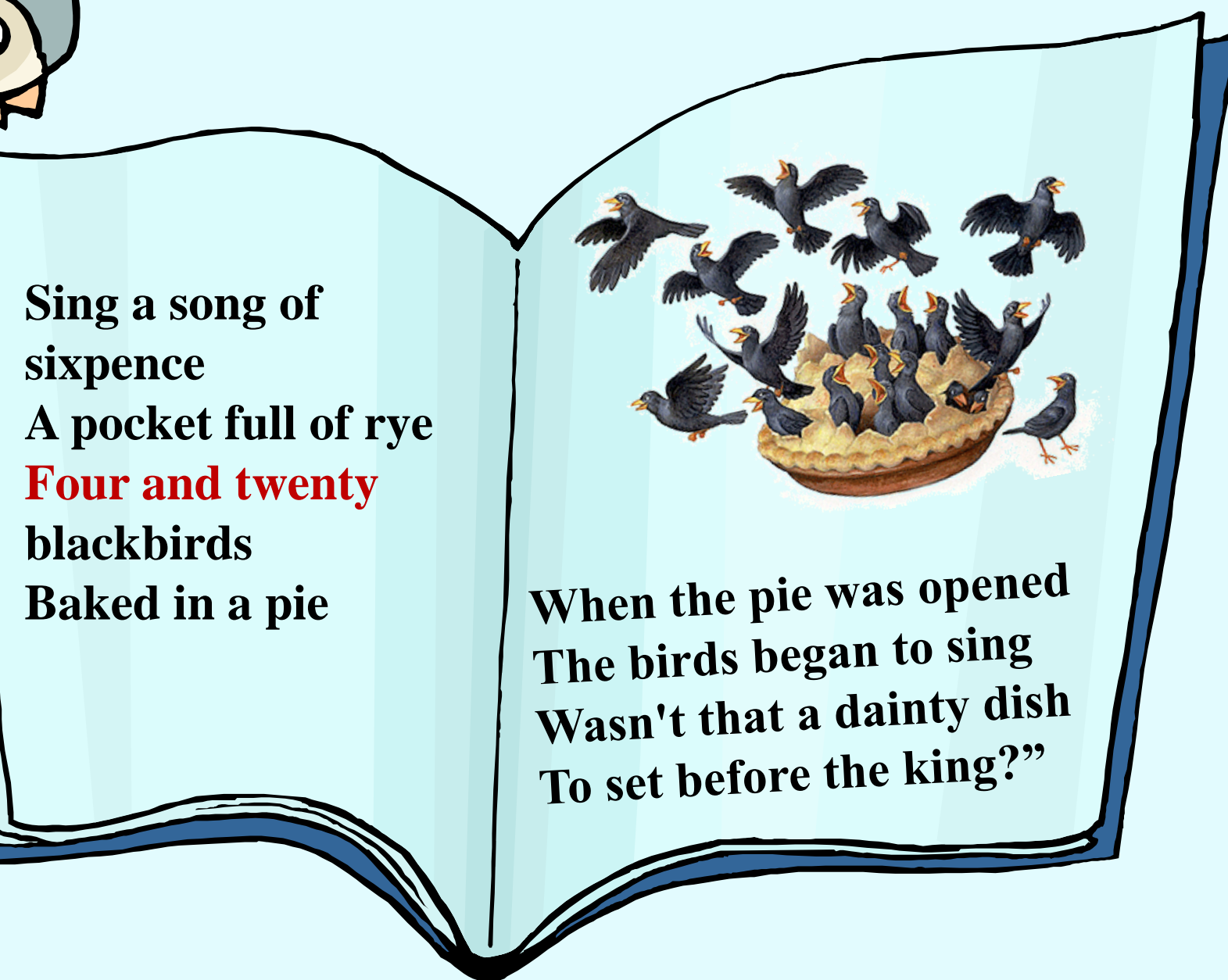


Four-and-twenty blackbirds: The effect of number word structure at different ages

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Introduction



Decade-unit inversion, or pronouncing 24 as four-and-twenty, is a property that is still present in many contemporary languages, such as Dutch and German. With the present study the influence of inversion on Dutch children's performance was investigated: both their ability to transcribe spoken numerals, and the degree to which inversion errors relate to mathematical performance.

Method

We used data from 25,620 children that had played the Transcription Game in Math Garden between February and May 2013. In this online game, children had to type a number that was presented auditorily. The items range from very easy ('5') to very difficult ('466,423,562'). The items are presented adaptively, so



regardless of ability, each child answers 75% of the items correctly. IRT-based procedures are used to estimate the ability of each child and the difficulty of each item.

These ability and difficulty estimates, and error type (inversion error or other) were analyzed.

Research Questions

Item difficulty

Are items with an inversion more difficult to transcribe than items without an inversion and does decade-unit inconsistency in pronunciation ('twee' in 42 vs 'twin' in 24 affect this?)

Development

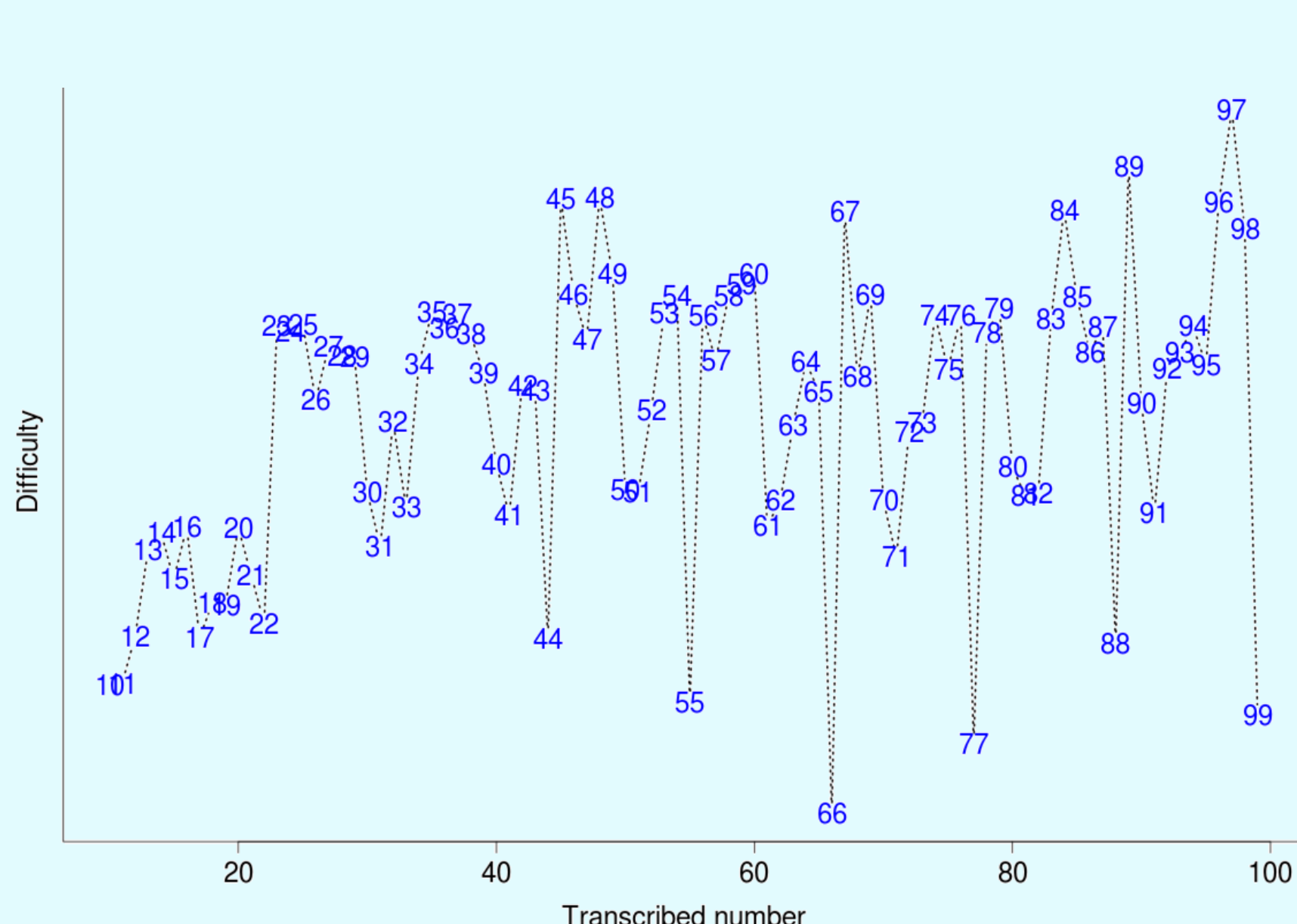
At what age are inversion errors most common? Do inversion errors disappear with age, or do they continue under sufficient load?

Mathematics

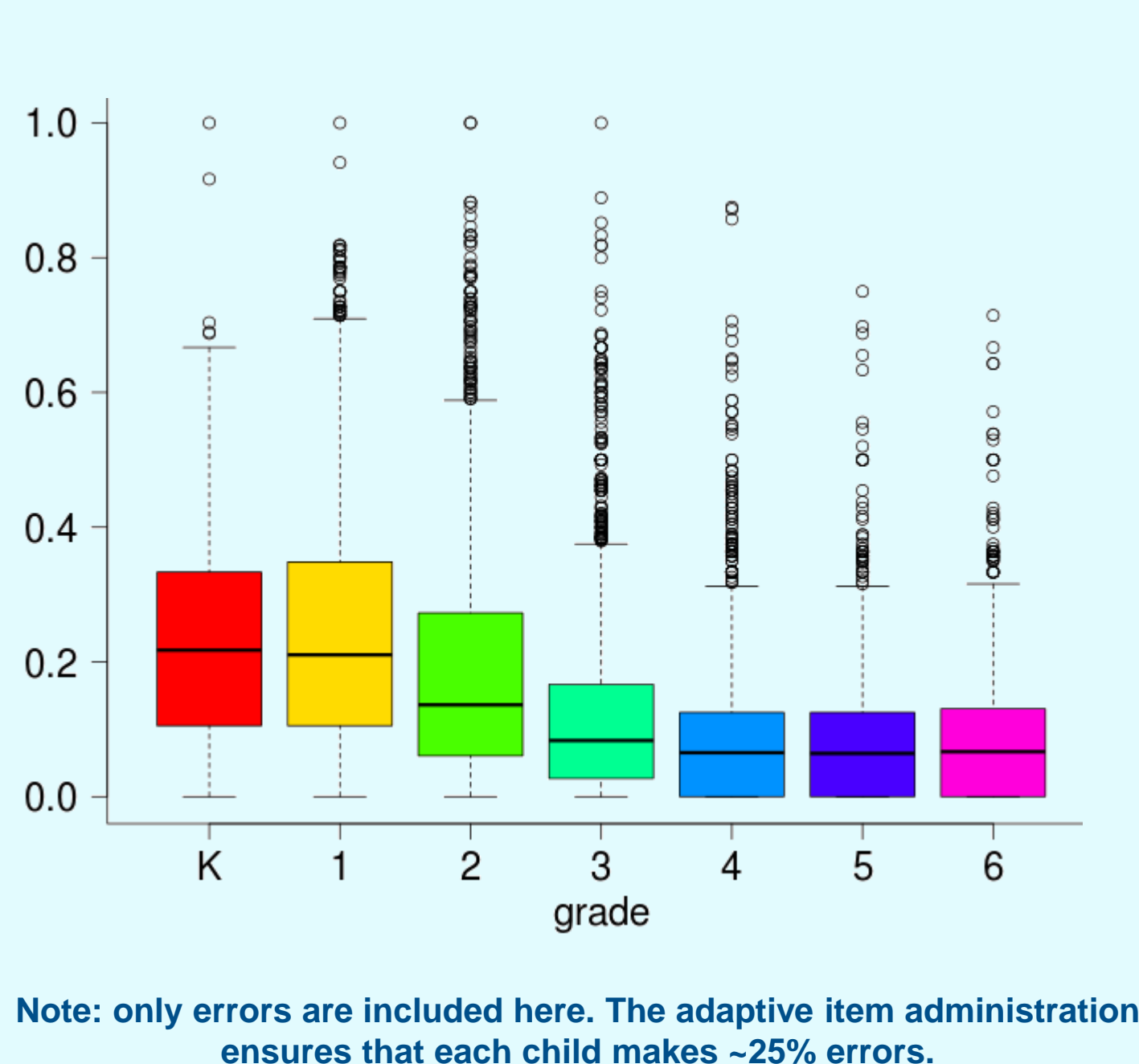
Visuospatial working memory (VWM) predicts both inversion error making and math performance. Does inversion mediate the relationship between VWM and math, and does it explain the decrease with age in this relation that has been found in previous studies?

Results

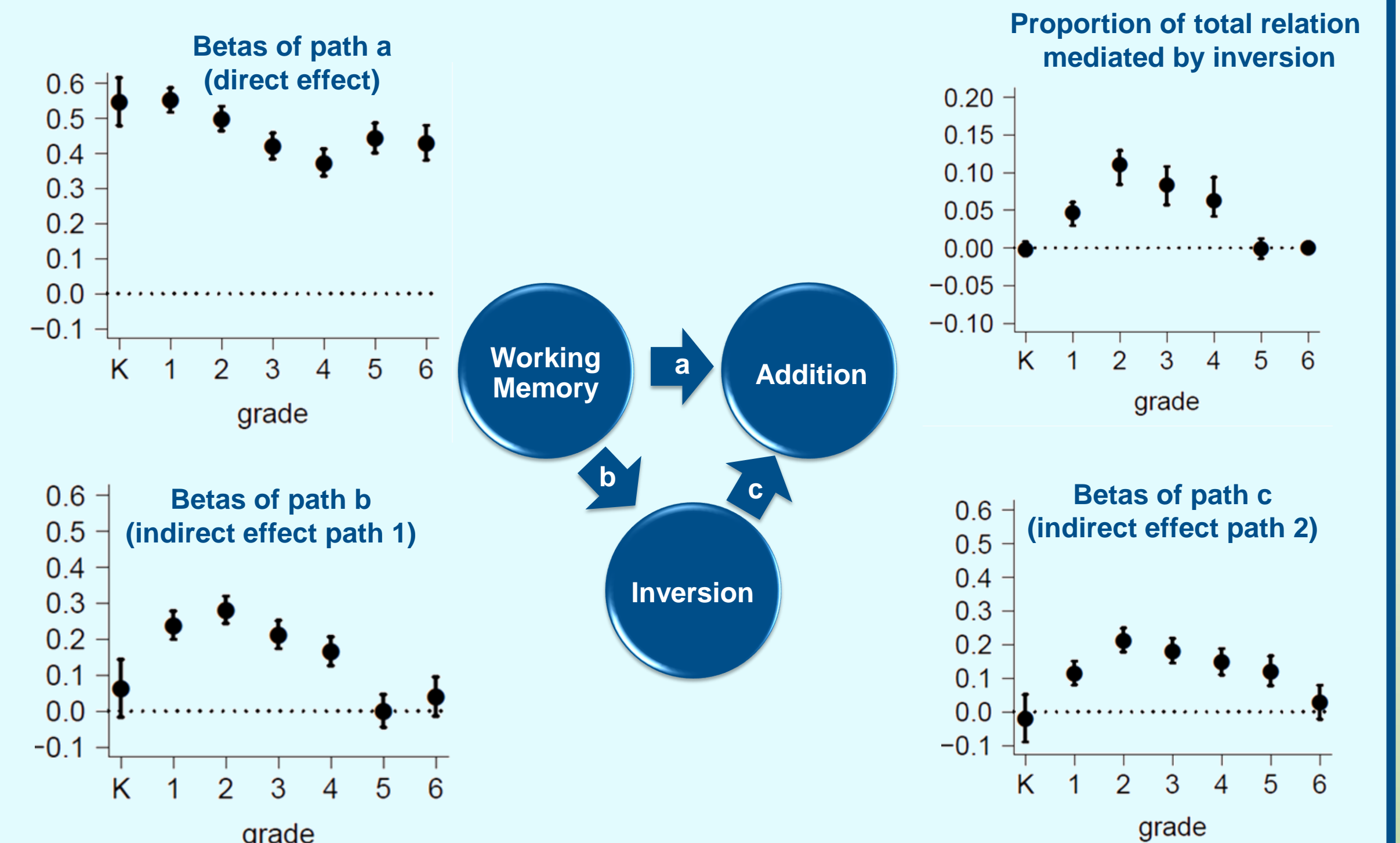
Difficulty of transcription of two-digit numbers



Proportion of inversion errors, by grade



Mediation model by grade



Conclusions and discussion

Inverted numbers ('24') are more difficult to transcribe than ties ('66') and decades ('70'). This is attenuated in numbers with pronunciation inconsistency (1 or 2 in units or decades).

Inversion errors are most frequent until grade 2 (7-8 years), but most older children make inversion errors too. This is more persistent than previously thought!

Inversion errors are a partial mediator of the relation between VWM and mathematics, especially around grade 2. When correcting for inversion, there is no longer a diminishing trend with age in the relation between VWM and addition ability.