VISUAL RECURSION DEVELOPS IN ABSENCE OF LINGUISTIC RECURSION. A CASE REPORT

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Introduction

Recursion is a cognitive capacity, potentially unique to humans, which allows the generation of hierarchies with multiple levels of embedding. This capacity is thought to primarily underlie syntactic structures in language (Berwick & Chomsky, 2016), but is also available in other domains such as vision (Martins, 2012). An open question is whether a purportedly primary linguistic capacity is used in other domains, or whether visual recursion can develop in the absence of language. If the latter, is recursion a domain-general or multi-domain-specific?

To address this question, a Visual Recursion Task (VRT) has been used. In this task, participants are shown the first 3 steps of a recursive rule generating 3 visual fractals, and then asked to choose the correct 4th step from 2 alternatives. While in VRT each step generates a new hierarchical level, a control task —the Embedded Iteration Task (EIT)—, has been devised in which each step adds elements within a nested hierarchical level, without generating new levels.

Results suggest that VRT is not distinctively associated with language: (i) both visual recursion and iteration develop around 9-10 y.o. and both correlate with grammatical skills (Martins et al., 2014b), (ii) visual recursion is not interfered by a concurrent verbal memory task (Martins et al., 2015) and (iii) fMRI studies do not show language brain areas involved for either VRT or EIT (Martins et al., 2014a). However, these experiments could be criticized since, a) the grammar task in (i) did not contain complex sentences, b) the verbal memory task —digit sequence— does not tap into language specific resources (Cook et al., 2018), and c) the fMRI task was performed by well-trained participants, who might solve it via automatic visual template matching. Besides, a recent study (Martins et al., 2019) shows that lesions in the pMTG, a language area, impair visual recursion and that VRT, but not EIT, correlates with the comprehension of sentences with two levels of clausal center-embedding.

Case report

Here we further test the hypothesis that linguistic and visual recursion are independent, in the framework of a case study. Its subject is Álex (AX), a 12-year-old autistic child (ADI-r and ADOS assessed) with an oral open-ended but almost exclusively nominal lexicon in three languages, which he has learned mainly by reading, with nouns as captions of bi-dimensional images. He has no verbs and no grammar. Nouns for depicted objects together with some adjectives for perceptually salient attributes are not enough for AX to deploy a functional language. Similarly to nonverbal autistic children, AX‘s communication is only imperative even in the rare occasions he communicates orally. In such cases his utterances are maximally two-word demands (e.g. *batido rosa* Sp.: *pinky shake* Engl.). Lack of linguistic recursion in production extends to comprehension — AX’s PPVT-III/verbal mental age outcome, 4.3 y.o., manifestly overestimates his comprehension. He has a non-verbal IQ of 79, tested through Leiter-3 with the following subtest scores: Figure-Ground (FG), 5; Form Completion (FC), 5; Classification and Analogies (CA), 8; and Sequential Order (SO), 6. Only CA reaches the ‘medium’ range while the rest of subtests yield a ‘medium-low’ score. Interestingly, CA assesses pattern analysis and prediction of “what goes next” while FG is a visual interference task where the target object is embedded in an increasingly complex background; FC, a task where the subject has to arrange parts in a whole, demands a capacity for synthesis in visual organization and finally, SO, tests the ability to analyze sequential order (Roid & Koch, 2017).

We ran the EIT→VRT tests on AX, in this order, and his accuracy in VRT was similar to 9-10 y.o. age group (77%) (Martins, 2014b). Interestingly he was a slow responder in the first half of EIT (57% of trials timeouts) but performed well in the second half (77%).

Discussion

AX has no impairment in visual recursion despite lacking linguistic recursion, which suggests that linguistic recursion has no ontogenetic primacy. AX’s performance seems nevertheless contrary to the hypothesis of multiple-domain specificity because such view entails domain-specific visual resources at the basis of VRT, which does not cohere with the fact that the maximum Leiter-3 score he obtained ('medium') was in CA, the least specifically visual subtest, which closely matches VRT. Furthermore, the visual processing difficulties revealed by ‘medium-low’ FG, FC, SO scores might explain why he failed in EIT (more dependent on visual working memory; Martins et al., 2016), which is easier than VRT for typical children. If recursion is a domain-general capacity, then why would it selectively fail to develop in language? The comparison between VRT and speech processing suggests that the motor and generative dimensions present in speech (that are absent in visual representation), in conjunction with the fast and transient character of the sequential auditory stimuli of speech, properties that have all been shown to be costly to manage in autism, could be responsible for the selective absence of linguistic recursion in AX.

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