WORDS, CATEGORIES, AND THE LANGUAGE-COGNITION INTERFACE

CUVINTE, CATEGORII SI RELAȚIA LIMBAJ-COGNIȚIE

(Rezumat)

Analizele empirice recente privind relația dintre limbaj și cogniție evidențiază efectele interlingvistice ale limbajului asupra unei game largi de sarcini cognitive, cum ar fi diferențele în percepția culorilor, categorizarea, conceptualizarea și reprezentarea formei, a mișcării, a spațiului și a timpului (Gleitman & Papafragou 2012; Boroditsky 2012). Descoperirile sugerează că o perspectivă lineară sau predictivă asupra procesului cognitiv nu explică în mod adecvat interacțiunea dintre limbaj și cogniție.

Vom examina descoperirile empirice ale efectelor induse de limbaj asupra conceptualizării relației spațio-temporale și cele induse de etichetarea (prin cuvinte) și de categorizarea (prin concepte) în ceea ce privește percepția. Aici susținem ipoteza interactivității, în pofida recentelor descoperiri privind procesarea lineară în sfera recunoașterii vizuale a cuvintelor (Whiting et al. 2014) și, de asemenea, vom discuta în termeni generali teoria lingvistică, în lumina ultimelor cercetări empirice.

Cuvinte-cheie: limbă, cogniție, etichetare, categorizare, percepție.

1. Introduction

Recent cognitive approaches to understanding what language is and how it works in the mind have found with increasing regularity that language plays a fundamental role interacting with, channeling and shaping categories of thought and other cognitive abilities (Gleitman & Papafragou 2012). Does, for example, the fact that the future lies *ahead* in English, but *below* in Mandarin and *behind* in Aymara (Casasanto 2008: 69) assume a different conceptual representation of the world, or a different way of organizing it?

Language-induced effects on cognition appear to be both lasting (see Boroditsky 2012) and transient (see Lupyan 2012a, b). A striking example of a lasting effect of language on cognition is noted by Boroditsky (2012:

618ff), who reports that five-year-old children that speak Kuuk Thaayorre (an Aboriginal language of Australia) can perform a cognitive task that adult academic audiences routinely fail at, namely, to close their eyes and point to the southeast. These children know absolute spatial reference at all times, regardless of their location or environment, presumably *because* their language uses cardinal direction terms vs. words like *left* and *right* to describe spatial relations (see also Haviland 1998). They also organize sequential events from east-to-west regardless of the direction they are facing (Boroditsky & Gaby 2010). This ability appears to constitute a "qualitatively different way of organizing the world" (2012: 620). What accounts for it if not the repeated use of language that has been internalized?

Another lasting effect of language on cognition is found in the domain of color perception. It is well established that Russian (or Greek or Korean) monolinguals see a color boundary within the color *blue* that English monolinguals do not (Winawer et al. 2007; see Imhoff 2015 for discussion). What determines this color boundary if not the language used during cognitive development?

Leaving aside developmental issues for the present, these findings relate to modularity, which is a central and controversial concern in cognitive inquiry. In a classical model of cognition (see, for example, Gleitman & Papafragou 2005), external percepts activate concepts, which then feed (forward) verbal labeling that "maps" words to concepts in a linear process. In contrast, a dynamic or interactive model of cognition examines whether cognitive modules are penetrable in a "top-down" or "down-regulated" direction by other cognitive processes, including the "higher order" cognitive activity that we commonly call language.

In what follows, I consider the domains of spatio-temporal referencing, of categorization and labeling in relation to perception, and of visual word recognition in support of top-down processing.

2. Spatio-Temporal Referencing

The concepts of space and time are connected in a great many languages, some would say universally. Neonates, for example, from zero to three days old appear to expect duration (and also number) to vary with distance in the same direction, either increasing or decreasing, but not in the opposite direction (De Hevia et al. 2014). If distance increases while duration decreases, for example, they distract. De Hevia et al. conclude that representations of space, time, and number are "systematically interrelated" (2014: 4809) when postnatal life begins. But to what extent is this interrelatedness symmetrical and why does it differ so significantly cross-linguistically?

Casasanto and Boroditsky (2008: 579ff) found that English monolinguals demonstrate a much greater cross-dimensional effect for distance on duration than for duration on distance. That is, although English speakers strongly prefer spatial metaphors to represent time, e.g. *They moved the truck/meeting forward*, they also use temporal metaphors, e.g. *I'm a few minutes (vs. blocks) from the library*. Across six experiments, the effect of distance on time was consistently and significantly greater than the effect of time on distance for English speakers, strongly suggesting an asymmetrical dependence, which is a predictable pattern that corresponds to the overwhelming preference for spatial vs. temporal metaphors in English (2008: 589-590). It seems that English speakers are unable to ignore irrelevant spatial information when making judgments about duration, but not the converse.

In contrast to English speakers, Greek monolinguals strongly prefer amount metaphors to express duration. What in English would be a *long* vacation is rendered roughly as one that lasts *much* ('*poli*') in Greek. Contrasting English and Greek monolinguals, Casasanto (2008) showed that English speakers correlated duration more accurately with distance, and that Greek speakers correlated duration more accurately with amounts (2008: 72). In his view, "language can also shape our basic, nonlinguistic perceptuomotor representations of time…. [B]ecause these [spatial] metaphors vary across languages, members of different language communities develop distinctive conceptual repertoires" (2008: 75ff). Crucially, after a training intervention was assigned to the English monolingual speakers, randomly for distance and amount, English speakers' estimates for amount interference were indistinguishable from Greek speakers, suggesting that linguistic metaphor can activate conceptual mapping transiently.

In a related experiment testing Mandarin and English monolinguals and bilinguals, Tzuyin Lai and Boroditsky (2013) found a preference for "ego-moving" representations in English monolinguals but "time-moving" representations in Mandarin monolinguals, e.g. *We are approaching the deadline* vs. *The deadline is approaching*. Bilinguals fell somewhere in the middle: They were more likely than Mandarin but less likely than English monolinguals to make ego-moving representations with time, suggesting that habits of metaphor use in one language can have a chronic effect on patterns in thought (2013: 1).

These representative studies indicate that spatio-temporal conceptualizations vary cross-linguistically in ways that appear to correspond to language use, suggesting a down-regulated effect from language onto cognition. The correspondence is not absolute, but the effects appear to be lasting and sometimes transient under different conditions.

3. Categorization and perception

Lupyan (2012b) examined the penetrability of early visual processing by conceptual information. Subjects performed physical-identity judgments on visually equidistant pairs of letters that were either in the same conceptual category (B-b) or in different categories (B-p), both simultaneously and sequentially. Response times were longer for nonidentical letters when the stimuli were from the same category (B-b), but only when the letters were presented sequentially (2012b: 682). This suggests that subjects were able to access categorical information because they were given more time -- from 150 to 600 ms to do so. Evidently, activating the concept "B" delayed subjects' ability to perceive the nonidentical B-b pair, but it had no effect on the perceived difference between nonidentical B-p or on the perception of identical B-B, etc. The authors conclude: "Performance on an explicitly visual task was influenced by conceptual categories as a function of processing time, which suggests that it was produced by the direct influence of category knowledge on perception, rather than by a postperceptual decision bias" (2012b: 682).

4. Verbal labels and perception

Verbal labels also appear to penetrate perception. With one-year-old infants, both familiar and novel verbal labels appear to facilitate object processing (Gliga et al. 2010). In adults, verbal labels have been shown to facilitate simple object detection (Lupyan & Spivey 2010; Lupyan & Swingley 2012), and to do so more quickly than nonverbal cues (Lupyan & Thompson-Schill 2012). It seems that hearing a verbal label causes the mind's eye to see something, or somehow focus on it, more quickly. Even when verbal cues are redundant, visual detection is heightened when it is cued explicitly (Lupyan & Spivey 2010).

In two behavioral experiments (see Figure 1; Lupyan 2012: 272ff) subjects viewed the numbers 2 and 5 presented in groups; they were instructed to press a button as soon as a small dot appeared next to one of the 5s -- crucially only the number five was targeted in experiment one. In a random 50% of the trials they heard the word *five* prior to display, and on those trials they responded more quickly and with greater accuracy. The result is striking when one considers that for the duration of the 45-minute test, participants knew that they were to attend to the number five, yet hearing the redundant word enhanced performance significantly.

In their second test, subjects were shown briefly flashed groups of 2s and 5s and were instructed to click on corresponding blank locations for either number immediately following the display. Again, when labels were heard randomly prior to display, performance was enhanced significantly, even when items were seen for only 100 ms, which is as fast as eye movement. Taken together, the results support the interpretation that facilitation of verbal labels occurs in parallel with visual display and suggests that words automatically activate visual properties (Lupyan 2012: 274).

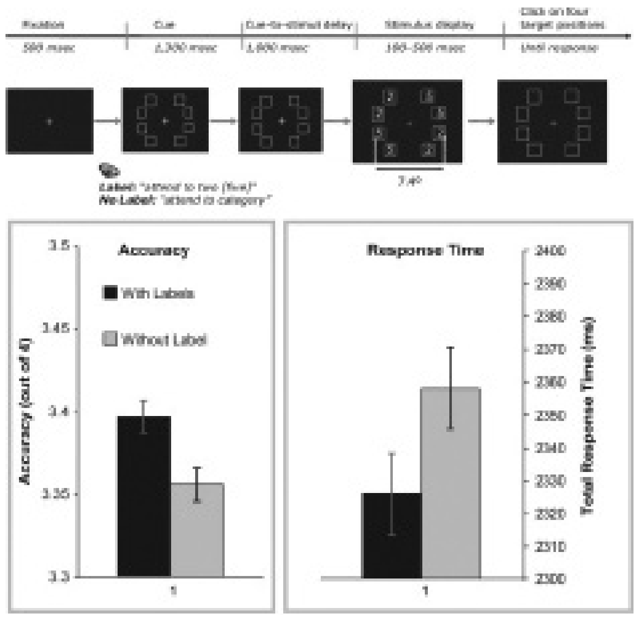

Figure 1: Object detection with/without (redundant) labels (Lupyan 2012: 273)

However, since object recognition entails higher-level processing, in some cases it can be argued that perception judgments may be affected by postperceptual semantic processing. That is, visual information takes 30 ms to reach the visual cortex, but object recognition (i.e. information processing) takes somewhere in the region of 100–400 ms, which allows: “ample time for multiple cortical interactions at all levels of the system” (Foxe & Simpson 2002: 145). Thus, in some cases it may be semantic priming rather than language that is affecting perception.

In order to rule out semantic priming, Lupyan and Ward (2013: 14197ff) examined interocular rivalry with Continuous Flash Suppression (CFS) to suppress explicit visual awareness and, therefore, semantic processing, on the assumption that if something is blocked from vision, semantic priming is also blocked. Measuring hit rates, false alarms, and reaction times for valid, invalid and absent trials, while verbal cues were heard randomly, they found that hearing a label helped subjects become aware of objects that were suppressed from visual awareness (14199). They conclude: “facilitated detection of invisible objects due to language occurs at a perceptual rather than semantic locus; … when information associated with verbal labels matches stimulus-driven activity, language can provide a boost to perception, propelling an otherwise invisible image into awareness” (14196).

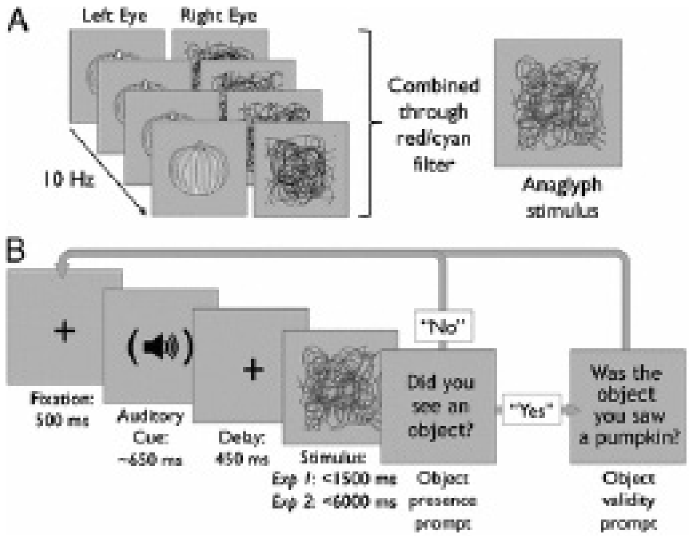

Figure 2: (A) Stimulus creation using CFS; (B) Basic procedure of experiments (Lupyan & Ward 2013: 14197)

Here we see that categorization and auditory labels exert top-down effects on perception. These and similar studies call into question the modularity of visual perception and suggest, rather, that visual representations are penetrable by factors outside of vision. They support a broader view that perceptual modules adapt at evolutionary, lifelong, and moment-to-moment temporal scales: "In classic conceptions of perceptual modules, people have access to the modules' outputs but no ability to adjust their internal workings. However, humans routinely and strategically alter their perceptual systems via training regimes that have predictable and specific outcomes" (Goldstone et al. 2014: 24).

5. Visual word recognition

One recent study in support of feedforward visual processing (Whiting et al. 2014) deserves special attention in this context. It is to my knowledge the most comprehensive study of word-level processing to date in that it considers morphologically complex and pseudo-complex stems, affixes, words and pseudowords using electrophysiological (MEG) and neuroimaging (fMRI), and independent behavioral (masked priming) evidence.

Previous findings (see Whiting et al. 2014: 246–247) have pointed to an automatic process of morphological decomposition underlying lexical access whereby words like corner, which is not based on corn, are processed morphologically like farmer, hunter, baker, etc., all of which are based on their respective semantic stems (farm, etc.). Other words with potential stems, like scandal, however, are not processed in that way; that is, although scan is a potential stem for scandal, the fact that dal is not a grammatical morpheme seems to block the decomposition of scandal.

With this insight in mind, the authors examined where and when neural activity was triggered while subjects read words in isolation. Contrasting morphologically complex stimuli of the kind seen in Table 1, they found feedforward processing of orthographic analysis (150-230 ms; bilateral posterior temporal regions) and segmentation into linguistic substrings triggering lexical access (from 300 ms; left middle temporal locations), followed by lexical constraints in both simple and complex words (from 390 ms) with increased processing, thus mapping out the real-time functional architecture of visual word recognition (Whiting et al. 2014: 246).

Table 1. Experimental Conditions and Example of Stimuli (reproduced from Whiting et al. 2014: 248)

Condition	Example	Stem/ Affix	Semantic Relatedness	Stem Form
Derived				
Transparent	*farmer*	+S+A	+Sem	*farm*
Pseudo-der.	*corner*	+S+A	-Sem	*corn*
Pseudo-affix	*blemish*	-S+A	n/a	*blem*
Inflected				
Transparent	*blinked*	+S+A	+Sem	*blink*
Pseudo-infl.	*ashed*	+S+A	-Sem	*ashed*
Non-affixed				
Pseudo-stem	*scandal*	+S-A	-Sem	*scan*
No stem/affix	*biscuit*	-S-A	n/a	*bisc*
Pseudoword				
Derived	*frumish*	-S+A	n/a	*frum*
Inflected	*bected*	-S+A	n/a	*bect*

S = Stem; A = affix

The crucial differences involved derivationally and inflectionally complex words like corner and ashed, which showed decompositional effects, and words like scandal and biscuit that did not: “The finding that these early processes do not discriminate between genuinely complex and pseudo-complex strings demonstrates that the processes generating candidates for lexical access and recognition are blind to the lexical properties of the strings they are generating" (Whiting et al. 2014: 259). Thus, basic feedforward processing obtains for orthographic form, morphological structure, and lexical meaning with non-contextual visual word recognition (2014: 246).

However, the authors concede that other cognitive tasks, such as reading continuous text, may involve top-down effects, opining that these affects: "would serve to modulate the performance of the basic feedforward process we have described, not to replace it" (2014: 262). This point is crucial. For far from undermining an interactive model of cognition, it is precisely what interactive models claim, namely, that language can and at times does serve as an online modulator of cognition. Interactivity does not preclude feedforward cognition; rather, it questions its exclusivity in a model of cognition. The extent to which feedforward processing underlies or precedes top-down processing in real-world language is a matter for further empirical investigation.

6. Conclusion

Recent empirical work in language and cognition supports the view that some of the ways we perceive, conceptualize and interpret the world are derived from the development and use of environmental language. That language-induced effects on cognition are lasting, I would argue, is consistent with developmental theory in evolutionary genetics. Phenotype plasticity, or gene-environment interaction, by definition accepts that environmental factors affect the expression of genetically coded information (Gilbert & Epel 2009). Nutrition, for example, affects how genetically coded information for height, or any number of other features or abilities, comes to be expressed. We assert here that externalized language use is environmental in a developmental context, insofar as a child needs a "daily dose" of language for proper cognitive development. It would follow that perception, mental representations and other cognitive activity would be shaped by language use and would differ cross culturally, as they clearly do.

This view does not disavow an internalist approach to language. Rather, it emphasizes the role of environmental language on phenotype expression of cognitive capacities in the developmental context. The phenotypic expression of whatever genetically endowed language and cognitive capacity that an individual carries will be affected, in part, by the ways in which language is used in its environment during development. I would argue that language-induced effects on cognitive activity, whether lasting or transient, need to be accounted for in any theoretical account or model of language and cognition.

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