

Longitudinal influence of (meta)phonological skills on the typical and atypical reading development of monolingual and bilingual children in a shallow orthography

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INTRODUCTION

Scientific Objectives (SO)

The present research explores longitudinally

- Phonological (Hulme et al., 2015; Snowling, 2001) and metaphonological (Ball & Blachmann, 1988; Bradley, 1988; Frith, 1985; Hulme & Snowling, 1988; Lundberg et al., 1988; Morais, 1991) skills are deemed essential to reading development.
- Recent studies deem Rapid Automatized Naming (RAN) as a measure of automaticity (Norton & Wolf, 2012) rather than a subcomponent of phonological processing (Wagner et al. 1999).
- The existence of a possible bilingual advantage in executive functions (Adesope et al., 2010) and (meta)language (Bialystok, 2001) is vividly debated (Borragan et al., 2021; Lukasik et al., 2018; Paap et al., 2015).
- Longitudinal research about the influence of phonology and metaphonology on reading is scarce (Dehaene, 2009), notably in shallow-orthography languages (Zoccolotti, 2005) and bilingual populations (Casani, in preparation).

- SO1.** the differences btw. Italian mono and bilingual children in the typical development of (meta)phonology and reading
 - SO2.** the (meta)phonological predictors of typical reading development in mono and bilinguals;
 - SO3.** the (meta)phonological predictors of reading difficulties in mono and bilinguals;
 - SO4.** the effects of a metaphonological and a RAN intervention on the typical reading development of mono and bilinguals;
 - SO5.** the effects of a metaphonological and a RAN intervention on the atypical reading development of mono and bilinguals;
- in the Italian shallow orthography

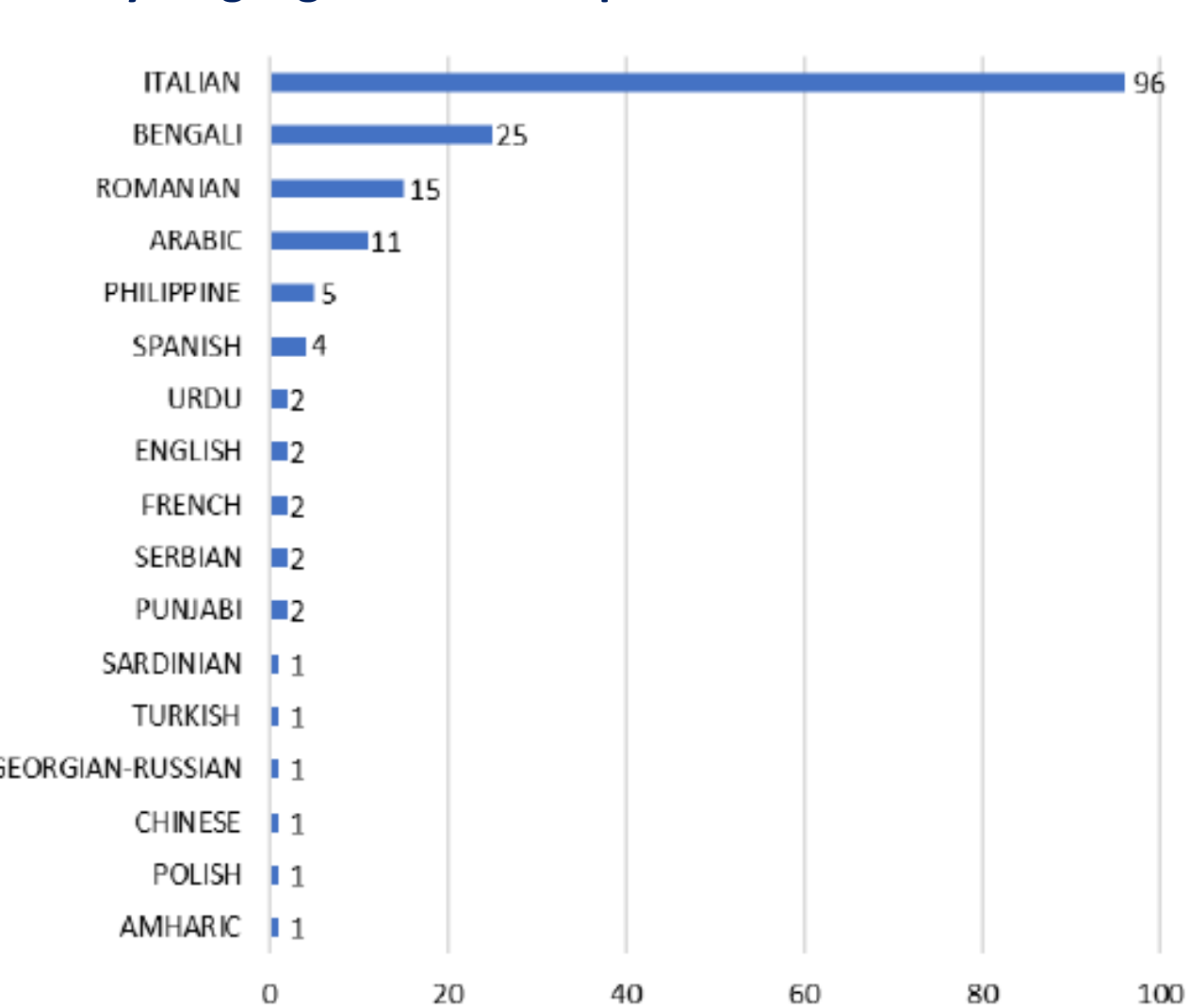
METHOD

SO1

Participants

172 children (96 mono + 76 bilinguals born in Italy from migrant families) attending the same Italian comprehensive school (last year of kindergarten – 2nd grade).

Family languages of the sample



Materials

Standardized Italian tests of

- phonology:** pseudoword repetition (Cornoldi et al., 2009)
- metaphonology:** syllable awareness in kindergarten and phonemic awareness in primary school (Marotta et al., 2008)
- RAN** of pictures (from kindergarten), colors and digits (from 1st grade) (De Luca et al., 2005; Terreni et al., 2002)
- sublexical decoding** (Calgaro et al., 2018; Traficante et al., 2017)
- word decoding** (Traficante et al., 2017)
- text decoding** (Cornoldi & Carretti, 2016)

Procedures

5 testing sessions:

- in the middle (KG-1) and end (KG-2) of the last year of kindergarten
- in the middle (1-1) and end (1-2) of the 1st grade
- in the middle of the 2nd grade (2-1)

Analyses

Generalized (Linear) Mixed Models for Repeated Measures (GMMRM)

- variable:** test scores
- fixed effects:** bilingualism*administration time
- random effect:** presence/absence of intervention

SO2

Participants, Materials, and Procedures
As in SO1

Analyses

- GMM(RM)s**
- variable:** reading scores
- fixed effects:** (meta)phonological and RAN scores*administration time
- random effect:** bilingualism

SO3

Participants: 49 children:

- 19 (12 mono+7 bilinguals) with reading/writing difficulties (< 2 SDs), 6 monitored from the last year of kindergarten to the 2nd grade+13 (reported by teachers for learning difficulties) monitored from the 1st to the 3rd grade;
- 30 typically developing children (17 mono+13 bilinguals included in SO1 and SO2) monitored from the last year of kindergarten to the 2nd grade.

Materials: as in SO1 and SO2

Procedures

- 5 testing sessions as in SO1 and SO2 (KG-1; KG-2; 1-1; 1-2; 2-1) for the 36 children monitored from kindergarten to the 2nd grade;
- 5 testing sessions (1-1; 1-2; 2-1; 2-2; 3-1) for the 13 children monitored from the 1st to the 3rd grade.

Analyses: Logit GMMRMs

- variable:** impaired/non-impaired ability
- fixed effects:** (meta)phonological and RAN scores
- random effects:** mono/bilingualism and grade

SO4

Participants: as in SO1 and SO2

Materials

Testing: as in previous SOs

Interventions: printed and digital materials adapted or prepared ad hoc.

Procedures

Testing: as in SO1 and SO2
Intervention: 34 children (19 mono+15 bilinguals) attended a double cycle (last year of kindergarten+1st grade) of different training programs:

- a **META** training (N = 12)
- a **RAN** training (N = 11)
- a graphic training (N = 11)

A Control Group (**CG** = 96) did not attend any training.

Analyses: GMMRMs

- variable:** reading test scores
- fixed effects:** bilingualism(group)*test session

SO5

Participants: as in SO3.

Materials: as in SO4.

Procedures

Testing: as in previous SOs
Intervention groups (N = 34):

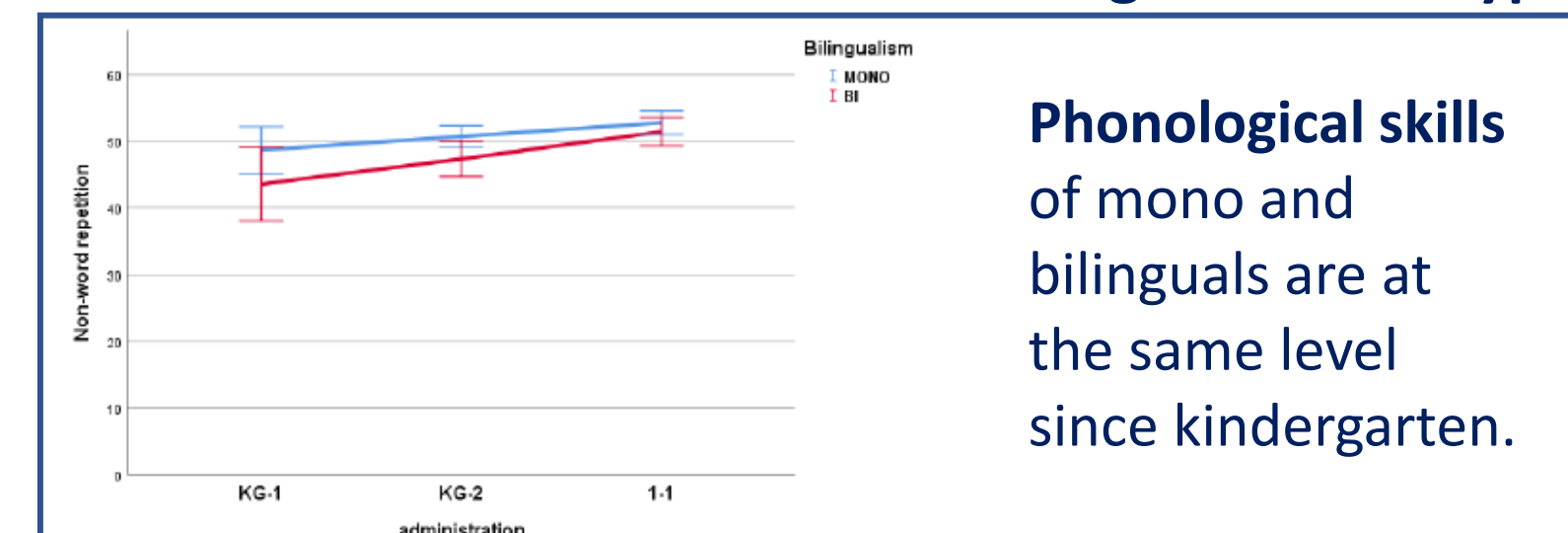
- META-1:** 6 children (5 mono+1 bilinguals), monitored from 1st to 3rd grade, receiving one META intervention in 1st grade
- META-2:** 9 children (6 mono+3 bilinguals) receiving a double metaphonological intervention (KG+1st grade)
- RAN:** 10 children (6 mono+4 bilinguals) receiving a double RAN intervention.
- GRAPH:** 9 children (7 mono+2 bilinguals) receiving the double graphic intervention.
- CG:** 10 children (6 mono+4 bilinguals) did not receive any intervention (7 monitored from the 1st to the 3rd grade and 3 from kindergarten to 2nd grade)

Analyses: Logit GMMs

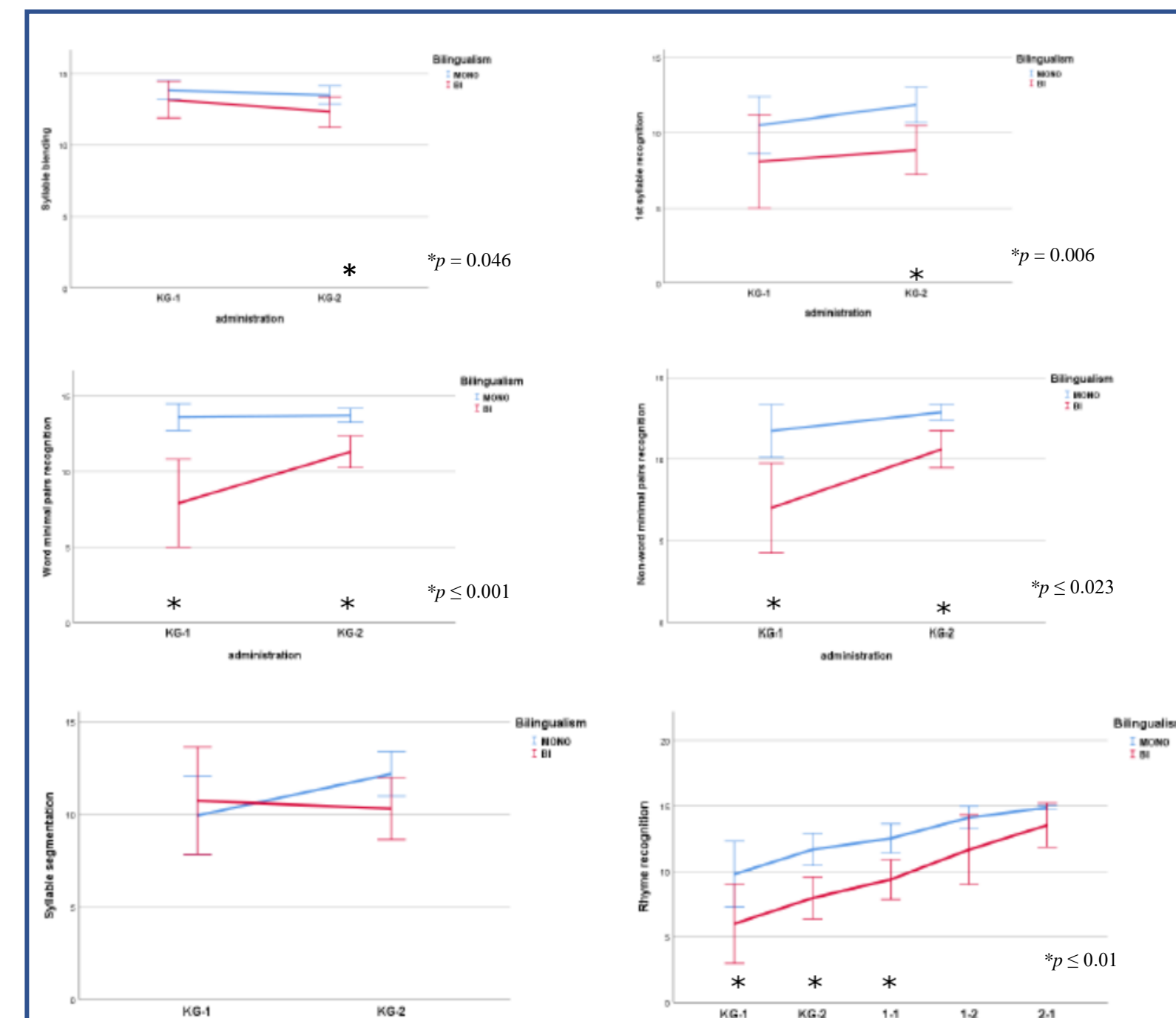
- variable:** impaired/non-impaired ability
- fixed effects:** group
- random effects:** mono/bilingualism and grade

RESULTS

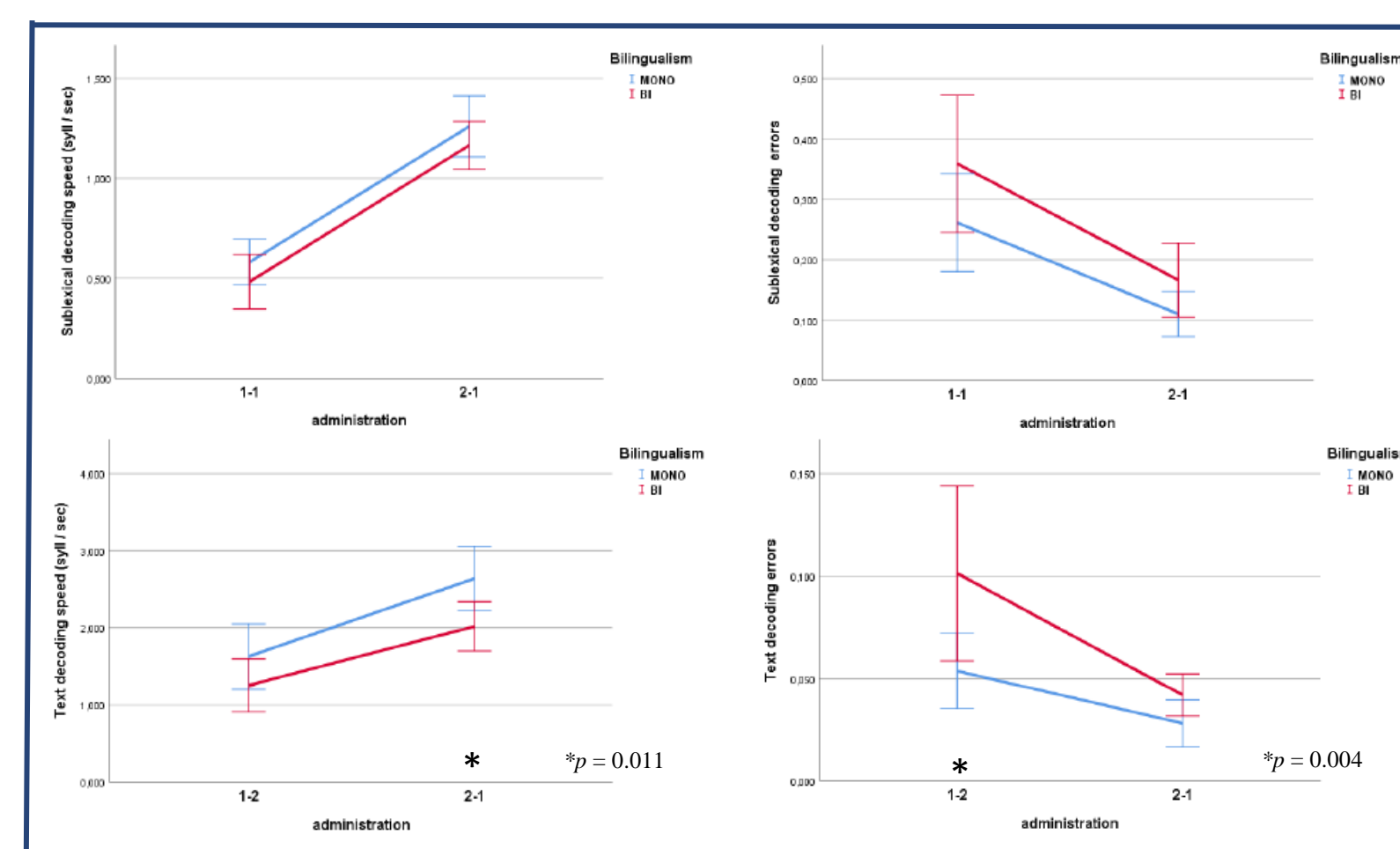
SO1. Differences btw. mono and bilinguals in the typical development of (meta)phonology and reading



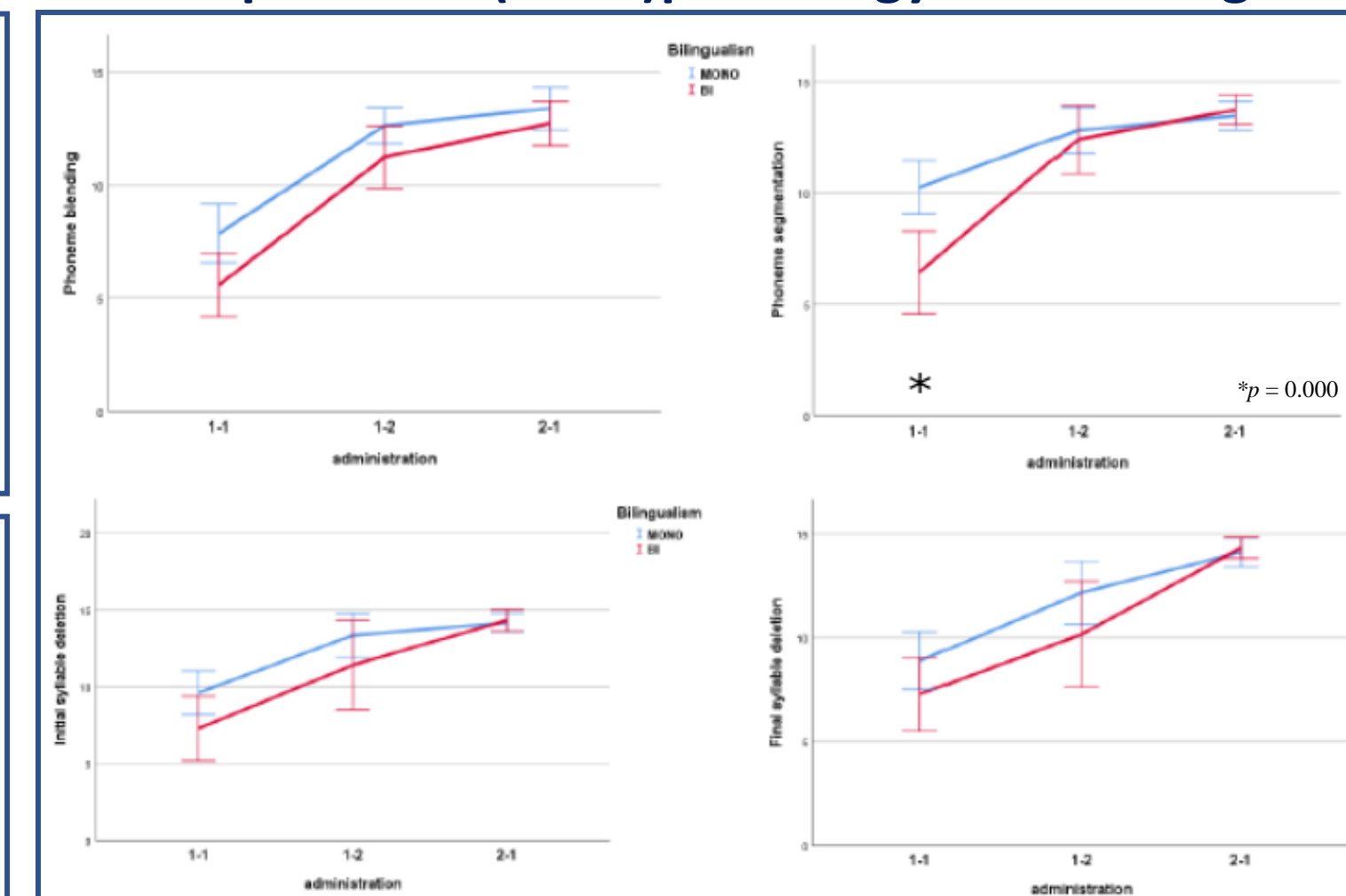
Phonological skills of mono and bilinguals are at the same level since kindergarten.



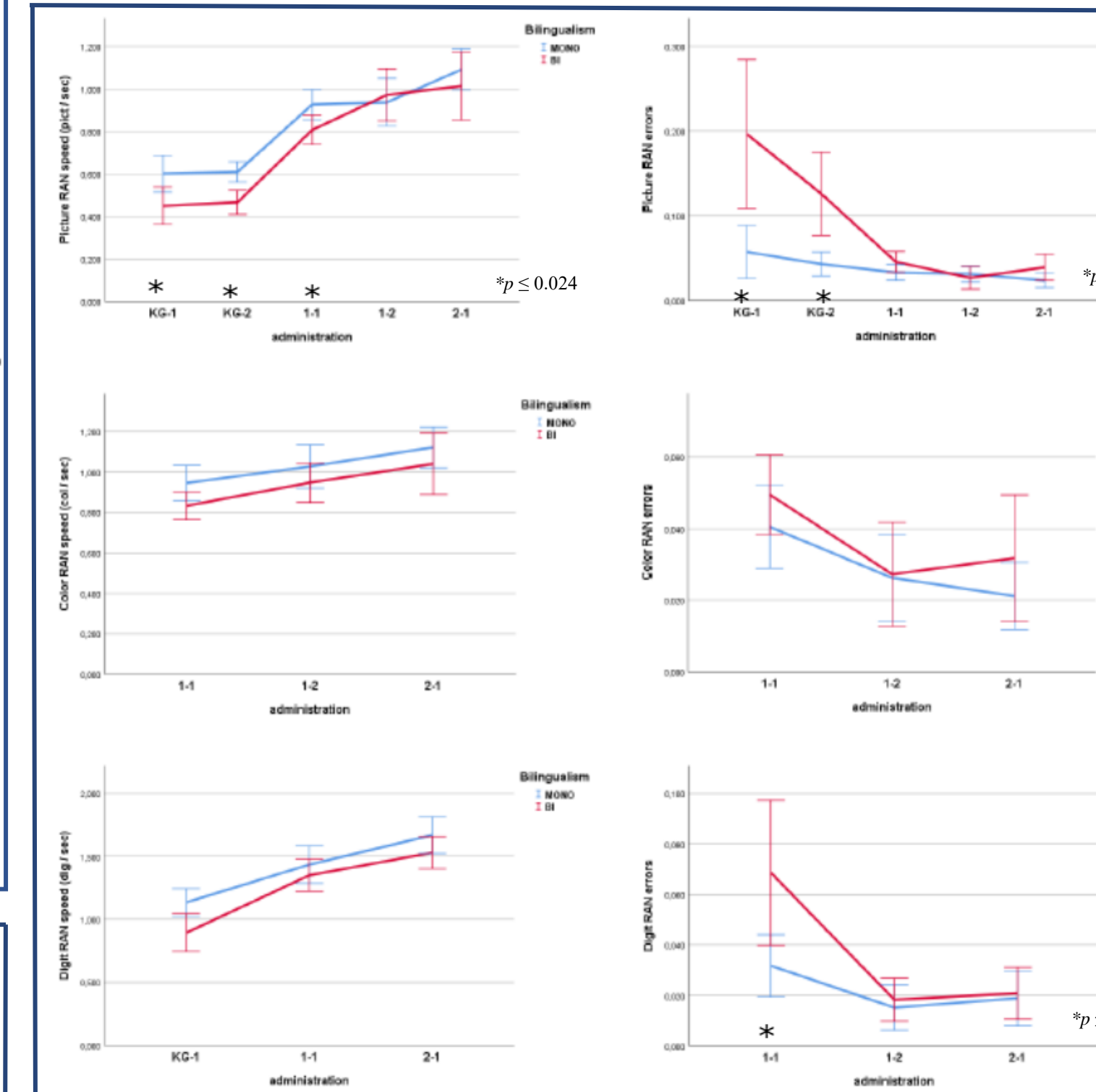
Global metaphonological skills of bilinguals in kindergarten are significantly lower than those of monolinguals, except for syllable segmentation.



Sublex decoding: similar btw. mono and bilinguals.
Text decoding: bilinguals are slower in 2nd grade and less accurate in 1st grade than bilinguals.



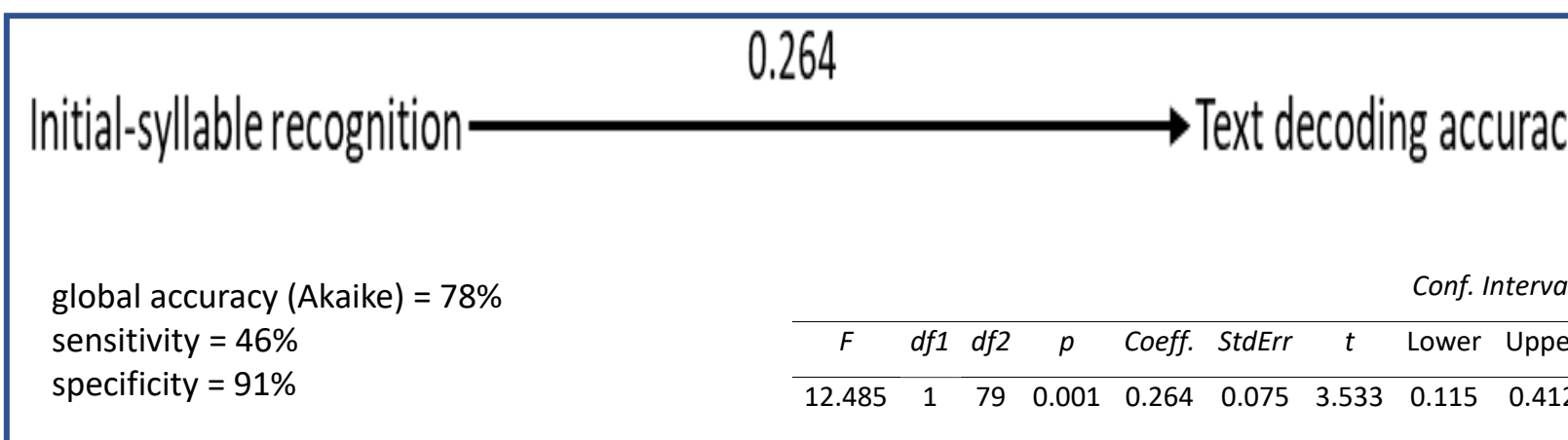
(Meta)phonological skills of mono and bilinguals reach the same level btw. the middle and the end of the 1st grade, except for phonemic verbal fluency.



RAN skills of mono and bilinguals also reach the same level btw. the middle and the end of the 1st grade.

Word decoding: in 2nd grade, bilinguals have comparable speed as monolinguals but make more stress errors in decoding non-paroxytone words.

SO3. KINDERGARTEN (META)PHONOLOGICAL PREDICTORS OF READING DIFFICULTIES

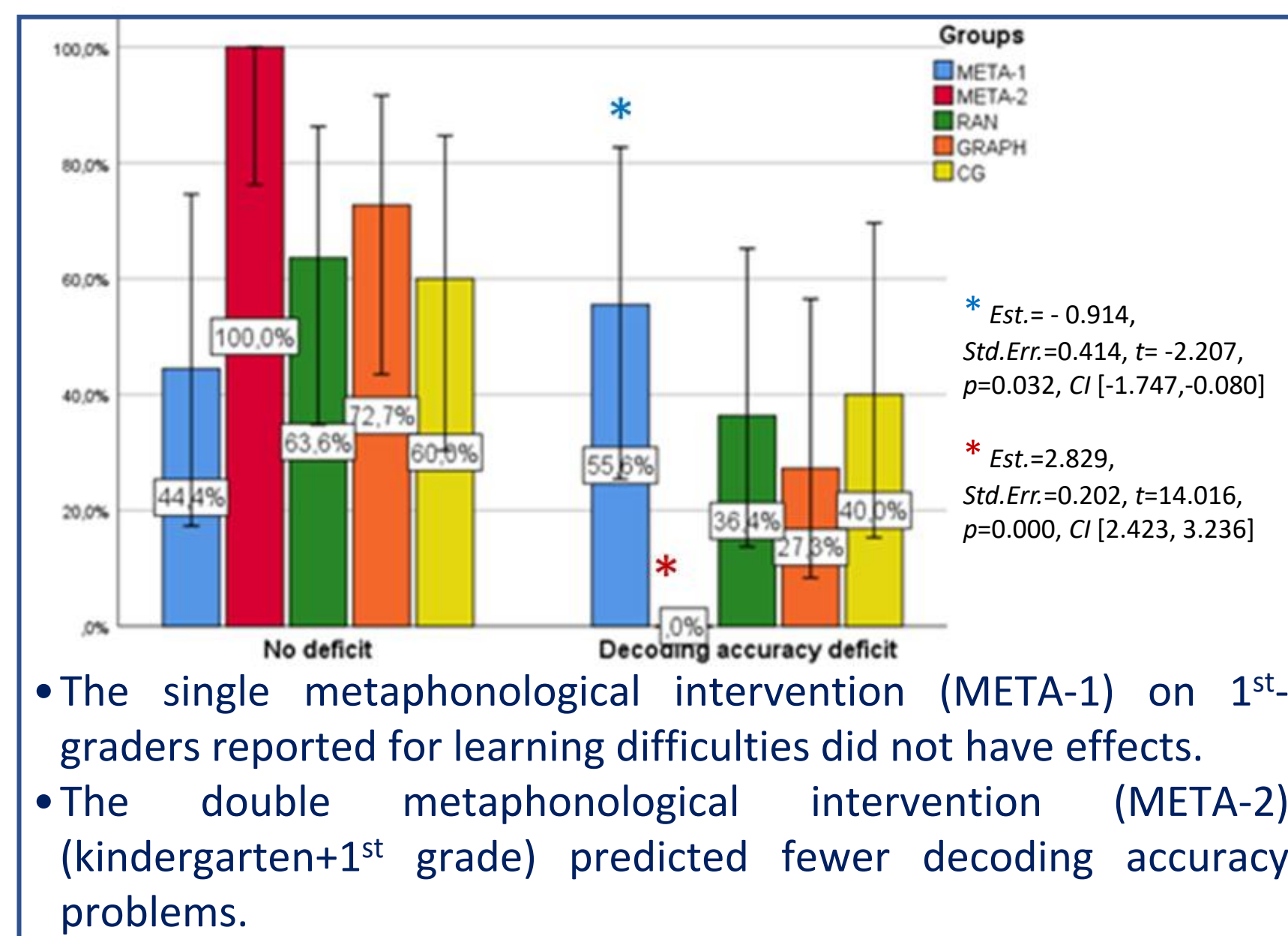


SO4. Effects of metaphonological or RAN intervention on typical reading development

Dependent variable	Predictor	Coeff.*	StdErr	t	p	Conf. interval
Word decoding speed (syll/sec)	META (MONO)	0.213	0.096	2.225	0.038	0.013 0.414
Word decoding errors (%)	META (BI)	0.410	0.136	3.023	0.007	0.127 0.693
Pseudoword decoding speed (syll/sec)	META (MONO)	0.409	0.141	2.900	0.009	0.115 0.704
Sublexical decoding speed (syll./sec.)	META (BI)	0.399	0.163	2.450	0.024	0.059 0.739
Sublexical decoding errors (%)	META*1-1 (MONO)	0.349	0.134	2.606	0.017	0.071 0.628
Text decoding speed (syll/sec)	META*1-1 (BI)	0.342	0.155	2.210	0.038	0.020 0.664
Text decoding errors (%)	META*1-2 (MONO)	-1.088	0.521	-2.089	0.042	-2.133 -0.043
	META*1-2 (BI)	0.450	0.180	2.506	0.021	0.077 0.824
	META*2-1 (MONO)	-0.756	0.234	-3.237	0.003	-1.230 -0.283
	META (MONO)	-1.548	0.359	-4.308	0.000	-2.277 -0.819
	RAN (MONO)	-0.866	0.338	-2.565	0.014	-1.549 -0.183
	RAN (BI)	-0.937	0.277	-3.377	0.002	-1.499 -0.374

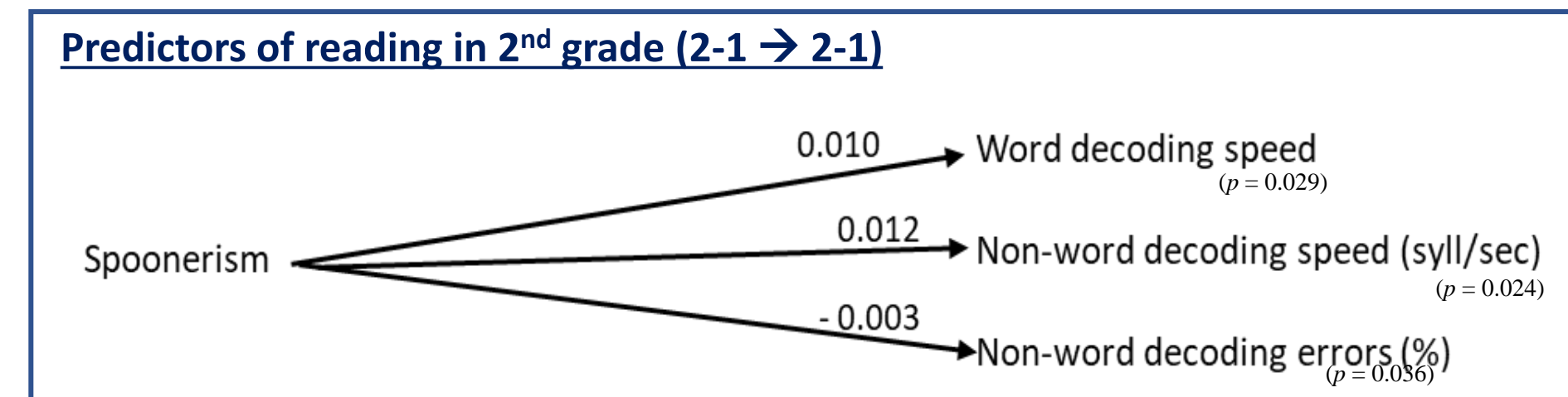
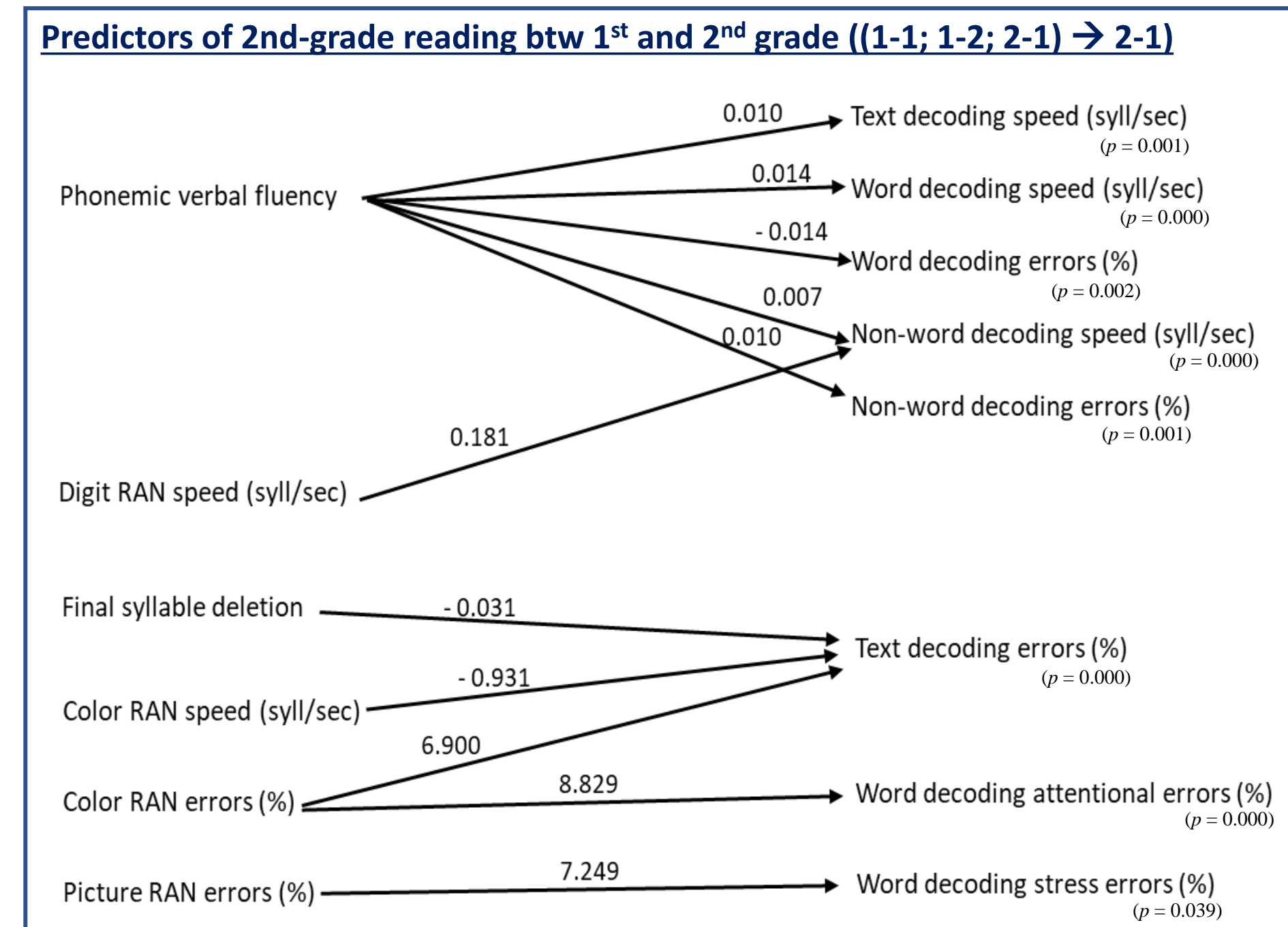
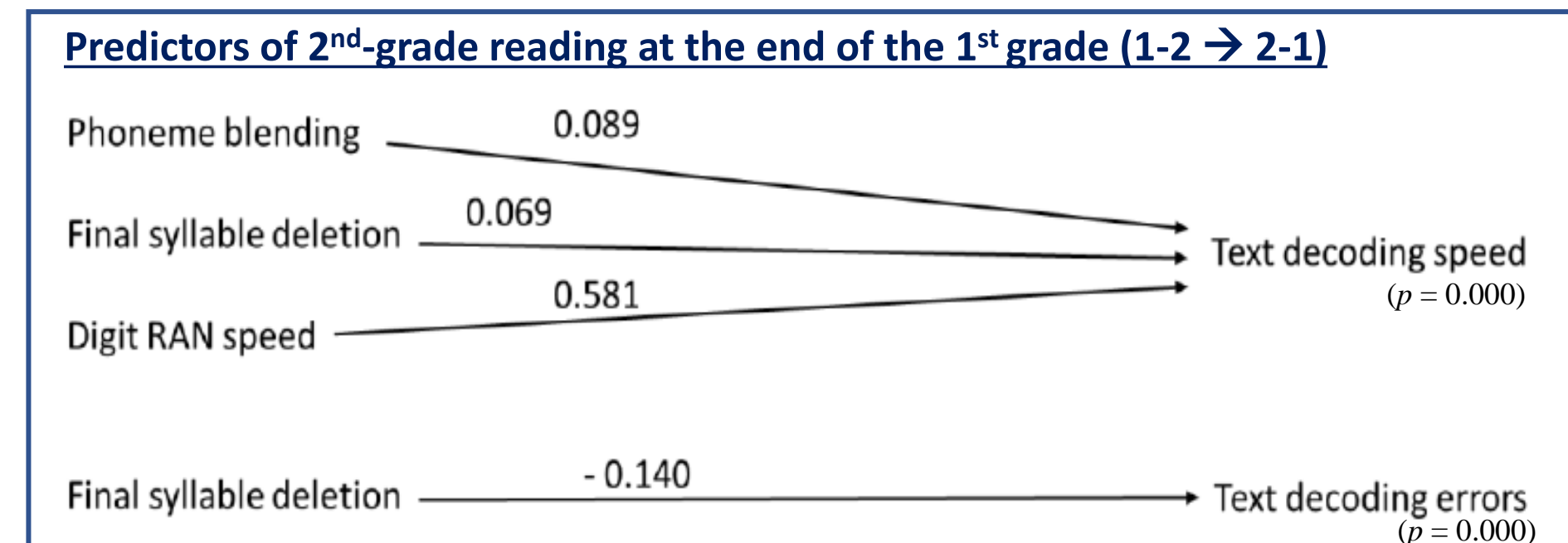
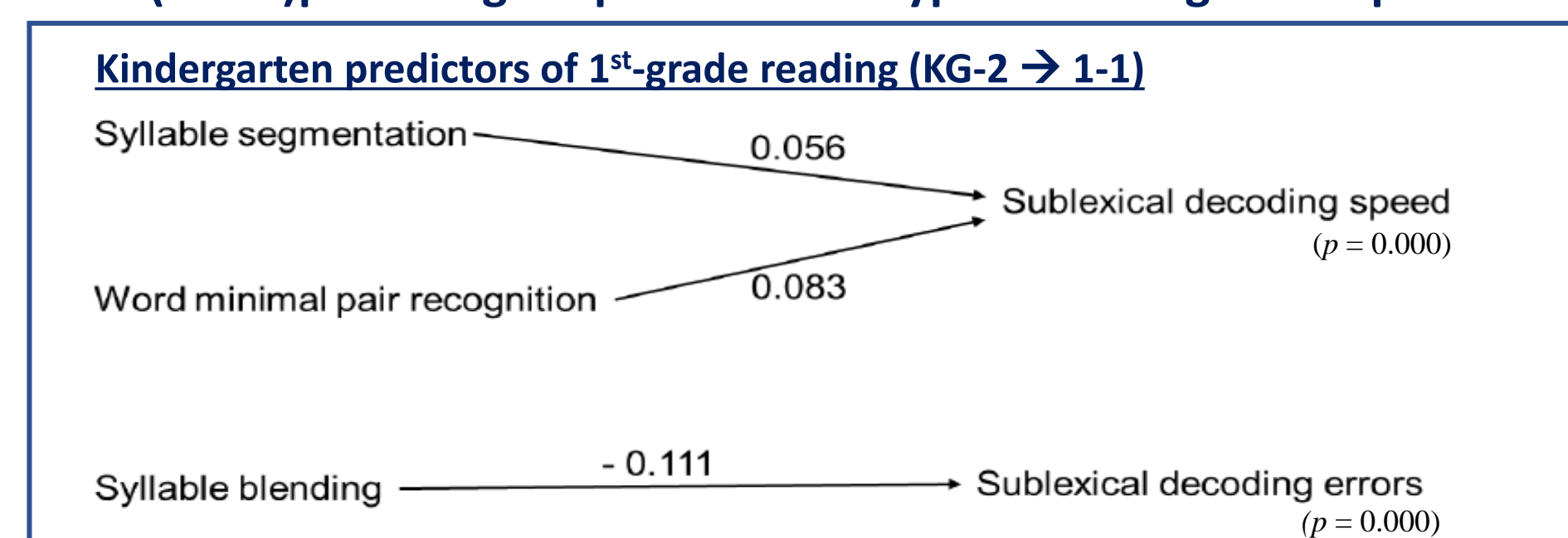
- The double metaphonological intervention (kindergarten+1st grade) affected decoding speed and word decoding accuracy in typically developing children, with some differences btw. mono and bilinguals.
- The double RAN intervention affected text reading accuracy in 2nd grade.

SO5. Effects of metaphonological or RAN intervention on atypical reading development



- The single metaphonological intervention (META-1) on 1st-graders reported for learning difficulties did not have effects.
- The double metaphonological intervention (META-2) (kindergarten+1st grade) predicted fewer decoding accuracy problems.

SO2. (Meta)phonological predictors of typical reading development



DISCUSSION

(SO1) Pseudoword repetition and syllable segmentation might be used to test, respectively, phonological and global metaphonological skills of both mono and bilinguals since kindergarten, as the two groups did not show any significant differences in these two abilities. Bilinguals reach a comparable level as monolinguals in both metaphonological skills and RAN btw. the middle and the end of the 1st grade, thus suggesting that the bilinguals' initial difficulties are not due to a delay in their language development but to their reduced exposure to the Italian input. The only exception (phonemic verbal fluency), which is still problematic in 2nd grade for bilinguals, depends on their reduced vocabulary compared to monolinguals. Bilinguals' difficulties in decoding non-paroxytone words have the same reason. No bilingual advantage emerged, thus suggesting that the putative bilingual advantage has linguistic rather than cognitive nature (Borragan et al., 2021). (SO2) A developmental metaphonological pattern emerged (from global to analytical, from recognition to manipulation). Analytical metaphonological skills develop interactively with reading (Bradley & Bryant, 1983; Frost, 2006; Morais, 1991). Different measures of metaphonology and RAN predict different portions of reading (Zoccolotti et al., 2005), for both accuracy and speed. The role of RAN in reading emerges later than that of metaphonology, but relatively soon compared to more opaque orthographies (Norton & Wolf, 2012). This confirms RAN as a measure of automaticity and suggests that phonological processes are early automatized in the (Italian) shallow orthography (Norton & Wolf, 2012). (SO3) Initial-syllable recognition in kindergarten is a good longitudinal predictor of text decoding accuracy difficulties. High specificity suggests that children that are proficient in initial-syllable recognition in kindergarten are unlikely to experience text decoding accuracy problems in 2nd and 3rd grade. (SO4) The double metaphonological intervention increased decoding speed in mono and bilingual typically developing children, but accuracy only in monolinguals, who have larger Italian vocabulary. Both mono and bilinguals benefited from the double RAN intervention to increase text decoding accuracy, thus confirming RAN as a predictor of reading accuracy besides speed (Di Filippo et al., 2005). (SO5) Metaphonological interventions should be planned timely (in kindergarten) and reinforced during early literacy acquisition.