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Matthias Lebreton, John Trueswell, Alex de Carvalho. When do children become able to revise in an adult-like manner? Examining the role of cognitive control and socioeconomic background in children's ability to revise. The 46th Boston University Conference on Language Development - BUCLD, Nov 2021, Boston, United States. , 2021. halshs-04044422

HAL Id: halshs-04044422

<https://shs.hal.science/halshs-04044422>

Submitted on 24 Mar 2023

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When do children become able to revise in an adult-like manner? Examining the role of cognitive control and socioeconomic background in children's ability to revise.

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BACKGROUND

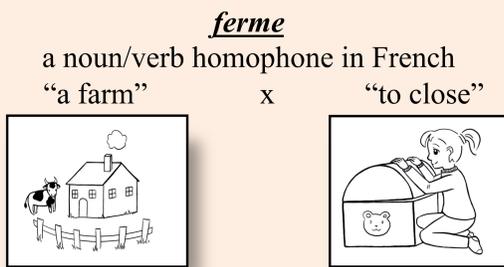
- During spoken language processing, both adults and children use their knowledge of words, syntax and prosody to make interpretive commitments as sentences unfold (e.g., Trueswell et al., 1999; de Carvalho et al., 2019). However, contrary to adults, children have difficulties in revising misinterpretations: *the kindergarten-path-effect* (e.g., Trueswell et al. 1999).
- Although around 8-to-9 years, children start to regulate revision (e.g., Weighall, 2008) it remains unclear when they become able to revise like adults, and what determines individual differences in this ability.
- For some authors, children's difficulty in revising reflects **immature cognitive control skills** (e.g., Hsu & Novick, 2016; Woodard et al., 2016), while for others, **socioeconomic background (SES)**, as a proxy of language variation, is a better predictor of children's ability to revise (e.g., Huang & Hollister, 2019).

RESEARCH QUESTIONS

- When do children become able to revise in an adult-like manner?
- What factors underlay individual differences in this ability?

PREVIOUS RESEARCH

de Carvalho, A., Dautriche & Christophe (2016) *Developmental Science*
Preschoolers and adults use phrasal prosody online to constrain their syntactic analysis.



Noun: [La petite _A ferme_N] ... **Verb:** [La petite_N] [ferme_V] ...
[The little *farm*] ... [The little *(girl)* closes] ...

de Carvalho, A., Trueswell, J. C., & Christophe, A. (2018). *BUCLD 43*

How strong is prosodic information to constrain parsing?

How listeners interpret an ambiguous noun-verb homophone when prosodic structure and later lexical content provide conflicting information?

Stimuli

Noun sentence: [La petite ferme] [sera pour les enfants]
The small farm will be for children

Verb sentence: [La petite] [ferme sa boîte à poupée]
The little_(one) closes her puppet box

We created cross-spliced sentences:

Noun+Verb sentence: [La petite ferme] [sa boîte à poupée]
The small farm her puppet box

Verb+Noun sentence: [La petite] [ferme sera pour les enfants]
The little_(one) closes will be for children

8 pairs of ambiguous sentences in total.

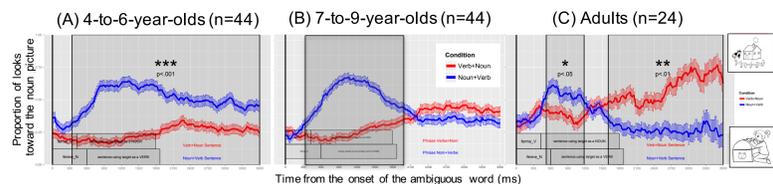
Each participant listened to 4 Noun+Verb sentences & 4 Verb+Noun sentences

Procedure

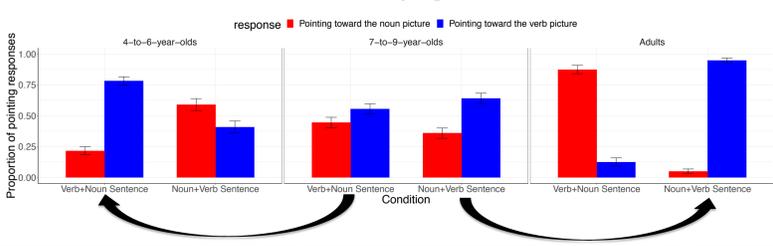
Intermodal preferential looking task (eyetracked) while participants listened to sentences.

Results from de Carvalho et al., (2018)

Looking behaviour



Pointing responses



GOAL OF THE CURRENT STUDY

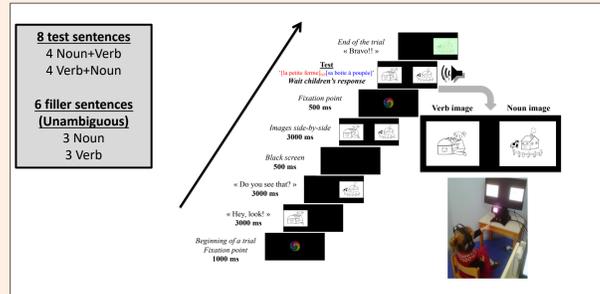
- To investigate at which age children become able to revise in an adult-like manner.
- To evaluate how **cognitive control** and **SES** (Socioeconomic Status) relate to revision, within the same children.

METHOD

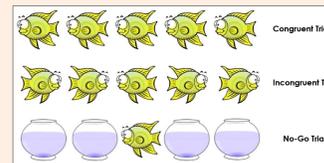
Participants: 46 French-speaking children
(8-to-9-year-olds (N=16); 10-to-11-year-olds (N=14); 11-to-12-year-olds (N=16))

Measures:

- SES computed based on the number of years of maternal education for each participant.
- Revision abilities (measured by the N/V revision task used in de Carvalho et al., 2018)



- Cognitive Control (measured by the Flanker Task used in Woodard et al., 2016)



RESULTS

Revision task

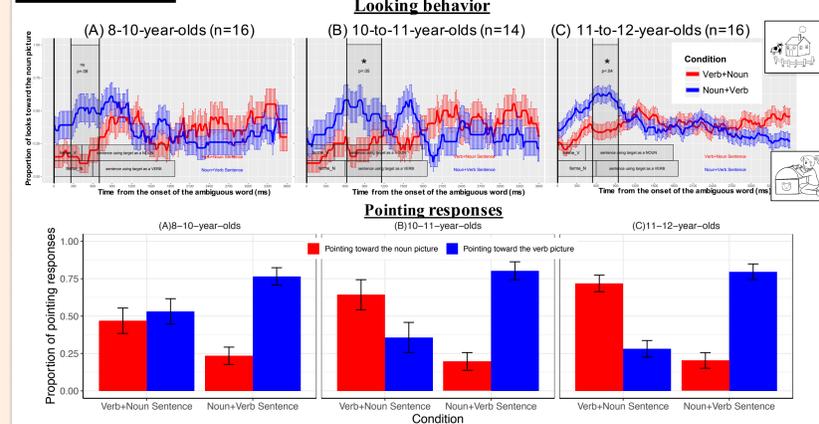


Figure 1: On the top, Proportion of looks toward the noun image, time-locked to the onset of the ambiguous word, for each age group (A)(B)(C). Grey-shaded windows show significant differences between conditions, measured by a cluster-based permutation test (e.g., Maris & Oostenveld, 2007). On the bottom, Pointing responses for each group. While eye-tracking data shows that all age groups initially looked more toward the picture supported by sentence-initial prosody and seemed unable to revise online, the pointing data shows that after age 10, children were able to select the 'correct' pictures in the Noun + Verb condition and the noun picture in the Verb + Noun condition ($\beta = -2.11$, $SE = 0.53$, $z = -3.95$, $p < 0.01^{***}$).

- All age groups initially looked toward the picture supported by sentence-initial prosody (Fig.1-top), but only after age 10, children were able to select the 'correct' pictures in an adult-like manner upon hearing disambiguating lexical evidence, in both conditions.
- 8-to-10-year-olds selected the 'correct' picture in the Noun+Verb condition but still failed in the Verb+Noun Condition (Fig.1-A, bottom).

SES & Cognitive Control

Table 1: Mean, standard deviation, and range for the key measures of interest to predict children's ability to revise: Age, SES, and performance in the Flanker task (unstandardized).

	M	SD	Range (low:high)
Flanker Congruency Errors (Incongruent minus Congruent)	-.005	.02	-.06:.07
Flanker Congruency RTs (Incongruent minus Congruent)	45.20	.05	-0.03:0.20
Flanker Switch Errors (Switch minus No Switch)	0.004	.02	-0.06:0.09
Flanker Switch RTs (Switch minus No Switch)	70.97	66.19	-11.51:262.84
No-Go Cost (Omission Errors minus Hits)	-68	6.59	-72:-31
SES (nb of years of maternal education after High School)	3.41	3.02	-6:10
AGE (in days)	3781.7	413.04	3017:4440

Assessing the relationship between Age, SES and Cognitive Control in children's ability to revise

Table 2: Results of a multiple regression showing the relationship between ambiguity resolution (z-scores of accuracy in the pointing task of the N/V revision task) and of performance (z-scores) on the other cognitive and SES measures. Z-scores of Age was computed on participant's age in days. Z-scores of SES was computed based on the number of years of maternal education. $lm(Ambiguity_resolution \sim Age + Flanker_Switch_Cost + Flanker_Congruency_Cost + No_Go_Cost + SES)$

Fixed effects	β	SE	t-value	p-value
Intercept	1.442e-08	1.365e-01	0.000	1.00000
Age	3.183e-01	1.512e-01	2.106	0.04157*
Flanker Switch Cost	-1.435e-01	2.073e-01	-0.692	0.49276
Flanker Congruency Cost	2.121e-01	2.272e-01	0.933	0.35629
No-Go Cost	1.340e-02	1.443e-01	0.093	0.92650
SES	4.007e-01	1.443e-01	2.777	0.00831**

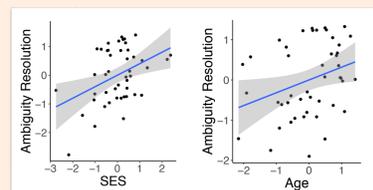


Figure 2: Relation between Ambiguity resolution (residuals) and SES (residuals) on the left, and between Ambiguity resolution (residuals) and Age (residuals) on the right, following the same analysis as in Woodard et al., (2016). No interaction was found between SES and Age, which suggests that SES has its effects on all age groups in a similar manner. Improvements with Age seem unrelated to effects of SES.

- Performance in the Flanker task and SES were used to predict children's pointing performance in the ambiguity resolution task (see Table 2+Fig2). In addition to the expected effect of Age, We found that **SES was the strongest predictor of children's ability to revise between ages 8 and 12.**

DISCUSSION

- In accordance with the findings of Huang and Hollister (2019) we found that SES was the strongest predictor of children's ability to revise.
- Our study did not replicate the correlation effect found in Woodard et al. (2016) between cognitive control skills and the ability to revise. Note however that our children are older and the type of ambiguity tested was different.
- The effect of cognitive control in revision might be stronger in preschoolers than it is in school children and adolescents.
- Future studies should investigate whether the effect of SES and Cognitive Control in revision might depend on the type of ambiguities tested (e.g., Conflict between prosody and lexical content in the current study, but PP-attachment ambiguity in Woodard et al., (2016) and passives in Huang & Hollister (2019).

CONCLUSIONS

This is the first study to show that it is only after age 10 that children become able to revise in an adult-like manner.

Across development, when SES is used as a proxy for language variation, children from higher-SES backgrounds revise mispredictions better than their lower-SES peers.

This suggests that variation in revising after age 8 may be related to linguistic knowledge and socioeconomic factors more strongly than to cognitive control.

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