

RE-EVALUATING HOCKETT'S DESIGN FEATURES FROM A COGNITIVE AND NEUROSCIENCE PERSPECTIVE: THE CASE OF DISPLACEMENT

MICHAEL PLEYER^{*1,2} and ELIZABETH QING ZHANG^{1,2}

^{*}Corresponding Author: pleyer@umk.pl

¹Center for Language Evolution Studies, Nicolaus Copernicus University in Toruń, Toruń, Poland

² University Center of Excellence IMSErt - Interacting Minds, Societies, Environments, Nicolaus Copernicus University in Toruń, Toruń, Poland

Hockett's Design features of language (e.g. Hockett, 1960; 1963) have proven highly influential within the field of linguistics in describing the differences between human language and animal communication. However, they have not remained without criticism over the many years since their inception. In particular, although frequently mentioned, they have "generally failed to motivate theoretical discussion or empirical tests" (Hauser, 1996: 47) in animal communication research. Focusing on language evolution, Wacewicz & Żywicki (2015) have argued that the design feature approach does not pay enough attention to the actual cognitive capacities underlying these features and the ecological and social settings in which they are used.

Despite these criticisms, Hockett's design features are still frequently appealed to by linguists. Here we argue that if linguistics wants to continue using them, this needs to be complemented by a decompositional approach that explicates a given design feature with regard to the cognitive and neuroscientific component parts that underlie the feature. Only by re-evaluating Hockett's design features from a cognitive and neuroscience perspective can linguistics be brought into a productive dialogue with animal communication research and language evolution research. Our proposal follows that of Wacewicz & Żywicki (2015) but extends it by adding a neuroscientific perspective where all of Hockett's design features are decomposed in a systematic fashion.

We illustrate this approach by focusing on the property of displacement, which suggests that, instead of being specific to human language, displacement is evolutionarily continuous. Displacement in language depends on episodic

memory, which has been detected in nonhuman animals, and is supported by an ancient subcortical region—the hippocampus. This has important implications for an overall re-evaluation of Hockett's design features.

Displacement describes linguistic messages referring to events remote in both time and space (Hockett, 1963). Episodic memory, which enables one to revisit the past and imagine the future (Tulving, 2001), is necessary to achieve displacement. Comparative evidence reveals that although it might be rare, neither displacement nor episodic memory are unique to humans. As Hockett (1963) observes, the waggle dance of honeybees is always displaced (Root-Bernstein, 2010). In addition, chimpanzees have been shown to communicate about objects that are absent or displaced (Lyn et al. 2014; Bohn et al. 2015). Regarding episodic memory, “what-where-when” has been taken as a reference for identifying episodic-like memory in nonhuman animals. For example, food caching birds, rodents, and nonhuman primates have been shown to be able to accomplish episodic-like memory tasks (Clayton & Dickinson, 2010).

Neurological studies reveal that the hippocampus could play a key role in displacement. In humans, the hippocampus has been shown to be involved not only in episodic memory, but also in encoding spatial and temporal information (Howard & Eichenbaum, 2015). It is also assumed to store when, where and what information (Tsao et al., 2018). In birds, the behavior of food-caching engages the hippocampus. For instance, Black-capped chickadees and dark-eyed juncos whose hippocampus is lesioned exhibit memory impairment for location, which is a crucial part for food-caching (Colombo & Broadbent, 2000). It has also been reported that the seasonal change in hippocampal size is correlated with seasonal change in caching food in food-storing birds (Sherry & Hoshooley, 2010). In rodents, different subregions of the hippocampus are involved in subcomponents of episodic memory like recognition, temporal order and spatial memories (Aggleton & Pearce, 2001). The hippocampus has been shown to take part in object recognition and time delay between sample and test sessions (Cohen & Stackman, 2015). Specifically, the dorsal part is critical for temporal information processing, and the ventral part is crucial for temporal order of the spatial information (Hoge & Kesner, 2007; Howland et al., 2008). In nonhuman primates, the what-where association has been investigated by recording single neurons in macaques, and the results showed that the hippocampus is involved in separation and combination of representations of objects and the places where they are located (Roll et al., 2005). Zola et al. (2000) also found that hippocampal lesions affected object recognition memory.

As the case of displacement shows, a cognitively and neuroscientifically informed re-evaluation of Hockett's design features therefore offers the potential of turning them into a useful analytical device for comparisons of human language and animal communication.

References

- Aggleton, J. P., & Pearce, J. M. (2001). Neural systems underlying episodic memory: Insights from animal research. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 356(1413), 1467–1482.
- Bohn, M., Call, J., & Tomasello, M. (2015). Communication about absent entities in great apes and human infants. *Cognition*, 145, 63–72.
- Clayton, N.S., & Dickinson, A. (2010). Mental Time Travel: Can Animals Recall the Past and Plan for the Future? In *Encyclopedia of Animal Behavior* (pp. 438–442). Elsevier.
- Cohen, S. J., & Stackman, R. W. (2015). Assessing rodent hippocampal involvement in the novel object recognition task. A review. *Behavioural Brain Research*, 285, 105–117.
- Colombo, M., & Broadbent, N. (2000). Is the avian hippocampus a functional homologue of the mammalian hippocampus? *Neuroscience and Biobehavioral Reviews*, 24(4), 465–484.
- Hockett, C. D. (1960). The origin of speech. *Scientific American*, 203, 88–111.
- Hockett, C.F. (1963). The problem of universals in language. In J. H. Greenberg (Ed.), *Universals in language* (pp. 1–22). MIT Press
- Hoge, J., & Kesner, R. P. (2007). Role of CA3 and CA1 subregions of the dorsal hippocampus on temporal processing of objects. *Neurobiology of Learning and Memory*, 88(2), 225–231.
- Howard, M. W., & Eichenbaum, H. (2015). Time and space in the hippocampus. *Brain research*, 1621, 345–354.
- Howland, J. G., Harrison, R. A., Hannesson, D. K., & Phillips, A. G. (2008). Ventral hippocampal involvement in temporal order, but not recognition, memory for spatial information. *Hippocampus*, 18(3), 251–257.
- Lyn, H., Russell, J. L., Leavens, D. A., Bard, K. A., Boysen, S. T., Schaeffer, J. A., & Hopkins, W. D. (2014). Apes communicate about absent and displaced objects: methodology matters. *Animal Cognition*, 17(1), 85–94.
- Rolls, E. T., Xiang, J., & Franco, L. (2005). Object, space, and object-space representations in the primate hippocampus. *Journal of Neurophysiology*, 94(1), 833–844.
- Root-Bernstein, M. (2010). Displacement activities during the honeybee transition from waggle dance to foraging. *Animal Behaviour*, 79(4), 935–938.
- Sherry, D. F., & Hoshoooley, J. S. (2010). Seasonal hippocampal plasticity in food-storing birds. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365(1542), 933–943.
- Tsao, A., Sugar, J., Lu, L., Wang, C., Knierim, J. J., Moser, M. B., & Moser, E. I. (2018). Integrating time from experience in the lateral entorhinal cortex. *Nature*, 561(7721), 57–62.
- Tulving, E. (2001). Episodic memory and common sense: How far apart? *Philosophical Transactions of the Royal Society B: Biological Sciences*, 356(1413), 1505–1515.

- Wacewicz, S., & Żywiczyński, P. (2015). Language evolution: why Hockett's design features are a non-starter. *Biosemiotics*, 8(1), 29-46.
- Zola, S. M., Squire, L. R., Teng, E., Stefanacci, L., Buffalo, E. A., & Clark, R. E. (2000). Impaired recognition memory in monkeys after damage limited to the hippocampal region. *Journal of Neuroscience*, 20(1), 451–463.