

Image complexity in the tracking of DLD

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Abstract

Image complexity in a picture-identification task (PI-task) is shown to affect children's comprehension of relative clauses (RCs), object RCs, in particular. Images depicting reversible thematic relations led to more errors than non-reversible images for 5-7-year-olds. Schoolchildren identified as at risk of Developmental Language Disorder (DLD) had poorer performance than their age-matched control in the comprehension of RCs and which-questions (particularly in object sentences with complex images). Results of a correlation between children's scores on a language assessment test by means of a PI-Task and two non-verbal inhibitory control tasks suggest low inhibitory capacity makes it more difficult for children at risk of DLD to cope with costly sentences.

Keywords: relative clauses; sentence comprehension; image complexity; executive functions; reversibility.

Introduction

This paper is concerned with the task demands in the assessment of children's comprehension of costly sentences and their implications for the tracking and understanding of language impairment in the syntactic domain. It focuses on the comprehension of relative clauses (RCs) and which-questions (WQ) in a picture identification task (PI-task). The asymmetry between subject and object RCs (SRCs/ORCs) with the latter being particularly demanding for both children and adults is widely attested across languages (Lau & Tanaka, 2021). The ability to comprehend ORCs has been presented as a late acquisition and as a possible index of language impairment in the syntactic domain due to Extended Relativized Minimality (ERM), an overextension of a language-specific principle (Friedmann et al., 2009). There is, nevertheless, the possibility of underestimation of children's language abilities. Language-independent factors may contribute to children's difficulties in the task.

The comprehension of RCs has been traditionally assessed by means of a PI-task in which children have to choose one out of two images in which the same characters perform the same action described by the RC, though assuming reverse thematic roles. Hence, children have to decide on the correct picture by keeping in mind the thematic roles of the subject and of the object of the RC while distinguishing in which picture the same characters assume the respective actor and patient roles. The competing demands of sentence and image processing in the comprehension of costly structures were characterized

(Rodrigues & Correa, 2013). In Correa & Augusto (2019), an effect of image complexity (IC) was obtained in the number of correct responses given by schoolchildren to RCs and Who-questions, suggesting that the difficulty imposed by the comparison of similar reversible semantic relations may confound the factors predominantly affecting children's performance: a domain-specific effect of ERM or inefficient inhibitory control. The aims of this paper are: to report an experiment in which the effect of IC (reversible actor-patient relations) is verified; to evaluate the impact of IC on the performance of children identified as in risk of DLD (R-DLD) and the extent to which coping with a PI-task may rely upon inhibitory control abilities.

Reversible and non-reversible images

In this experiment, the same setup of Correa & Augusto's study (2019) was used. A background picture shows two different characters of the same type, corresponding to the subject/object of the RC. The background scene presents the two characters of the same type performing the same action with reversed roles (eg. one lion pushes a bear; a bear pushes the other lion, reversible actions (RA)) or one of them as the actor-patient of a different action (non-reversible action (NRA))¹. Children have to choose among three options (the two characters of the same type and another corresponding to the subject/object of the RC), the one corresponding to the head noun (see Figs. 1 and 2). *Type of RC* (subject and object) and *image complexity (IC)* (RA – NRA) were the independent variables (within and between factors, respectively).

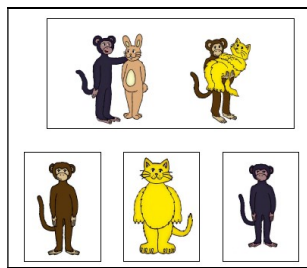


Figure 1. NRA (...the monkey that carried the cat).

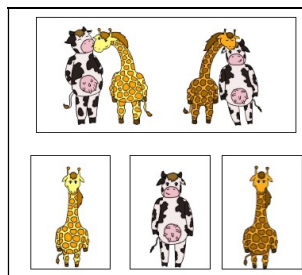


Figure 2. RA(...the giraffe that the cow kissed).

The participants were 34 middle-class Brazilian Portuguese (BP)-speaking children (age range 5.0 to 7.5), equally divided into two groups (NRA: 7 girls, mean age 6.0 years old; RA: 7 girls, mean age 5.8 years). 4 sentences of each type (1-2) (randomized in 4 lists) were presented, with 3 distractor sentences (subject who-questions) in a fixed order. The same sentences were orally presented to the two groups, with images in PowerPoint slides. Children were tested in an isolated room of the school. The procedure took around 10 min.

1. Mostra o macaco que carregou o gato. (Subject RC)
[Show (me) the monkey that carried the cat]
2. Mostra o elefante que o urso puxou. (Object RC)
[Show (me) the elephant that carried the bear pulled]

Results

Correct responses were analysed with R Version 4.2.1(2022-06-23), and the *lme4* package (Bates et al., 2015). A GLMM, using the maximum likelihood method in R (Laplace Appr.) was fitted, using binomial (logit) distribution, with *Type of RC* and *IC* as fixed effects, and participant as a random effect (Baayen et al., 2008). This analysis revealed that children performed significantly better with SRCs than ORCs with complex images (estimate = 1.2442, SE = 0.4016, $z = 3.098$, $\Pr(|z|) = 0.00195$) and ORCs were impacted by IC (estimate = 1.8687, SE = 0.4684, $z = 3.990$, $\Pr(|z|) = 6.61e-05$).

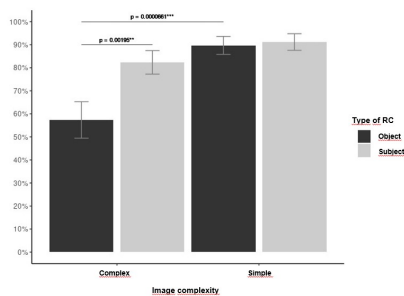


Figure 3. Percentage of correct answers as a function of conditions.

The results show that reversible images add difficulty to the task, particularly in the most demanding sentences, and reveal that the SRC-ORC asymmetry can be dissolved when RCs can be integrated with a non-reversible image. What is the impact of IC in the tracking of DLD by means of a PI-task?

Image effects, DLD and inhibitory control abilities

Two groups were created from a sample of 263 BP-speaking schoolchildren previously submitted to the MABILIN battery:² 15 whose overall performance was suggestive of risk of DLD (6 girls; mean age 7.2 years) (R-DLD group); 15 with high scores (6 girls, mean age 6.7 years), in the matched control (CTL) group). Subject/object RCs and WQs with simple (SI) (see note 1) and complex images (CI) were selected for the present analysis. There were 4 sentences in each condition. Additionally, the performance of 24 different children in the whole MABILIN battery was correlated with their performance in two inhibitory control tests Go/Nogo test and Flanker test.

Results

The number of correct responses in a Mann-Whitney test differed significantly in the R-DLD and the CTL group both in the simple ($U=55.500$, $z=-2.403$, $p=.016$) and complex image conditions ($U=22.00$, $z=-3.784$, $p=.0001$). For SI, which is more likely to capture difficulties in syntactic processing, there were significant differences between R-DLD and CTL only for ORCs ($U=69.000$, $z=-2.004$, $p=.045$). For CI, more likely to capture the additional burden of a reversible image, the groups differed significantly for SRCs ($U=60.000$, $z=-2.480$, $p=.013$); ORCs ($U=45.500$; $z=-2.860$, $p=.004$) and OWQs ($U=41.500$, $z=-3.029$, $p=.002$). There was a positive correlation between the total score on MABILIN and the total of correct responses on Flanker ($\rho(24) = 0.48$, $p=.02$) and on Go/Nogo test ($\rho(24) = 0.41$, $p=.04$). No correlations were obtained for response time.

Final remarks

The assessment of children's language comprehension abilities in the tracking of DLD has to take into account the specific task demands. The differential demands of simple and complex images in a PI-task can contribute to distinguishing children whose difficulty is more likely to stem from linguistic factors (difficulty with simple images) from those who are additionally sensitive to the demands of reversible images on inhibitory control abilities.

Notes

1. In Corrêa & Augusto (2019), the simple image had one of the characters of the same type standing by the scene.
2. The MABILIN battery for the tracking of DLD (Corrêa, 2000) includes simple reversible actives; non/reversible passives; right-branching and centre-embedded subject/object RCs (with in/transitive verbs), who and which questions.

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