

# Lexical Activations in Picture Comparison: A Cross-linguistic Approach to the Relation between Language and Thought in the Mental Lexicon

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## Abstract

Given that word translation equivalents in different languages can give rise to different word structures which can cause different shades of meaning, this study investigates whether such cross-linguistic differences influence how speakers of different languages compare two objects. Picture comparison tasks revealed that speakers of Japanese and English utilize distinct cognitive processes when asked to evaluate how similar two objects are, influenced by various lexical properties of the word translation equivalents of the names for the objects in each language. This result provides partial support for the Linguistic Relativity Hypothesis, which holds that the language speakers are exposed to influences their conception of reality, a hypothesis which allows us to explore empirically the relationship between language and thought in the mental lexicon.

The Linguistic Relativity Hypothesis, which holds that the specific language that people are normally exposed to influences their conceptualization of the world (Whorf, 1956), has attracted cognitive scientists for the last half century mainly as a means to study what thought is and how strongly non-linguistic cognition is influenced by language (Boroditsky, 2003; Pinker, 1994; Vygotsky, 1986). From a psycholinguistic perspective, this study explores what lexical properties contribute to a picture comparison task and discusses how the traditional dichotomy between language and thought can be interpreted within the mental lexicon. With regard to language processing tasks, the fundamental nature of the mental lexicon is to maximize opportunities by redundant activations of lexical items (Libben, 2006). However, psycholinguists have not tended to focus on whether the mental lexicon is involved in non-linguistic tasks as well and, if so, which properties

of lexical items actually contribute to non-linguistic cognitive processing.

Different languages use different words to express the same concepts, and cross language differences in word structure might reflect slight but perhaps significant differences in meaning. Many studies on language and thought suggest that different language groups behave differently in various non-linguistic tasks (Winawer et al., 2007; Baayen & Boroditsky, 2004; Majid et al., 2004; Lucy, 1992). Following this line of research, the present study investigated whether a task to compare and rate the degree of similarity between two pictorial objects involves language-specific cognitive processing. Baayen and Boroditsky (in press) conducted a picture comparison task to explore whether language-specific morphological structures in Dutch and English (e.g. the related Dutch *vrachtwagen* and *kinderwagen* compared to their unrelated English translation equivalents *truck* and *stroller*) influences how people perceive the same line-drawn objects and what lexical properties contribute to this picture comparison process. Their study revealed that the degree of judged picture relatedness is influenced by the morphological structure of the words used to describe the drawings in the two languages.

## Picture Comparison Task

To investigate the cross-linguistic applicability of their research, the present study compared the behaviour of Japanese and English speakers in picture comparison tasks. The primary questions addressed in this study were (1) whether differences in conceptual familiarity enhanced perceived picture similarity and (2) whether

pictorial objects that have single word representations give rise to greater picture similarity ratings.

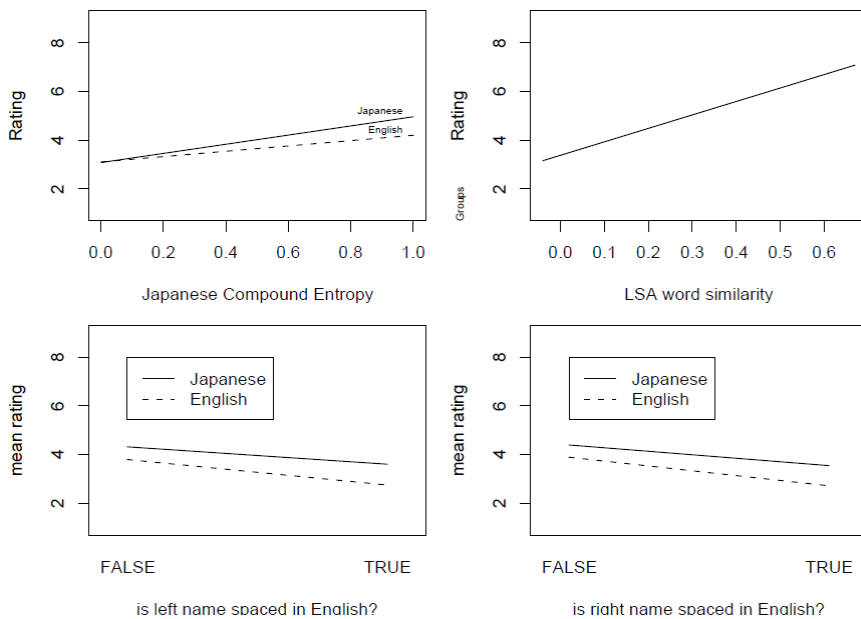


Figure 1: Significant predictors and interactions in picture comparison tasks

*Note:* The bottom two graphs show the effects of English names for the objects depicted: Whether they contain one (=FALSE) or two words (=TRUE). The names were always two-character compounds in Japanese. Monomorphemic words were grouped together with non-spaced compounds.

## Method

**Participants** Twenty native speakers of Japanese and twenty native speakers of English were recruited at the University of Alberta and in neighboring cities. Each participant was compensated at a rate of \$10 Canadian for a thirty-minute session.

**Materials** Sixty pairs of photographs of objects were prepared. All the depicted objects were describable as two-character compounds in Japanese, and forty of the pairs shared a constituent in Japanese, but not in their English translation equivalents. Among these linguistically related pairs, twenty object pairs shared the first *modifier* constituent of compounds in Japanese, but not in English (shared modifier condition: e.g. *hana-bi* ‘firework’ and *hana-tabu* ‘bouquet’). Another twenty object pairs shared the second *head* constituent in the Japanese compounds but were not morphologically related in English at all (e.g. *senro* ‘railroad’ and *mero* ‘maze’). The remaining twenty object pairs shared no linguistic element in either Japanese or English.

**Procedure** In each trial, a pair of two pictorial objects was presented side-by-side on a computer screen with a nine-point relatedness scale underneath. Participants were asked to compare the simultaneously presented picture pairs and decide how similar the two objects were by clicking an appropriate point on the relatedness scale (from ●▲ = *very different* to ●● = *very similar*).

## Results

In a mixed effect linear regression analysis, as shown in Figure 1, four predictors were found to contribute significantly to the relatedness ratings. LSA word similarity (co-occurrence values between the left and right pictures' English word equivalents) had the same facilitatory effect on both groups ( $p=0.0002$ ). This measure taps into general shared conceptual similarity across Japanese and English speakers. Japanese compound entropy (Shannon's entropy calculated for the probability distribution of frequency counts of the left and right pictures' word translation equivalents) was a significant facilitatory predictor for the Japanese group, but not for the English group ( $p=0.0001$ ). This suggests that language-specific familiarity with two-character compounds codetermined the ratings. English compound spacing (whether English word translation equivalents have a space between the two constituents of a compound or not or whether the object pairs were lexicalized by simplex words) interacted significantly with groups ( $p=0.02$ ), and pictorial objects that have single word representations gave rise to greater picture similarity ratings.

## Discussion

During the supposedly non-linguistic picture comparison tasks, certain lexical properties contributed to speakers' judgments of picture relatedness. The effects of frequency-based predictors, English LSA word similarity, and Japanese compound entropy were large. Such robust involvement of frequency-based predictors in a non-linguistic task reassures us that the locus

of word frequency effects is in the semantic/conceptual domain, rather than just the perceptual domain, and that these effects reflect the degree of entrenchment of concepts as conceptual familiarity (Baayen, Feldman, & Schreuder, 2006). Unlike the effects of LSA word similarity and Japanese compound entropy, the effect of orthographic spacing in the compound was tiny. Nevertheless, all were significant in a linear mixed effect model with subject and picture pair as crossed random effects. That the effect was small was expected, since the speakers in the two groups had many more commonalities than differences. In line with previous studies, the present study saw subtle differences reflecting how language experience affects non-linguistic cognition. The study thus provides some support to the Linguistic Relativity Hypothesis when the relationship between language and thought is scrutinized across items in speakers of different languages' mental lexicons.

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## References

- Baayen, R. H. & Boroditsky, L. (2004, October). *Effects of lexical structure on picture comparison*. Presented at Conceptual Structure, Discourse, & Language. Edmonton, Canada.
- Baayen, R. H., Feldman, L. B., & Schreuder, R. S. (2006). Morphological influences on the recognition of monosyllabic monomorphemic words. *Journal of Memory and Language*, 55, 290-313.
- Boroditsky, L. (2003). Linguistic Relativity. In Nadel, L. (Ed.) *Encyclopedia of Cognitive Science* (pp. 917-921). London: MacMillan.
- Libben, G. (2006). Why study compound processing? An overview of the issues. In G. Libben & G. Jarema (Eds.), *The representation*

- and processing of compound words* (pp. 1-22).  
New York: Oxford University Press.
- Lucy, J. A. (1992). *Grammatical categories and cognition: A case study of the linguistic relativity hypothesis*. New York: CUP.
- Majid, A., Bowerman, M., Kita, S., Haun, B. M. D., & Levinson, C. S. (2004). Can language restructure cognition? The case for space. *TRENDS in Cognitive Sciences*, 8 (3), 108-114.
- Pinker, S. (1994). *The language instinct*. New York: William Morrow.
- Vygotsky, L. (1986). *Thought and language*. (E. Haufmann & G. Vakar. Trans.). Cambridge, MA: MIT Press. (Original work published 1934)
- Whorf, B. L. (1956). Science and linguistics. In J. B. Carroll (Ed.). *Language, thought and reality: Selected writings of Benjamin Lee Whorf*. Cambridge, MA: MIT Press.
- Winawer, J., Witthoft, N., Frank, M. C., Wu, L., Wade, A. R., & Boroditsky, L. (2007). *Russian blues reveal effects of language on color discrimination*. In Proceedings of PNAS.