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Why is ambiguity detection in kindergarten a predictor of reading abilities ?

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ABSTRACT

Recent studies demonstrated that 5-to-6-year-olds' abilities to detect and solve ambiguities in speech is a strong predictor of their later reading abilities in first-to-third grade. However, the origins of this relationship remain unclear. For some researchers, success in ambiguity detection is reflective of global language knowledge, while for others, it is reflective of cognitive control skills. In this study, we examined the contributions of oral language knowledge, SES, and cognitive control skills to preschoolers' ability to detect ambiguities. Later we will investigate the relationship among all these factors to early reading development. Our preliminary results show that 5-to-6-year-olds vary greatly in their ability to detect both lexical and structural ambiguities in speech. Moreover, regression analysis revealed that children's cognitive control skills is the strongest predictor of kindergarteners' ambiguity resolution abilities. This is the first study demonstrating that the ambiguity detection task designed to predict reading performance in children is also reflecting their cognitive control skills.

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BACKGROUND

- Five-to-six-year-olds' abilities to detect and solve ambiguities in speech is a strong predictor of their later reading abilities in first-to-third grade [1-2].

But why does this relationship exist ?

- For some researchers, success in ambiguity detection is reflective of better language skills, which varies with socioeconomic status [3] and is known to impact reading [4].
- For others, kindergarteners' ability to deal with representational conflict in speech is better explained by their cognitive control skills (5), which also impacts literacy attainment [6].

RESEARCH QUESTIONS

- What is the contribution of oral language knowledge, SES, and cognitive control skills to children's ability to detect ambiguities ?
- And what is the relationship among all these factors to early reading development ?

METHODS AND MATERIALS

Participants: Thirty-eight French-learning preschoolers (*Age*=67.6mo, from 61 to 75months)

Procedure: Participants were tested in 3 different tasks and their SES was indexed by the number of years of maternal education after the end of high school.

1. Ambiguity detection task (adapted from [2]) :

- On each trial, the child heard a sentence and had to find the picture(s) that matched it.
 - 12 sentences contained a lexical ambiguity (6 with *noun-noun homophones* and 6 with *noun-verb homophones*)
 - 12 sentences contained structural ambiguities

For the ambiguous sentences, amongst the four pictures presented, two depicted different meanings for the same ambiguous sentence.

- 12 sentences were unambiguous (6 trials contained two pictures illustrating the same meaning for a given sentence, 6 trials had only one target picture)

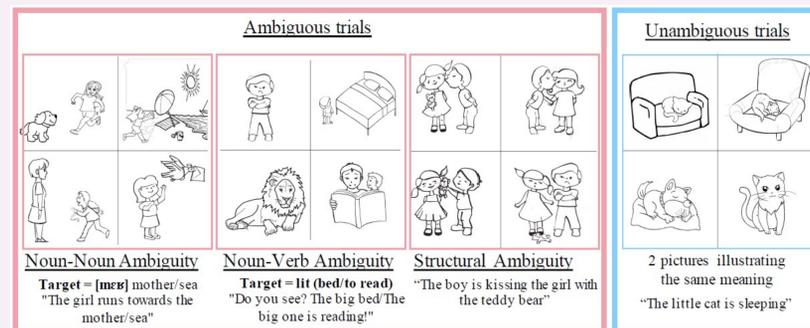


Figure 1. Examples of the trials used in the Ambiguity Detection Task.

- Participants earned 4 points if they spontaneously identified two pictures illustrating each of the possible meanings; 3 points if they answered correctly after one additional prompt ("Are there any two pictures that sound EXACTLY alike?"); 2 points for a correct answer after another prompt (the experimenter named each picture, played the sentence again and re-asked the question). If after all these attempts children did not identify the two correct pictures, no points were awarded in the trial and the experimenter passed to the next trial.

2. Cognitive control task (Flanker-No/Go task, same used in [5]) :

- Children had to "feed the hungry fish" in the middle of the screen by pressing a key at the left or the right side of the keyboard, depending on the direction in which the fish in the middle of the screen was swimming. When they saw empty fish bowls around the middle fish, they were told they should not press any button.
- 36 trials (12 in each condition: congruent, incongruent and no-go, e.g., Fig. 2)

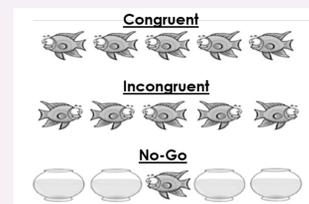


Figure 2. Examples of the three conditions in the Flanker / No-go task from [5]

3. Standard assessments of vocabulary and oral language comprehension (BSEDS, [7]):



Figure 3. Example of images presented for the vocabulary task (BSEDS): Band of images corresponding to the item "WINTER".

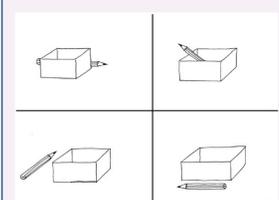


Figure 4. Example of images presented for the oral language comprehension task (BSEDS): images corresponding to the item "the pencil is behind the box".

- In the vocabulary task, bands composed of 6 images were presented (e.g., Fig. 3) and children were asked to point towards the image corresponding to the word they heard (e.g., "winter"). 15 words were presented.
- In the oral language comprehension task, the experimenter pronounced a sentence and presented 4 images to the child and asked her to show the image that best corresponded to the spoken sentence they heard (e.g., Fig 4). 10 sentences were presented.

RESULTS

- The relationship between individual differences on all the measures with children's performance in the ambiguity detection task was investigated.
- For the ambiguity detection task, we kept only the comparison with ambiguous and unambiguous sentences with two targets in our analyses.
- Our results (Fig2-A-B) show that 5-to-6-year-olds vary greatly in their ability to detect both lexical and structural ambiguities and their performance in the two type of ambiguities are strongly correlated.

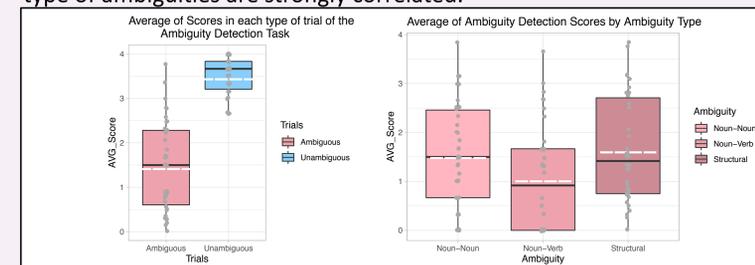


Figure 2-A-B: Results of the Ambiguity Detection Task. The box-and-whiskers represents the average of the scores in (A) Ambiguous vs Unambiguous Trials on the left, and (B) in each type of Ambiguous sentence, on the right. Each gray dot represents the average for one participant in each condition. Within each plot, the white dashed line represents the mean of the distribution, and the solid black line in the middle represents the median. Children performed better in Unambiguous trials than Ambiguous trials ($t(1,37)=-12.37, p<.001^{***}$) and in Structural Ambiguities than Lexical Ambiguities ($t(1,37)= 4.09, p<.001^{***}$). Within lexical ambiguities, participants performed better in detecting Noun-Noun Ambiguities than Noun-Verb Ambiguities ($t(1,37)=5.13, p<.001^{***}$).

	<i>M</i>	<i>SD</i>	Range (low:high)
Vocabulary score	22.3	5.05	9:30
Oral language comprehension score	7.5	1.7	4:10
SES	4.5	2.9	0:11
Flanker Congruency Errors (I minus C)	-.10	.25	-1:08
Flanker Congruency RTs (I minus C, in ms)	336	323	-169:1125
Flanker Switch Errors (Switch minus No Switch)	.01	.06	-.11:13
Flanker Switch RTs (Switch minus No Switch, in ms)	184	228.5	-262:737
No-Go Cost (Omissions Errors minus Hits)	-10.35	2.46	-12:0
Ambiguity Detection Score on Ambiguous Trials (with two target pictures)	1.47	1.01	0:3.8
Ambiguity Detection Score on Unambiguous Trials	3.49	.42	2.67:4

Assessing the relationship between Age, SES and Cognitive Control on children's ability to detect and solve ambiguities in speech

Table 2. Results of a multiple regression showing the relationship between ambiguity cost (z-scores of the difference in performance between Unambiguous minus Ambiguous trials) and performance (z-scores) on the other cognitive, linguistic and SES measures.

Fixed effects	β	<i>SE</i>	<i>t</i> -value	<i>p</i> -value
Intercept	-0.01064	0.16301	-0.065	0.9484
Age	-0.14696	0.18258	-0.805	0.4270
Flanker Congruency Cost (Incongruent minus Congruent)	-0.12228	0.18044	-0.678	0.5030
Flanker Switch Cost (Switch minus No Switch)	0.61461	0.27424	2.241	0.0323*
Overall_Language (Vocabulary and Sentence Comp)	0.24483	0.21128	1.159	0.2554
SES (nb of years of maternal education)	-0.16856	0.18274	-0.922	0.3634
No-Go Cost (Omission errors minus Hits)	0.04380	0.18018	0.243	0.8095

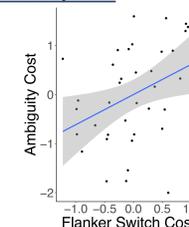


Figure 3. Relation between Ambiguity Detection Cost (residuals) and Flanker Switch Cost (residuals), following (5).

- Children's cognitive control skills (i.e., Flanker Switch Cost) is the strongest predictor of kindergarteners' ambiguity resolution abilities. This effect does not interact with the type of ambiguity tested (lexical vs structural).

DISCUSSION

- From the age of 5, children are able to detect and successfully solve ambiguities in oral language. As a group, they successfully detected and solved both lexical and structural ambiguities.
- However, at the individual level, these ambiguity detection skills vary greatly from child to child.
- In accordance with the results of [5], we found that children's cognitive control skills measured via a Flanker task is the strongest predictor of preschoolers' ambiguity resolution skills.

CONCLUSIONS

- This is the first study demonstrating that the ambiguity detection task designed (by [1],[2]) to predict reading performance in children is also reflecting their cognitive control skills.
- The next step is to test these same participants again once they learn to read (in two years) and evaluate the impact of all these factors in children's reading comprehension skills. We predict that any relationship between ambiguity detection and reading ability will be explained by cognitive control.

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