TESTING THE 'ROUNDNESS' AND 'SHARPNESS' OF NONWORDS AND SHAPES IN GREAT APES.

Konstantina Margiotoudi[*1] and Friedemann Pulvermüller [2,3,4]

[*]Corresponding Author: konstantina.margiotoudi@univ.amu.fr
[1]Laboratoire de Psychologie Cognitive, Aix-Marseille University, CNRS, Marseille, France
[2]Brain Language Laboratory, Department of Philosophy and Humanities, Freie Universität, Berlin, Germany
[3]Berlin School of Mind and Brain, Humboldt Universität, Berlin, Germany
[4]Einstein Center of Neurosciences, Berlin, Germany

Although sound symbolic effects of 'bouba-kiki' type have been reported across cultures (Ćwiek et al., 2022), it remains unclear whether this effect is an ability unique to humans. Sound symbolic effects between speech sounds and shapes (Köhler, 1919) might have played an important role in shaping protolanguages. Humans could have understood that certain speech sounds can evoke certain sensory properties. This ability could have plausibly assisted referential insight in our human ancestors (Perniss and Vigliocco, 2014). The discussion on the role of sound symbolism in shaping human languages gives rise to the following question: "Can nonhuman great apes detect congruencies between 'round' and 'sharp' nonwords and curved and sharp shapes?". Previous research has shown that a group of touchscreen trained chimpanzees (N=6) and gorillas (N=2), when tested with a two-alternative forced choice task on sound-shape mappings showed no sound symbolic effects (Margiotoudi et al., 2019). Specifically, both gorillas and chimpanzees failed to detect that a 'round' nonword, such as "bouba", is a good fit to a curved shape and a 'sharp' nonword, such as "kiki", is a good fit to a spiky shape. In parallel, humans were tested with the same task and showed a significant sound symbolic congruency. In both tasks, neither the nonhuman nor the human great apes were explicitly instructed to detect congruencies between nonwords and shapes. Notably, when a second group of human participants were explicitly instructed to detect sound symbolic congruencies in the same task, they

showed above chance performance and detected congruencies 10% more often compared to the previous implicit task. Conclusively, when humans are explicitly instructed to detect sound symbolic congruencies, they achieve a better performance. However, humans are exposed to speech stimuli compared to nonhuman great apes and have referential insight. Could a nonhuman great ape exposed to speech stimuli detect speech sound-shape consistencies? In a different study, a language competent bonobo was tested with a match-to-sample task on the 'bouba-kiki' effect. The bonobo has been able to match English words to pictures with the same task. Hence, he tries to pick the best match from different stimuli. Using his strategy, a second study investigated whether a nonhuman great ape being exposed to speech stimuli would be able to detect sound symbolic congruencies under an explicit match-to-sample task. Specifically, the bonobo performed his familiar match English words to pictures task, while sound symbolic trials of "bouba-kiki" type were interspersed. This kind of paradigm allowed testing a nonhuman primate under explicit instructions. The bonobo tried to guess the best matching shape for the 'round' and 'sharp' nonwords as he did for the English word-picture matching. The results of the study revealed no sound symbolic congruency detection but significantly above chance performance in matching English words to pictures (Margiotoudi et al., 2022).

These findings suggest that the 'bouba-kiki' mapping is plausibly an ability unique to humans. These results might be explained by neurobiological differences found between human and nonhuman great apes that are relevant to the mechanism supporting the speech sounds-shape mappings. We suggest that the mechanism of this effect is found in the knowledge of the multimodal products of our hand actions. This binding has special preconditions found at a neuronal level, with auditory-visual and motor systems linked in the brain via long white matter tracts.

References

Ćwiek, A., Fuchs, S., Draxler, C., Asu, E. L., Dediu, D., Hiovain, K., ... & Winter, B. (2022). The bouba/kiki effect is robust across cultures and writing systems. *Philosophical Transactions of the Royal Society B*, *377*(1841), 20200390.

Köhler W. 1929 Gestalt psychology. New York, NY: Liveright.

Margiotoudi, K., Allritz, M., Bohn, M., & Pulvermüller, F. (2019). Sound symbolic congruency detection in humans but not in great apes. *Scientific reports*, *9*(1), 1-12.

Margiotoudi, K., Bohn, M., Schwob, N., Taglialatela, J., Pulvermüller, F., Epping, A., ... & Allritz, M. (2022). Bo-NO-bouba-kiki: picture-word

mapping but no spontaneous sound symbolic speech-shape mapping in a language trained bonobo. *Proceedings of the Royal Society B, 289*(1968), 20211717.

Perniss, P., Thompson, R., & Vigliocco, G. (2010). Iconicity as a general property of language: evidence from spoken and signed languages. *Frontiers in psychology*, *1*, 227.