HOW SELF-DOMESTICATION AND PROSOCIALITY MAY SHAPE CROSS-MODAL LANGUAGE

KEES SOMMER*[1,2], CHRISTINE CUSKLEY[3], SIMON KIRBY[4] and TESSA VERHOEF[2]

*Corresponding Author: k.sommer@hhs.nl
[1]IT & Design, The Hague University of Applied Sciences, The Hague, Netherlands
[2]Leiden Institute for Advanced Computer Science, Leiden University, Leiden, Netherlands
[3]Center for Behaviour and Evolution, Newcastle University, Newcastle, UK
[4]Center for Language Evolution, University of Edinburgh, Edinburgh, UK

An emerging literature in language evolution has highlighted the key role of self-domestication, with at least two crucial features for language evolving in other species through domestication: vocal learning in birds and the recognition of communicative intent in dogs (Thomas & Kirby, 2018). Selection for less aggressive individuals is also associated with the appearance of higher prosociality, and closely linked to increased levels of serotonin and other 'bonding' neurochemicals (Hare, 2017). Interestingly, substances that interact with such neurochemicals can heighten integration of the senses (synesthesia) in humans (Brang & Ramachandran, 2008; Luke & Terhune, 2013). Both synesthesia and the related phenomenon of shared cross-modal mappings may have played a key role in the early evolution of language (Bankieris & Simner, 2015; Cuskley & Kirby, 2013; Imai & Kita, 2014) as a way to bootstrap shared linguistic form-meaning mappings. The current paper links self-domestication and cross-modality, using a task intended to enhance participants' prosociality and measuring their sensitivity to linguistic cross-modal associations.

A total of 62 participants were recruited at the University of Edinburgh and paid £5. Half of the participants performed a social clapping task with the experimenter using a composed rhythm, aimed at stimulating prosociality: synchronising through a rhythm has been shown to increase prosociality in individuals (Kirschner & Tomasello, 2010; von Zimmermann et al., 2018). The remaining participants completed an asocial clapping task, using a random rhythm with the computer. Participants in both groups then performed a task designed to test their cross-modal sensitivity to linguistic stimuli, where pre-recorded pseudowords had to be matched with a shape that could be manipulated in size and weight through a circular slider (see figure 1). The pseudowords were designed based on previously found strong associative reactions between consonant voicing and visual weight, and vowel openness and visual size (Schmidtke, Conrad, & Jacobs, 2014; Cuskley, 2013), and were therefore distinctive for both these features, as well as place of articulation (bilabial vs alveolar) to create more variation in the data. This created a total of 8 pseudowords: /ipi/, /ibi/, /iti/, /idi/, /apa/, /aba/, /ata/, and /ada/. Lastly, all participants were asked to answer an open question, where word count was used as a prosociality measure (Baumsteiger & Siegel, 2019).

Figure 1. Cross-modal interface. Left to right: Slider at initial position, at largest position and at smallest position.

Since size and weight were simultaneously adjusted with one slider, we refer to size for the shape produced. Pseudowords were grouped into 4 types (ordered): 1: *closed-voiceless*, 2: *closed-voiced*, 3: *open-voiceless*, 4: *open-voiced*, since participants were expected to map closed vowels and voiceless consonants with smaller sizes, where openness was expected to have a stronger effect, and no strong relationship between size and place of articulation was expected. Size in relation to condition, word type and prosociality was analyzed using linear mixed-effects models with maximum likelihood estimation (P-values calculated using the Satterthwaite's method). Sizes produced for word types followed the expected cross-modal pattern (1<2<3<4). Shape sizes were significantly larger for *open-voiceless* than for *closed-voiceless* (*b* = 0.97 ± 0.28 SEM, P <0.001) and for *open-voiced* items relative to *closed-voiceless* items (*b* = 1.02 ± 0.28 SEM, P <0.001). This also interacted with task final measures of prosociality: participants with a higher prosociality score had even larger shapes for both *open-voiceless* (*b* = 0.39 ± 0.18 SEM, P = 0.03) and *open-voiced* words (*b* = 0.40 ± 0.18 SEM, P = 0.03) relative to *closed-voiceless* items, suggesting a link between prosociality and cross-modal associations. However, the effect of the clapping task is less clear: social clapping only affected *open-voiceless* items, actually dampening associations relative to asocial clapping (*b* = -0.36 ± 0.15 SEM, P = 0.02). Differences between the social and asocial clapping tasks may not have been sufficient, since both involved rhythmic coordination. Since the clapping task did not measurably influence cross-modal sensitivity but prosociality did, perhaps the effect relates more strongly to more stable neurochemical interactions. For example, while mu-opioids are more sensitive to prosocial manipulations (Manninen et al., 2017), serotonin is much more stable (Mitchell, 2006). Future work in this direction could take this into account.

Overall, this experiment presents an initial exploration of a role for prosociality in mechanisms facilitating intuitive meaning sharing. This could potentially open up new comparative and experimental research directions in the context of self-domestication.

References

Bankieris, K., & Simner, J. (2015). What is the link between synaesthesia and sound symbolism? *Cognition, 136*, 186-195.

Baumsteiger, R., & Siegel, J. T. (2019). Measuring prosociality: The development of a prosocial behavioral intentions scale. *Journal of personality assessment*, *101*(3), 305-314.

Brang, D., & Ramachandran, V. S. (2008). Psychopharmacology of synesthesia; the role of serotonin S2a receptor activation. *Medical hypotheses*, *70*(4), 903-904.

Cuskley, C. (2013). Mappings between linguistic sound and motion. *Public Journal of Semiotics*, 5(1), 39-62.

Cuskley, C. and Kirby, S. (2013). Synaesthesia, cross-modality and language evolution. In: Simner, J. and Hubbard E.M. (Eds) Oxford Handbook of Synaesthesia, pp. 869-907.

Hare, B. (2017). Survival of the friendliest: Homo sapiens evolved via selection for prosociality. *Annual review of psychology*, *68*, 155-186.

Imai, M., & Kita, S. (2014). The sound symbolism bootstrapping hypothesis for language acquisition and language evolution. *Philosophical transactions of the Royal Society B: Biological sciences*, *369*(1651), 20130298.

Kirschner, S., & Tomasello, M. (2010). Joint music making promotes prosocial behavior in 4-year-old children. *Evolution and Human Behavior*, *31*(5), 354-364.

Launay, J., Tarr, B., & Dunbar, R. I. (2016). Synchrony as an adaptive mechanism for large-scale human social bonding. *Ethology*, *122*(10), 779-789.

Luke, D., & Terhune, D. B. (2013). The induction of synaesthesia with chemical agents: a systematic review. *Frontiers in psychology*, *4*, 753:1-12.

Manninen, S., Tuominen, L., Dunbar, R. I., Karjalainen, T., Hirvonen, J., Arponen, E. & Nummenmaa, L. (2017). Social laughter triggers endogenous opioid release in humans. *Journal of Neuroscience*, *37*(25), 6125-6131.

Mitchell, A. J. (2006). Two-week delay in onset of action of antidepressants: new evidence. *The British Journal of Psychiatry*, *188*(2), 105-106.

Schmidtke, D., Conrad, M., & Jacobs, A. M. (2014). Phonological iconicity. *Frontiers in psychology*,*5*,80.

Thomas, J., & Kirby, S. (2018). Self-domestication and the evolution of language. *Biology & philosophy*, *33*(1), 1-30.

von Zimmermann, J., Vicary, S., Sperling, M., Orgs, G., & Richardson, D. C. (2018). The choreography of group affiliation. *Topics in Cognitive Science*, *10*(1), 80-94.