

Sentence comprehension and word recall in noisy primary classroom: what is the effects of the individual cognitive competences?

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Background and study motivations

- **Acoustic conditions in classroom** are often suboptimal (long reverberation time, high background noise level).
- The effort required in such conditions to hear what the teacher is saying may leave fewer resources for other, more **complex tasks** (e.g., comprehension, memorization).
- The Ease of Language Understanding framework suggests that the effect of listening conditions on auditory tasks might be modulated by **individual competences of the listeners**.
- The mediation effect of individual competences on task performance should be apparent in both **task performance and listening effort**.

Study aims

With reference to children aged 8 to 10 years, performing an auditory task in presence of an internal background noise:

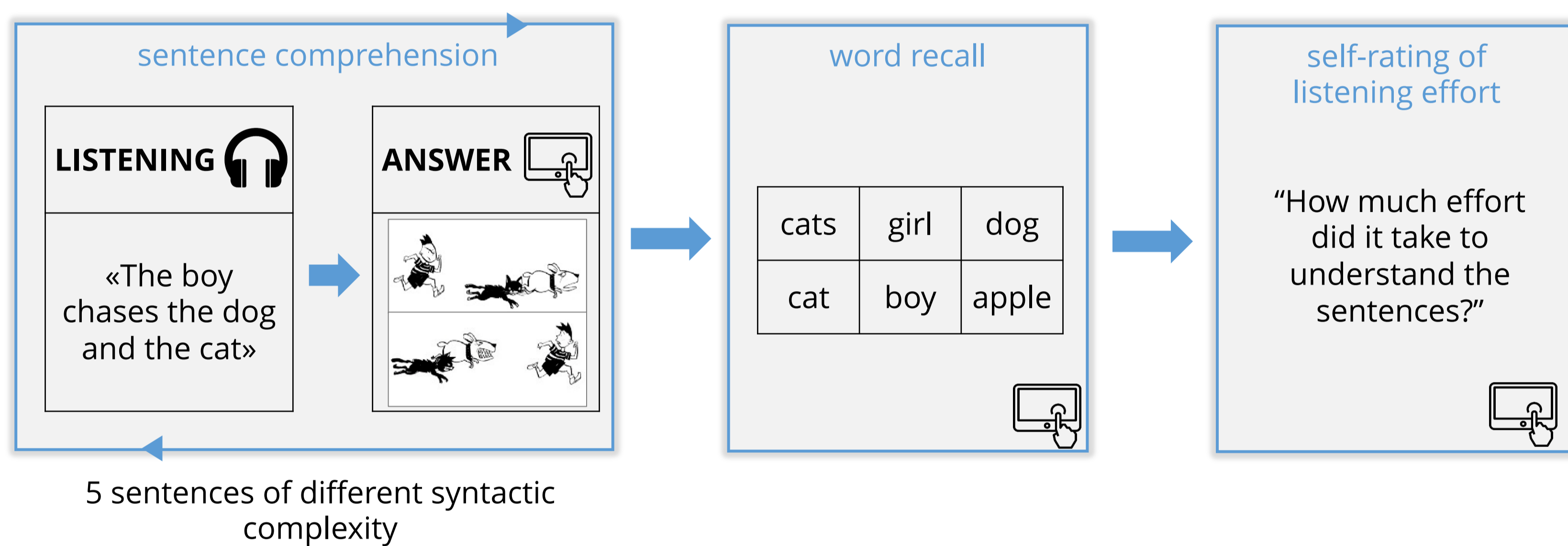
1. Is there an effect of **age** and **listening condition** on task performance?
2. Is the effect of listening condition mediated by the following individual competences
 - i. **cognitive skills** (inhibitory control)
 - ii. **linguistic skills** (reading comprehension)
 - iii. self-rated **noise sensitivity**

Methods

Participants 120 primary school children (two schools in Ferrara, Italy):
 - age: 8 yrs (n=28, grade 3)
 - age: 9 yrs (n=62, grade 4)
 - age: 10 yrs (n=30, grade 5)



Tasks



Procedures

Children collectively presented with the tasks in their classrooms. One week after the experimental session: measures of individual cognitive competences in quiet.

Assessment of the individual competences

Inhibitory control:

- assessment of the individual capacity of selectively attending on a stimuli and suppressing attention to other stimuli.
- go/no go task presented in the auditory domain.

Linguistic skills:

- assessment of the individual proficiency in a reading comprehension task (reading short stories and answering to multiple-choice questions)
- skills assessed in the visual domain

Noise sensitivity:

- reduced Italian version of the Weinstein Noise Sensitivity Scale (based on five statements).

All results were categorized as low/high based on a median split of the distribution

Listening conditions
 - acoustic simulations of a primary school classroom with $T_{mid} = 0.73$ s
 - background noise: two intelligible talkers (two children speaking simultaneously around the listener)
 - three SNRs: +1, +5, +9 dB

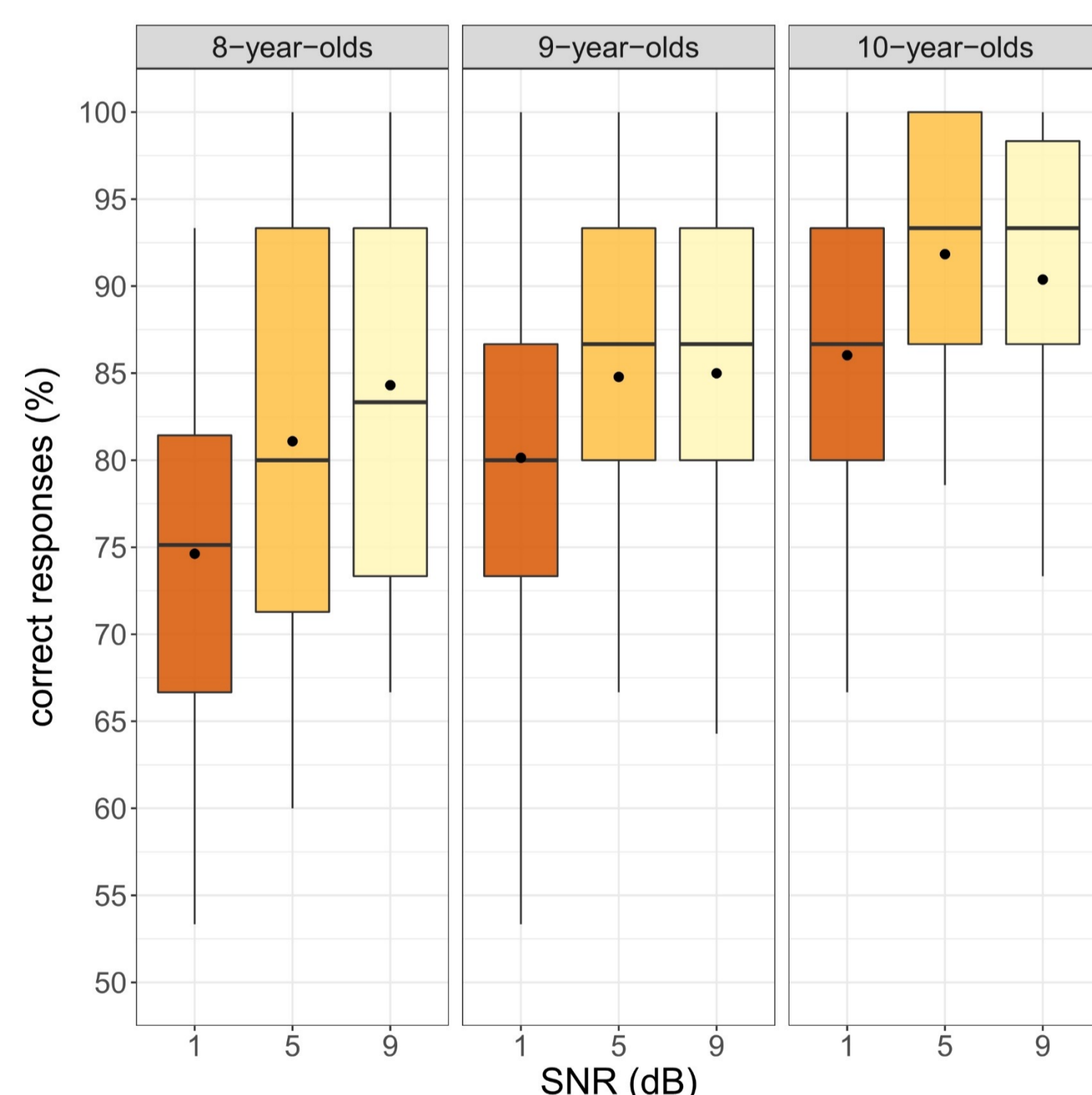
Data analysis

Repeated measures design: LMMs or GLMMs.
 - fixed factors: listening condition (SNR), age
 - random factor: participant
 Post hoc: pairwise comparisons (Bonferroni correction)

Results: sentence comprehension

Main effects	p value
Listening condition	<0.001 ***
Age	<0.001 ***

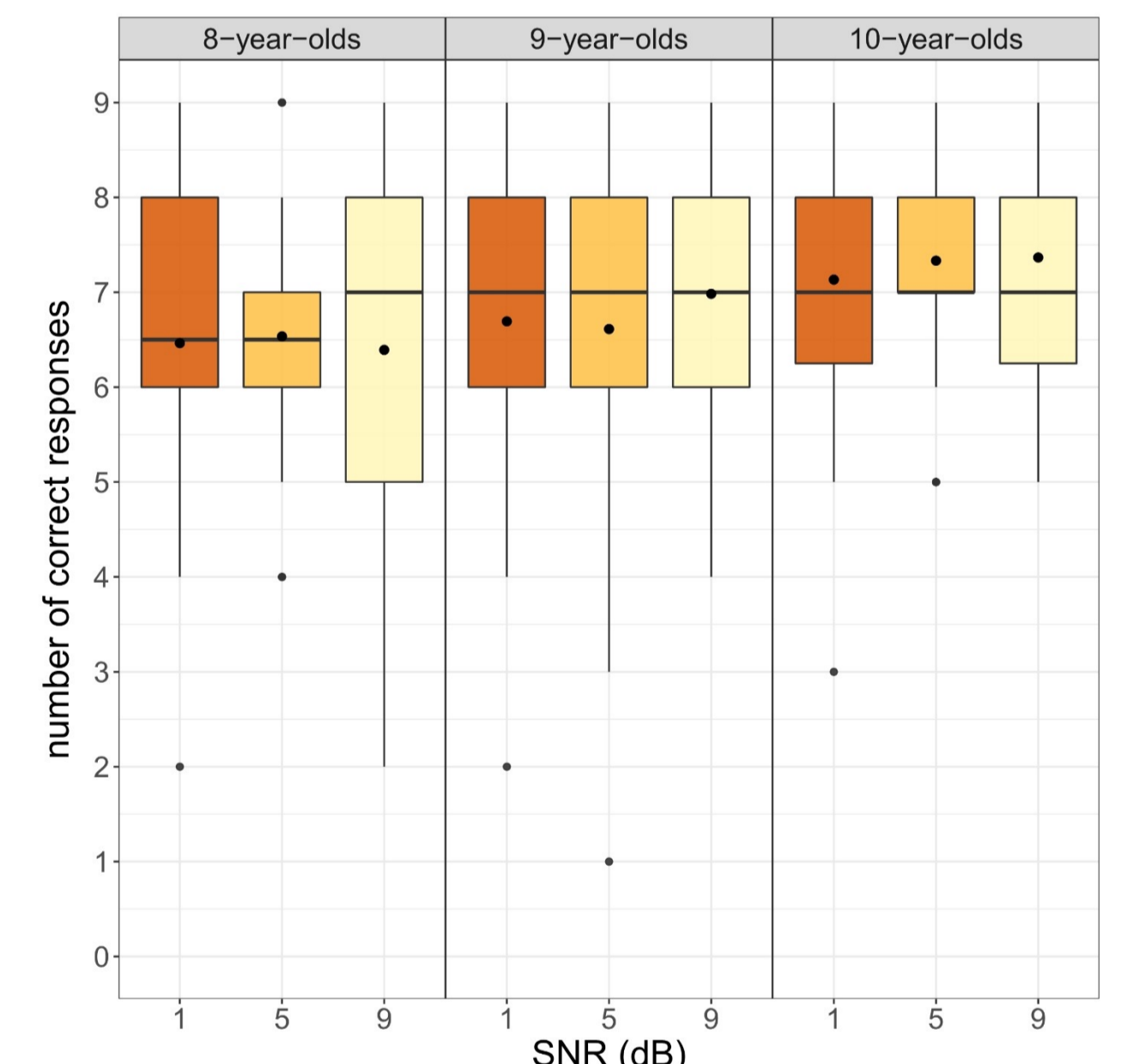
- Significant effect of the listening condition (worse performance in SNR=1 dB compared with SNRs=5, 9 dB)
- Significant effect of the children's age (worse performance for 8- and 9-year-olds compared with the oldest students)
- Planned post hoc comparisons: the effect of age is significant only for the least favorable SNRs (1 and 5 dB)



Results: word recall

Main effects	p value
Listening condition	n.s.
Age	0.004 **

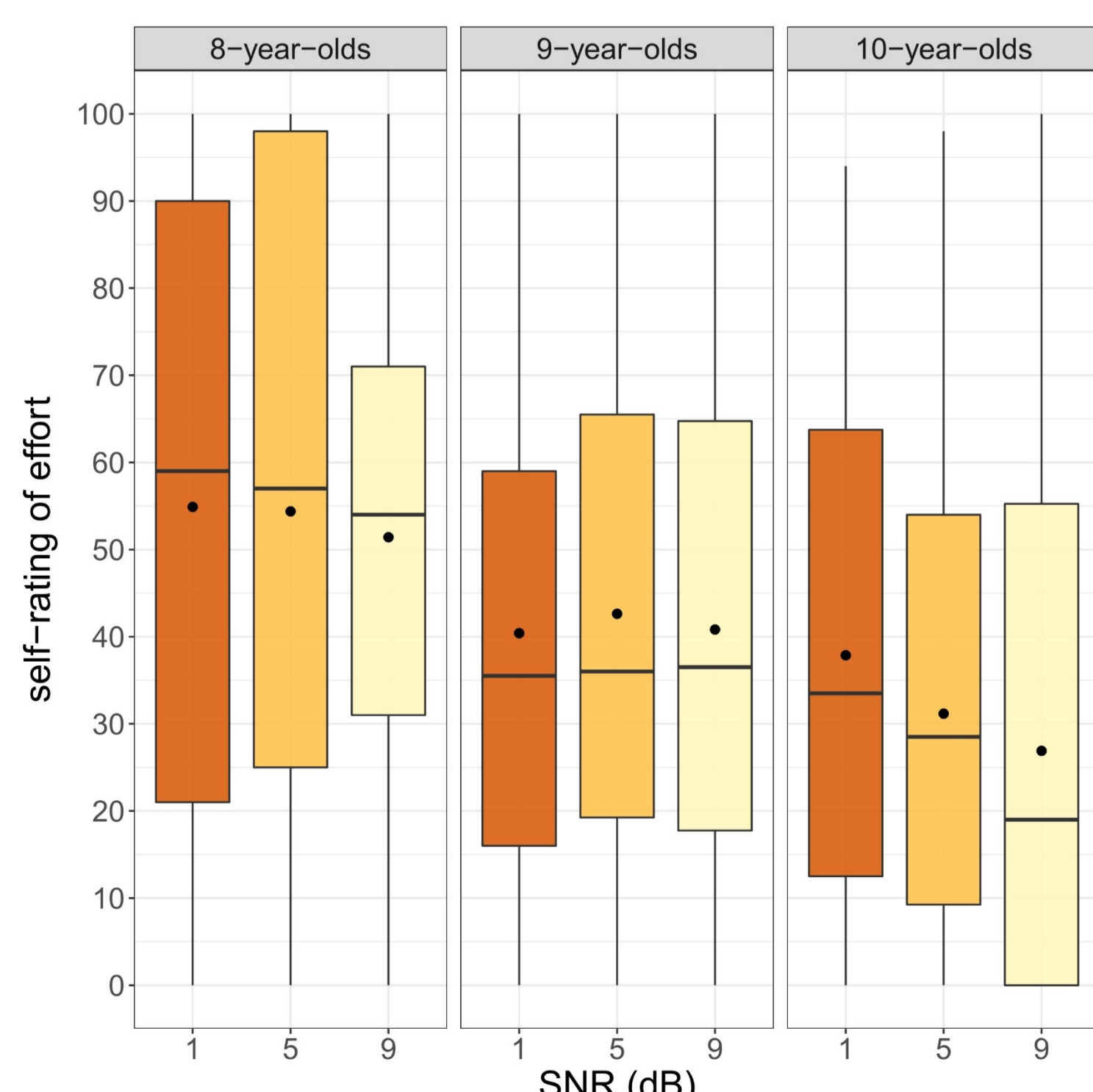
- No effect of the listening condition during the comprehension task on the performance in the subsequent word recall task
- Significant effect of age (young children – 8 and 9 years – recall less words than 10-year-olds)



Results: self-rating of effort in sentence comprehension

Main effects	p value
Listening condition	n.s.
Age	0.007 **

- No significant effect of listening condition on the self-ratings of effort, despite the presence of differences in task performance.
- Significant effect of children's age: younger children (8 years old) rate the task as more effortful than older children (10 years old).



Results: correlation with individual competences

Individual competences (and their interaction with SNR) were included in the statistical models, to examine the presence of a mediation effect.

	Sentence comprehension	Word recall	Self-ratings of effort
Inhibitory control	- main effect - no interaction (SNR)	- main effect - no interaction (SNR)	- main effect - no interaction (SNR)
Linguistic skills	- main effect - no interaction (SNR)	no effects	no effects
Noise sensitivity	no effects	no effects	no effects

Take home messages

- Significant effect of SNR only for the sentence comprehension task. The chosen word recall task might be too easy for the children, thus preventing to observe an effect of the listening conditions.
- *Inhibitory control* and *linguistic skills* never mediated the effect of listening condition on task performance. However, the presence of a main effect indicates that children with lower cognitive competences are vulnerable to the effects of an informative noise, independently on the SNR.
- No significant effect of *noise sensitivity* on the considered outcomes: the WSNN scale might not be specific enough to be related to measures of performance