hypothesis
Early experiments (Smith, Brown, Toman, & Goodman, 1947) demonstrate that cognition can operate independently of language capacity. However, many scholars argue that the way we speak influences the way we think, even if they disagree on the extent of that influence. At one extreme, the Whorfian hypothesis (Whorf, 1956) asserts that the language we speak determines the thoughts we can have (*linguistic determinism*). In relation to this, Green (2010) suggests two criteria that the evidence for linguistic determinism should meet:

> In order to support efficiently linguistic determinism, one would need to provide evidence that

* Glasgow Caledonian University, United Kingdom
  odysseassss@gmail.com

speakers of one language cannot think or entertain thoughts that come naturally to speakers of another language and also that those differences in thinking involve higher cognitive processes, which are demonstrably caused by language. (pp. 366–367)

In the following section, we will review the relevant literature against the above criteria.

Language and colour perception
Early studies investigated colour perception and naming as a means of supporting the Whorfian hypothesis. Brown and Lennenberg (1954) found a positive correlation between recognition of a given colour and its 'codability' (i.e., its categorisation under a concept that is represented with a word). However, the researchers acknowledged that these results did not qualify as support for a causal link between language and thought. Instead, it seems that the codability of a colour facilitates the recognition of that colour, rather than conclusively determining the colours that we can recognise. Hence, if we teach someone how to label given colour hues with (new) language terms, this could make the future recognition of those colours easier. In other words, the language vocabulary an individual holds, or the colour terms available in the language an individual speaks, does not seem to decisively constrain the recognition of unlabeled colour variations. If the acquisition of new terms can readily facilitate recognition or even memorisation of the newly named colours, it seems implausible to argue that the language we speak disables us from entertaining thoughts produced within a different language (e.g., "this is colour *x*"). Moreover, if the spectrum of recognisable objects can be easily expanded or modified, it would be

hard to claim that this spectrum belongs to a fixed higher cognitive process. A number of studies that present this line of argument are presented below.

Heider and Olivier (1972) examined the possible impact of the differences in colour terms used by different languages in the memorisation of those colours. They conducted a cross-cultural study between English-speaking Americans and the Dani of Indonesian New Guinea. They found no significant differences in the memory task. However, the Dani speakers tended to use the two colour terms existing in their own language, while the English speakers tended to use the basic eleven colour terms of the English language. In spite of this, Roberson, Davies, and Davidoff (2000) replicated Heider's and Olivier's study using English-speaking participants and the Berinmo of Papua New Guinea. They found differences in the key memory measures.

These inconsistent results support criticism about the design of such experiments. In particular, Munnich and Landau (2003) argue that this kind of experimental design does not really test the influence of language on non-linguistic tasks (and thus non-linguistic thought). Indeed, it makes sense that if an individual has more available colour terms in their vocabulary, it should be easier for them to memorise the variations of colours that they have seen. However, this interpretation of the above studies implies that the processes of both categorisation and naming are utilised in the memory tasks. Therefore, we cannot regard this as an influence of language on non-linguistic thinking.

The influence of language on spatial cognition

Other studies overcome the above difficulties with linguistic mediation in assumed non-linguistic tasks by examining the influence of language on spatial cognition. Brown and Levinson (1993) investigated the differences in how Dutch speakers and South American Mayans (who speak the language Tzeltal) understand non-verbal spatial orientation since Dutch and Tzeltal exhibit different usage of spatial words. In particular, while Dutch uses a relative frame of reference for locating objects (e.g., object A is to the left of the observer), Tzeltal uses an absolute frame of reference (e.g., object A is to the north of the observer). Thus, Tzeltal speakers would still identify object A at the north of the observer, even if the body was turned 180 degrees. Within a relative frame of reference, left would become right. Brown and Levinson first asked participants from both groups to identify a sole arrow on a first table. They then turned participants 180 degrees to face a second table with two arrows on it and asked them to identify which one was the same as on the first table. The researchers found that Tzeltal speakers consistently used an absolute frame of reference to re-identify the original arrow, while Dutch speakers identified the original arrow in relation to the new position (e.g., left became right). This study is regarded as direct support for the Whorfian hypothesis, since in the study it was possible "to directly infer from non-linguistic behaviour the general nature of the conceptual representation used to code spatial arrays in memory" (Brown and Leninson, 1993, p. 6).

Li and Gleitman (2002) conducted a variation of the previous experiment exclusively among English speakers and demonstrated that changing the environment in which the spatial tasks occur can also change the frame of reference used. In particular, they found that participants tended to use an absolute frame of reference in a more natural, information-rich environment, in comparison with a minimal environment. This contrasts with the findings of Brown and Levinson (1993), as both Dutch and English have the same linguistic features. These results may not rule out the influence of linguistic structures to thought, but they certainly weaken the Whorfian hypothesis. If alterations in the environment of spatial cognition can override predispositions imposed by language, then the assertion that the way we speak decisively determines the thoughts we can have is doubtful.

Language and spatial representation of events in time

However, Boroditsky, Fuhrman, and McCormick (2011) make a strong case for linguistic determinism that contrasts with the above argument. They conducted an experiment with native English and Mandarin speakers. All participants were instructed in English to press the correct button on a computer keyboard to indicate the temporal relationship between two images that they had previously seen on a screen. Buttons were arranged horizontally (i.e., left/right) for the first group and vertically (i.e., top/bottom) for the second group. They found that only native Mandarin speakers responded faster when the 'earlier response button' was on the top of the 'later response button', compared with when it was on the bottom. This is consistent with the use of vertical metaphors for temporal events in the Mandarin language, whereby earlier events are placed 'higher' and later events are placed 'lower' in an imaginary vertical axis. In addition, it would be difficult to claim that the dependent variable (i.e., pressing buttons placed either horizontally or vertically on a computer keyboard) was mediated by linguistic representations.

On the other hand, January and Kako's study (2007, as cited in Green, 2010) showed that a short learning session can change the way in which native English speakers depict temporal relations in space. The researchers trained participants to press a button placed on top of a computer keyboard for previous events in time and another button placed below for subsequent events. It was shown that learning made participants switch their thinking from the horizontal metaphors naturally used in the English language to the vertical metaphors used by Mandarin speakers.

Linguistic relativity

These findings lead us towards *linguistic relativity* instead of linguistic determinism. Lucy (1997) describes the role of language in linguistic relativity as: "Language embodies *an interpretation* of reality and language can *influence* thought about that reality" (Lucy, 1997, p. 294). Elsewhere, Slobin (1987) makes an insightful argument that may

provide reconciliation between linguistic relativity and linguistic determinism:

> '…language influences thought, when we are thinking with the intent to use language (…) having thought about a topic with a view to talking about it, we select from a set of words available to us when we wish to express those thoughts.' (p. 437).

Hence, we can have various thoughts that are not necessarily constrained by the characteristics of our native language (e.g., metaphors, ways of spatial orientation, colour categories, syntactic structures, etc.). Yet when we wish to express these thoughts, we tend to utilise and be influenced by the available resources of our native language.

However, the above does not account for people who have been bilingual for their whole lives. Indeed, bilingualism poses a significant challenge to the Whorfian hypothesis. If both languages are equally weighted, but differ in their linguistic representations, which language governs the bilingual individual's way of thinking? Research shows that actually there is no first or second language for bilinguals and that they are able to adjust their ways of thinking depending on which language they are speaking at that moment in time (Kousta, Vinson, & Vigliocco, 2008). As such, the possibility exists that individuals can generally switch their ways of thinking as they switch the language they speak. Boroditksy et al. (2010) suggest that this is not the case, since Mandarin participants maintained the vertical concept of time, even though they had sufficient English language capabilities. However, as was demonstrated above with English speakers (January & Kako, 2007, as cited in Green, 2010) it is possible that Mandarin speakers could be trained to use the appropriate structures or metaphors that are commonly used in the context of the English language.

Furthermore, it is possible that the impact of language depends on the means through which we express our thoughts. For example, Brysbaert, Fias, and Noel (1998) demonstrated that the differences in numerical cognition between Dutch and French speakers disappeared when subjects were asked to type their answers rather than pronounce them. This provides evidence for the significant interference of modality of expression within linguistic relativity.

Conclusions

Overall, we could argue that speakers of one language seem to be able to consciously use their learning capabilities to practice the spatial and/or other ways of thinking that are common in another language. As Slobin (1987) implies, if an individual can adjust their thoughts when they intend to express them in a certain language, they are also probably able to alter other learned ways of thinking (e.g., metaphorical thinking about time). Nevertheless, Boroditsky et al. (2010) have shown that participants do not always engage in such learning and utilise their natural way of thinking (i.e., as depicted in their native tongue).

Areas for future research

As shown above, the question of how and to what extent learning can change the cognitive patterns that are present in our native language is certainly an interesting area for future research.

Another interesting topic is the extent to which our ways of thinking also depend on their varying environments. As we saw above, Li and Gleitman (2002) illustrated the effect of an information-rich environment versus a minimal one in spatial cognition. It is possible that other variations in the environmental context could have similar effects on linguistically dependent thought too. For example, depending on the language we communicate with, and to whom we are talking, we may be able to temporarily switch our modes of thinking. Of course, this approach entails a radically broader framework than linguistic determinism and linguistic relativity, since we would no longer consider the effects of language on non-linguistic thinking. Instead, we would regard language as only one of the varying components of the environment that flexibly influences our modes of thinking. This approach would also have to investigate the broader cultural and social factors involved in thinking as a means of verbal or written communication. This provides another interesting area for future research.

One such area is counterfactual thinking. This is a multi-faceted area of study that arguably involves higher cognitive processes. Bloom (1981, as cited in Lucy, 1997) compared counterfactual thinking between English speakers and speakers of different varieties of the Chinese language. He found that the linguistic resources available in the two languages contributed to sustaining a particular mode of counterfactual reasoning. However, Au's (1983) study shows that monolingual Chinese speakers (who were not familiar with the English subjunctive) were able to give counterfactual interpretations of a given story as much as native English speakers did, despite the fact that the mastery of the English subjunctive is tangential to counterfactual reasoning in Chinese. As such, this finding directly contradicts Bloom's above claim.

Therefore, it would be interesting for future research to examine how a culturally situated modality (e.g., counterfactual thinking in the Chinese language and culture) could be altered or paralleled with another language. This could occur either through learning, as January and Kako (2007, as cited in Green, 2010) demonstrated, or through the existence of a different context. In fact, despite the wide variety of grammatical structures and semantic representations found in different languages, it seems possible for a speaker to shift thinking between the different meanings and structures (e.g., use of metaphors) embodied in those languages (Langacker, 1976).

In conclusion, I attempted here to argue that the available evidence from the literature supports the hypothesis of (a flexible) linguistic relativity, instead of the linguistic determinism hypothesis. Moreover, I supported the idea that the impact of language on thought is not only mediated by the intention of an individual to express their thoughts, but also by the environmental and cultural context, and their ability to learn different modes of reasoning.

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