

Language Structure Programmes the Brain

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In this lecture I intend to direct attention towards three main points:

1. The hypothesis that language conditions perception, thought, and behaviour, is proven. The evidence has been delivered, mainly, by the work of cognitive psychologists, who made use of the experimental technique.
2. There exists a theory of language and language structure that implies and explains these experimental findings, and hence the hypothesis. A corollary is that multilinguality gives a cognitive advantage.
3. In my opinion, the fact that the hypothesis is valid constitutes the best conceivable argument for preserving and taking care of the diversity of languages of the world.

The idea that language conditions the way people think has been widely discussed, by philosophers, anthropologists, linguists, and psychologists – especially in the first half of the last century, in what has been called the “Golden Age of Native American Indian Linguistics” (Werner 1994: 3656). The idea was put forward by Wilhelm **von Humboldt** in his *Einleitung zum Kawi-Werk* (1836-39; cf. Humboldt 1973), but it was anticipated in the eighteenth century, by Étienne Bonnot **de Condillac** and by Johann Gottfried **von Herder**. It is generally named the Principle of Linguistic Relativity, or the Sapir-Whorf-Hypothesis, after Edward **Sapir** and Benjamin Lee **Whorf**, its most prominent proponents in the above-mentioned “Golden Age”.

They both deserve to be quoted. Sapir wrote 1929:

It is quite an illusion to imagine that one adjusts to reality essentially without the use of language and that language is merely an incidental means of solving specific problems of communication or reflection. The fact of the matter is that the ‘real world’ is to a large extent unconsciously built up on the language habit of the group. No two languages are ever sufficiently similar to be considered as representing the same social reality. The worlds in which different societies live are distinct worlds, not merely the same world with different labels attached. (Sapir 1973: 162)

And Whorf wrote 1941:

How does such a network of language, culture, and behavior come about historically? Which was first, the language patterns or the cultural norms? In main they have grown up together, constantly influencing each other. But in this partnership the nature of the language is the factor that limits free plasticity and rigidifies channels of development in the more autocratic way. This is because a language is a system, not just an assemblage of norms. Large systemic outlines can change to something really new only very slowly, while many other cultural innovations are made with comparative quickness. (Whorf 1941: 91)

However, as long as nobody made use of the experimental technique to investigate such assumptions, the discussions could easily be dismissed as yielding little more than idle speculations. They were ridiculed, especially in Chomskyan circles with their emphasis on

linguistic universals and their incessant striving to explain all differences between languages as different selections of binary options available within a common set of universal rules. Viewing the grammar of a given language as the output of a process of binary option selection naturally renders implausible and impossible all talk about different languages expressing different understandings of the world.

One of the first scholars to investigate **experimentally** the interdependencies between perception, language, thought, and behaviour was Frode Jens **Strømnes**, former professor of psychology at the University of Tromsø. On the basis of observations and experiments done by himself and fellow researchers, dating back to the end of the sixties, and of empirical material from other sources, Strømnes formulated a new theory of symbol systems, of which language is just one example. This theory implies and hence explains that interdependencies exist between perception, language structure, thought, and behaviour, and further that language structure directly conditions perception and thought, and thus, indirectly, behaviour (Strømnes 2006).

I shall give a short survey first of the theoretical main points, and then of the most relevant experiments and investigations:

Symbol systems, among which language is one example, function by the use of two kinds of entities, **addresses** and **homeomorphic models**. The addresses of a natural language for instance are words, parts of words, and word combinations. Addresses have a shape. On the basis of its shape an address, by convention, refers to a place in a store. An address of a natural language for instance refers to a position in the brain. In this position **knowledge** is stored: homeomorphic models of entities, states, actions, processes, and events. Homeomorphic models in the brain are called **mental models**.

Mental models are corporeal. They are operated on according to spatial rules in a **space for mental models**. Different symbol systems, for instance different languages, can have dissimilar mental model spaces and dissimilar spatial rules.

A word tells the brain to find a mental model and bring it to a space for mental models. A sentence tells the brain how several mental models are to be combined into a more comprehensive model. For this purpose a sentence contains elements that address **operations**. Addresses of this kind are called (*grammatical*) **operators**.

Thinking is a process of building, by means of mental models, in a space for mental models.

In a series of experiments Strømnes has shown that the essence of this theory, and its implications, are valid.

Most importantly, in a couple of experiments, published 1973 and 1974, he showed with short film sequences that he had found the general mental models of the Finnish cases and the Swedish prepositions, and that the mental model spaces of the two language communities are different. The space of the Finnish case operators is two-dimensional and the operators have

different duration. They concern relations between the contours of two forms. This is an uncomplicated topological geometry. The space of the Swedish prepositions is three-dimensional and the operators have the same duration. The operations concern how an entity moves in relation to a three-dimensional body. This is an uncomplicated vectorial system.

Follow-up experiments and investigations revealed that Finnish-speakers and Swedish-speakers model situations and tasks differently, report differently from them, evaluate them differently, and propose different solutions, and that the differences correlate with differences in language structure. A further study showed differences – correlating with the differences in language structure – between the spatial structure in Finnish and Scandinavian film versions of the same four plays – *Uncle Vanya* by **Chekhov**, *A Doll's House* and *The Wild Duck* by **Ibsen**, *Tartuffe* by **Molière**. One experiment showed differences in the eye movements of Finnish-speaking and Swedish-speaking men and women while watching excerpts from TV-films. And in yet another study Strømnes and his collaborators predicted and found a huge difference in accident rates between Finnish-speaking and Swedish-speaking workers, who were equal on all other conceivable, relevant variables than mother tongue.

Thus Strømnes has demonstrated experimentally the existence of a space for mental models, and that different languages – in this case: Finnish and Swedish – can have dissimilar mental model spaces and dissimilar spatial rules. And he found clear correlations between differences in the structure of Finnish and Swedish and differences in the perception, thought, and behaviour of Finnish-speakers and Swedish-speakers. As will be known, such clear correlations permit one to assume the **relation of interdependency**, in this case between – on the one hand – language structure as the reflection of the properties of the mental model space of Finnish, or Swedish, and – on the other hand – the perception, thought, and behaviour of Finnish-speakers or Swedish-speakers.

In this conception the grammar of a language may be viewed, basically, as consequences of the conditions or characteristics of its space for mental models, or at least as compatible with these conditions or characteristics – such as its dimensions, its special way of highlighting, the kind of movements in it and the duration of the movements, its possible distinctions, its possible relations, its possible operations, etc. This basic conception of the grammar of a language may be enriched with the insight from George **Lakoff**/Mark **Johnson** (1980) (in part verified experimentally by Matthew S. **McGlone**/Jennifer L. **Harding** (1998) and Lera **Boroditsky** (2000)) that the human conceptual system is structured around a small set of fundamental concepts that emerge directly out of physical experience, so that all the other concepts are understood and structured through metaphorical mappings from this set of fundamental experiential concepts. This means that the set of mental models of a language, and the system of its rules for mental modelling, are metaphorically structured, in ways diverging somewhat from language to language.

This view of language structure is compatible with the neural explanations given in Lakoff 2008, and also with Lakoff 2012 – with the important exception of the notion of the so called *cogs* (cognitive primitives), “universal cognitive structures, either there at birth or developed very early”, according to Lakoff (2012: 6). In my opinion, this point needs more investigation.

On the basis of the theory of Strømnes, with Lakoff/Johnson, one can directly predict and explain findings such as those revealed in investigations and experiments conducted from the eighties onwards:

- In 1982 Alexander **Guiora**, Benjamin **Beit-Hallahmi**, Risto **Fried**, and Cecelia **Yoder** revealed that there is “a relationship between the amount of sex-determined gender and the average age of attaining gender identity in children, in a specific linguistic environment” (p. 292). They compared children growing up with Finnish, with English, and with Hebrew as their native tongue. The sex-determined grammatical “gender loading” of these languages varies from almost zero in Finnish, through very low in English, to very high in Hebrew. The results are shown in the hand out, p. 3. The Hebrew sample reaches and exceeds 50% success considerably ahead of both the English and the Finnish sample. The difference may amount to almost one year.

Moreover, there is additional evidence to support the contention that it is linguistic and not cultural differences that account for the effect found:

In the Finnish portion of [the] study, Swedish-speaking Finns [were] compared with Finnish-speaking Finns. Even though the socio-cultural environments are similar for these two subgroups the difference in gender-loading is pronounced, with Swedish more approximating English. The results were in the expected direction with Swedish-speaking Finns scoring better in the [test] than Finnish-speaking Finns. These results [were] all the more impressive when one considers that in follow-up questionnaires, given to both subgroups, it was found that attitudinal and behavioral sex-role stereotyping differences between the two groups would have favored earlier gender identity attainment for the Finnish-speaking Finns. In fact, it [was] the other way around (Guiora 1983: 234).

- Stephen C. **Levinson** has investigated cross-linguistic differences in spatial thinking. In 1996 he published a study comparing the Mayan language Tenejapa-Tzeltal and Dutch. The hypothesis was: Speakers of a language with a certain predominant frame of reference utilise the same frame of reference in nonverbal tasks.

[He] seated the experimental subject before a table, on which a row of well-known objects was placed in full view before them. The participant was asked to inspect the row, and then to rise, turn around and sit at a similar table, oriented at an angle of 180° in comparison with the first one[, and then to arrange the objects on this table “in the same order” as on the first one]. The experiment revealed that [Tzeltal-speaking people] solve this task [differently from speakers of Dutch. Tzeltal-speaking] people order the row according to its relation to the cardinal directions [north and south etc.; Dutch-speaking people order the row in relation to left and right, that is, in relation to their own body] (quoted from Strømnes 2006: 24).

The results were exceptionally clear, in support of the hypothesis.

- Aspects of the experiential domain TIME can be understood and structured through metaphorical mappings from the experiential domain SPACE. **McGlone** and **Harding** (1998) showed that if spatio-temporal metaphors differ, so does people’s thinking about time. English has two sets of spatio-temporal metaphors: one in which times are entities moving towards you and passing you, the other in which times are locations along a path and you are moving towards them. Accordingly, the sentence *Next Wednesday’s meeting has been advanced by two days* may mean either that the

meeting is to take place on Monday, or on Friday. McGlone and Harding primed subjects with either a time-moving or an ego-moving context and then asked them to interpret sentences like the one quoted above. The subjects very clearly tended to interpret such ambiguities in accord with the metaphor provided.

- **Boroditsky** (and collaborators) has by means of a series of experiments shown – among other things – that
 - “[s]patial metaphors can provide relational structure to those aspects of time where the structure may not be obvious from world experience” (Boroditsky 2001: 20; about Boroditsky 2000);
 - changing how people talk about time changes how they think about it:

English and Mandarin talk about time differently – English predominantly talks about time as if it were horizontal, while Mandarin also commonly describes time as vertical. This difference between the two languages is reflected in the way their speakers think about time ... In [an] experiment native English speakers were taught to talk about time using vertical spatial terms in a way similar to Mandarin. On a subsequent test, this group of English speakers showed the same bias to think about time vertically as was observed with Mandarin speakers (Boroditsky 2001: 1);
 - “it is not sensorimotor spatial experience per se that influences people’s thinking about time, but rather people’s representations of and thinking about their spatial experience” (Boroditsky/Ramscar 2002: 185);
 - “even the subtlest instantiation of a metaphor (via a single word) can have a powerful influence over how people attempt to solve ... problems ... and how they gather information to make ... decisions” (Thibodeau/Boroditsky 2011: 1). In five experiments “participants were presented with a survey that included a short paragraph about crime in the fictional city of Addison ... The survey ... always contrasted a crime-as-virus framing with a crime-as-beast framing” (ibid.: 3). It was found that different metaphorical frames created differences in opinion “that are larger, for example, than pre-existing differences in opinion between Democrats and Republicans” (ibid.: 1).
- Recently Franziska **Günther**, Hermann **Müller**, Hans-Jörg **Schmid**, and Thomas **Geyer** have shown that there are differences in the way English and German speakers conceptualise spatial scenes. The authors based their investigations on the fact that the English sentence

The bottle is **on the front right hand side** (on the table).

has two translations into German:

Die Flasche ist **auf der vorderen rechten Seite** (auf dem Tisch).

Die Flasche ist **vorne rechts** (auf dem Tisch).

They argue that expressions of the type found in the English sentence and the first of

the German ones are object-focused, while expressions of the type found in the latter of the German sentences are space-focused.

In a first investigation they found that German speakers generally prefer construing this type of spatial relation between entities in a space-focused manner, whereas English speakers do so in a more object-focused manner. In a follow-up experiment they found clear correlations between the observed differences in preferred linguistic construal and performances in related nonverbal tasks, testing perception and memory (Günther et al. 2012).

Summing up, we find that in recent decades it has been demonstrated clearly and irrefutably that differences in language structure – in astounding detail, cf. Günther et al. – may correlate with cross-linguistic differences in cognition, and, accordingly, that interdependencies exist between language structure and cognition. The structural categories include on the one hand case, prepositions, frame of reference, syntactical constructions for expressing spatial relations between entities (attribute vs. adverbial), gender – that is, categories mostly reflecting properties of the space for mental models and denoting operations in it, meaning, **how to view or experience, and operate on, entities, actions, events, etc.**, in the mental model space in the language in question. They also reflect the metaphorical structuring of the language, which likewise conveys a certain way of experiencing (the target domain).

As mentioned above, the theory of Strømnes, enriched by the theory of Lakoff and Johnson, implies and explains such findings. It is also able to provide us with an answer to the question: Which way does the influence go? That is, does difference in language structure create difference in cognition, or is it the other way around?

We all of us know how much behaviour and culture influence language, most obviously as regards pronunciation and lexicon. However, the conception of Strømnes (with Lakoff/Johnson) tells us that the influence goes the other way, too. According to this understanding the structure of a language, that is, its grammatical structure and metaphorical structuring, to a certain extent reflects the properties of the space for mental models of the language community in question – its dimensions, its orientation, its special way of highlighting, the kind of movements in it and the duration of the movements, its possible distinctions, relations, and operations, etc. Learning a language, with its structure, therefore means learning **a specific way of seeing, of experiencing, of structuring**; and this way of experiencing and structuring underlies and conditions perception. For, “the brain does not wield ‘absolute’ perception. [It] orders the messages from the sense organs according to a way of modelling that it has learnt. It perceives that which complies with the geometry it knows” (Strømnes 2006: 68).

And, as learning a language also implies learning to establish a mental model space in accord with the structure of the language in question, language structure by necessity also conditions thinking – as a process of building, by means of mental models, in a space for mental models. And thinking, of course, further conditions behaviour and cultural expressions.

And as mentioned earlier, this implication of the theory has been experimentally verified: Boroditsky (2001), and Thibodeau/Boroditsky (2011) demonstrated that changing an element of the language structure changes how people think.

This means, in short, that **different languages – with different structures – represent different neural programmes**, different “software”, for the cognition. The “hardware”, our physical equipment, is fixed genetically; the “software” is, to a great extent, given us and developed through the acquisition of our mother tongue.

It is hardly possible to think of a better argument for preserving and taking care of the various languages of the world: They represent different neural programmes for the cognition. We need them all.

And the structure of the language, that is, the detailed grammatical and metaphorical structure, is the key to these neural programmes.

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