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Proceedings of the Annual Meeting of the Cognitive Science Society

Title

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Permalink

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Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 41(0)

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Publication Date

2019

Peer reviewed

Investigating bidirectionality of associations in young infants as an approach to the symbolic system

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Abstract

Symbolic associations in human children and adults are based on forming equivalence classes which include three main relations between the tokens. 1) $A = A$ (Reflexivity), if 2) $A \sim B$ and $B \sim C$ then $A \sim C$ (Transitivity) and 3) if $A \sim B$ then $B \sim A$ or Symmetry (1). Extensive studies on non-human primates have demonstrated success in Reflexivity and Transitivity in several species but a consistent failure in Symmetry in any given association. Comprehension of symmetry of an association can be a key contribution to linking abstract words to their corresponding tokens and later on in coupling writing forms of words to their spoken form (2). However to our knowledge it hasnt been investigated whether infants are capable of spontaneously reversing the direction of an association to any extent. In two EEG studies we investigated if 4.5-month-old infants are capable of applying symmetry in the context of word-learning.

In the first study we trained 2 groups of 25 infants, to two pairs of word-categories (bird or vehicle). At each trial infants were presented with a word and an image. The critical consideration was to introduce a 1 s of SOA between the two stimuli. In one group infants were trained on words always preceding the images (Word-Image group) and in the other group infants were trained on the opposite direction (Image-Word group). In the test blocks 70% of trials were as in the training and the other 30% were either with the incongruent trials in the original direction or the congruent and incongruent trials in the reversed direction. We observed significant cluster of electrodes, mainly in the right temporal, in both the trained and reversed directions while contrasting the congruent and incongruent conditions, with the word-image group showing a stronger effect.

In a 2nd experiment, designed as a comparative study between infants, adult humans and adult macaques, we sought to train each participant on 4 pairs of word-images, 2 pairs following a word-image direction and the other 2 an image-word direction, with a 1s SOA between the two stimuli similar to experiment 1. In this experiment the infants attended the training phase at home prior to the experiment through three YouTube videos on three consecutive days and on the test day, they were being tested either on the trained or the reversed direction of each single pair in a similar ERP design as in study 1. The results in a group of 54 4.5-month-old infants follow the pattern of results in study 1 that infants show an early as well as a late surprise effect relative to the onset of the second stimulus of the trial, while contrasting the incongruent versus congruent trials in both directions. Furthermore we utilized frequency tagging in both studies as an extra measure to compare the conditions of interest. The overall results suggest that contrary to the consistent failure of non-human animals, infants can readily learn an association in a bi-directional manner, which can be suggestive of an early access to their symbolic system.

1. Sidman and Tailby 1982 2. T. Medam, et al, Anim Cogn, 2016,