

Does the development of digital skills influence the  
development of basic numerical skills in children from  
three to four years old ?

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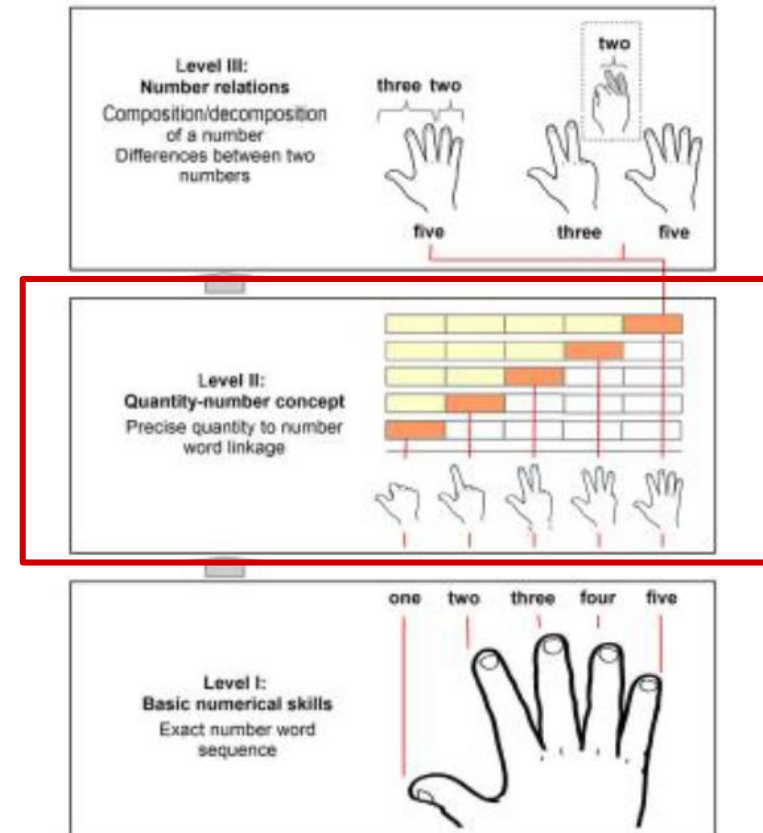
Catholic University of Louvain

Group of contacts - Tournai, May 2017

# Part 1

# Fingers

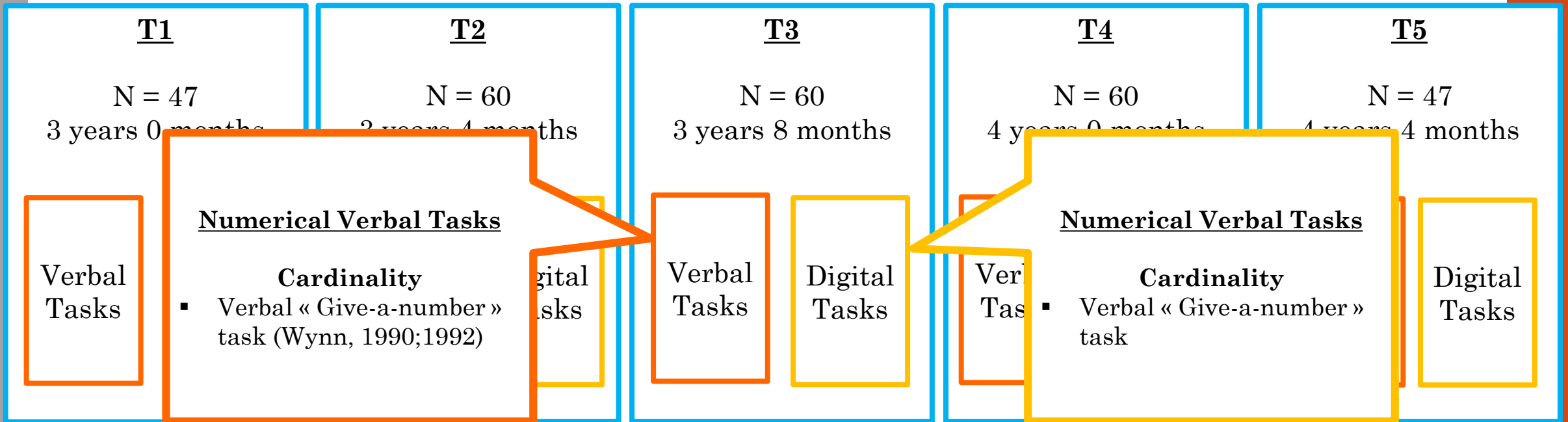
- Many studies show that gestures support verbal number knowledge (Di Luca & Pesenti, 2011; Goldin-Meadow, Levine & Jacobs, 2014; Roesch & Moeller, 2015)
- Cardinal number gestures: 2 contradictory studies
  - Nicoladis, Pika & Marentette (2010)
  - Gunderson, Speapen, Gibson & Goldin-Meadow (2015)



(Roesch & Moeller, 2015)

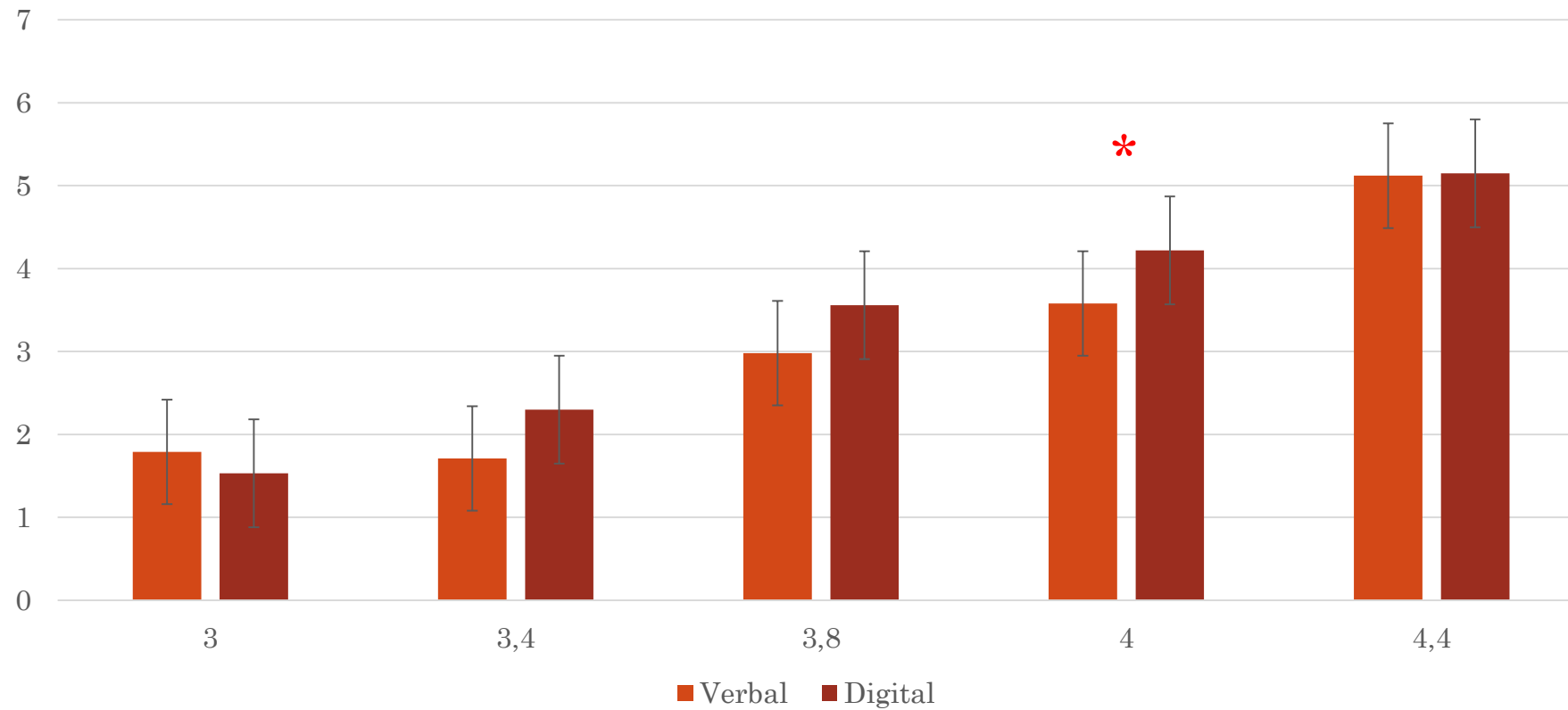
**Does the digital performance impact the verbal performance in a task assessing the comprehension of cardinality between the age of three and four years old?**

# Experiment design



# Tasks assessing Cardinality understanding

Performances in « Give-a-number » task



# Multi-level regressions

- Goal : using regressions at different levels to understand the implication of an independent variable on a dependent variable but, also taking into account the time and the interaction between the time and this independent variable.
- Equation :

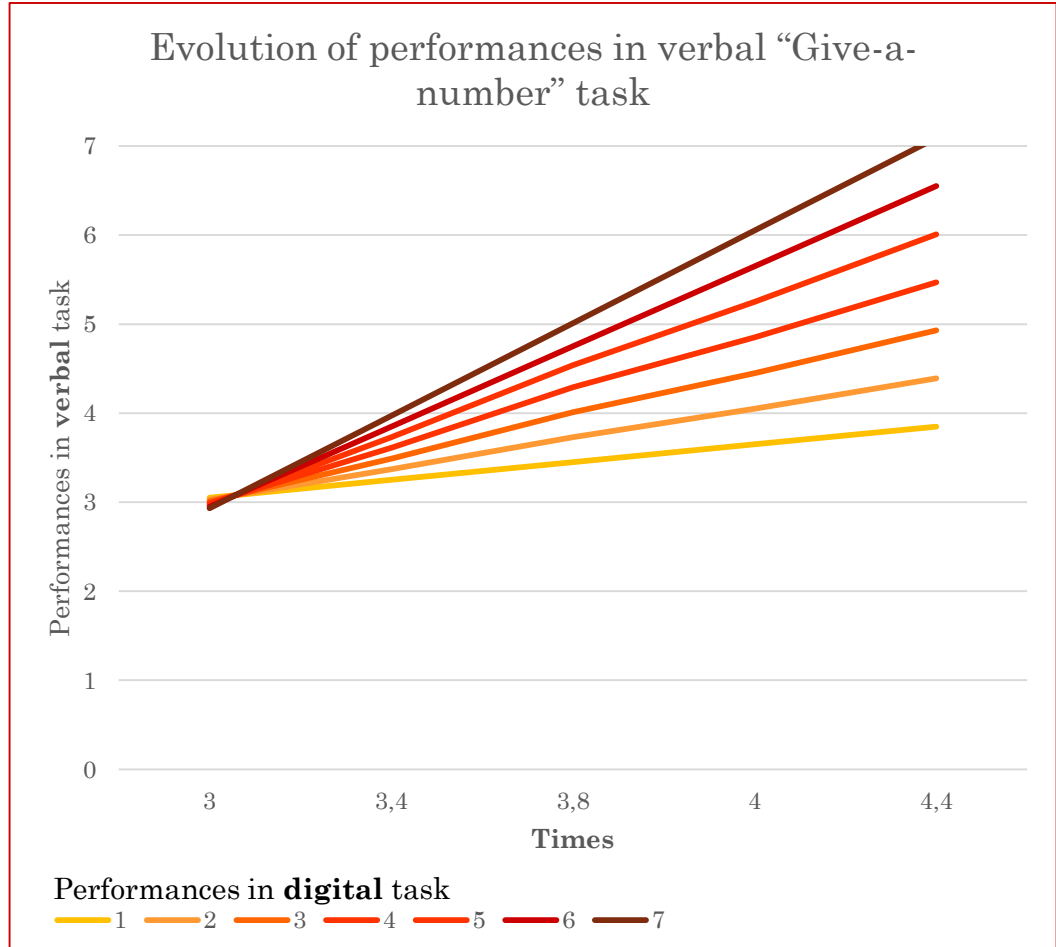
$$\text{« Dependant variable »} = \beta_{00} + \beta_{01}*(\text{Initial state}) + \beta_{10}*(\text{Time}) + \beta_{20}*(\text{Independant variable}) + \beta_{30}*(\text{Interaction}) + r_{0i} + e_{ti}$$

# Tasks assessing Cardinality understanding

« Give-a-number » tasks in digital and verbal modalities

$$\text{« VGaN »} = \beta_{00} + \beta_{01} * (DGaN-T2_i) + \beta_{10} * (TIMES_{ti}) + \beta_{20} * (DGaN_{ti}) + \beta_{30} * (TIMES * DGaN_{ti}) + r_{0i} + e_{ti}$$

	Coefficient	SE	t	p
Intercept	3,01	0,07	40,24	<.001
Times	0,06	0,09	0,63	.53
Digital « Give a number » task	-0,16	0,1	-1,51	.13
Interaction	0,14	0,03	5,55	<.001
Initial state	0,05	0,07	0,76	.45





# Tasks assessing Cardinality understanding

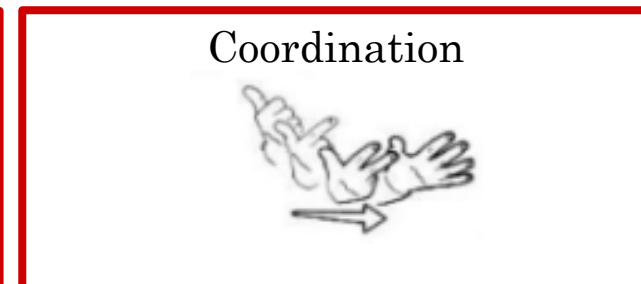
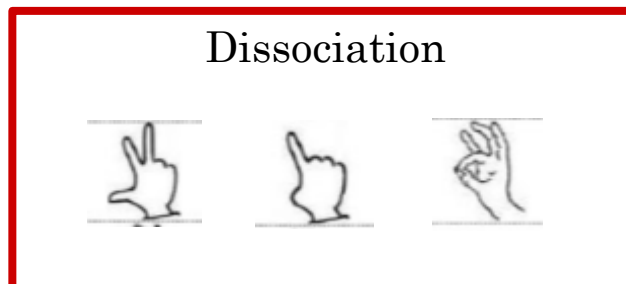
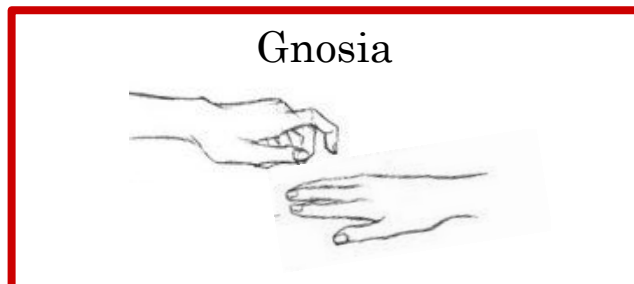
In « Give-a-number » task

- Digital performance plays a role in verbal performance, and this impact changes over time.
- The older the children are, the more verbal performance is impacted by digital performance on the same task.

## Part 2

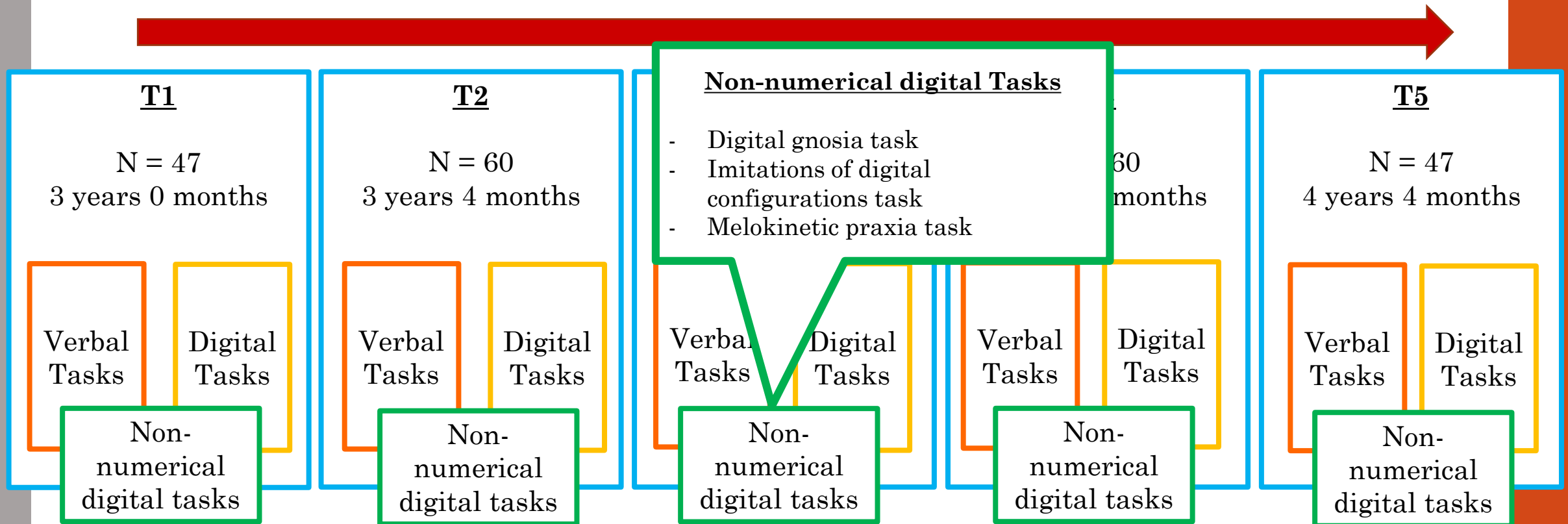
# Fingers

- Digital gnosis were described as a good predictor of numeric and arithmetic performance (Fayol, Barrouillet, & Marinthe, 1998; Marinthe, Fayol, & Barrouillet, 2001; Noël, 2005).
- Significant correlations were observed between manual dexterity and performance in addition tasks (Asakawa & Sugimura, 2009, 2011, 2014).
  - Lauzon (1990) split digital dexterity into 2 components : dissociation and coordination.



**Does the development of digital skills influence the development of verbal numerical skills in children from three to four years old ?**

# Experiment design

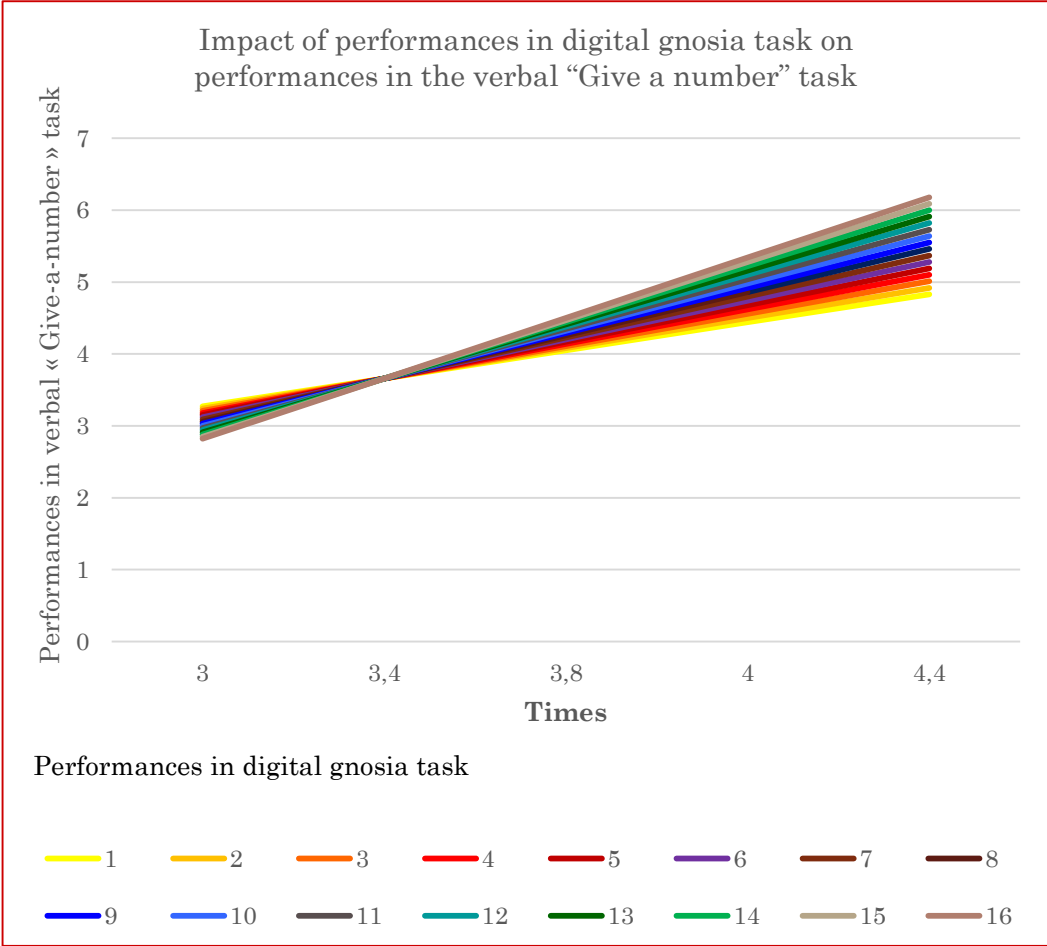


# Impact of non-numerical digital skills

Impact of digital gnosia performances on verbal performances in « Give-a-number » task

$$\text{« VGaN »} = \beta_{00} + \beta_{01} * (DG - T2_i) + \beta_{10} * (TIMES_{ti}) + \beta_{20} * (DG_{ti}) + \beta_{30} * (TIMES * DG_{ti}) + r_{0i} + e_{ti}$$

	Coefficient	SE	t	p
Intercept	2,94	0,1	29,66	<.001
Times	0,36	0,22	1,61	.11
Digital gnosia performance	-0,06	0,05	-1,19	.24
Interaction	0,03	0,02	1,73	<u>.09</u>
Initial state	-0,04	0,05	-0,72	.47

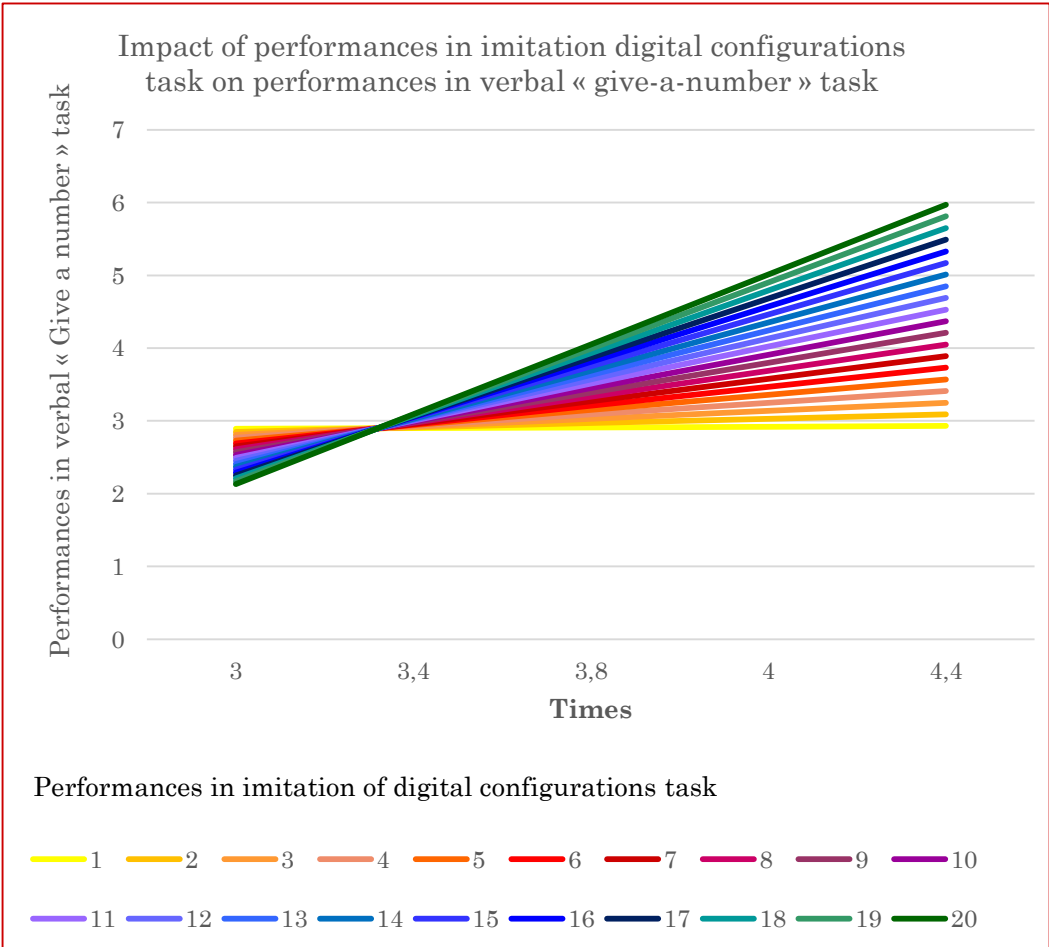


# Impact of non-numerical digital skills

Impact of digital imitation performances on verbal performances in « Give-a-number » task

$$\text{«VGaN»} = \beta_{00} + \beta_{01} * (\text{IDC-T2}_i) + \beta_{10} * (\text{TIMES}_{ti}) + \beta_{20} * (\text{IDC}_{ti}) + \beta_{30} * (\text{TIMES} * \text{IDC}_{ti}) + r_{0i} + e_{ti}$$

	Coefficient	SE	t	p
Intercept	2,97	0,1	30,49	<.001
Times	-0,04	0,25	-0,14	.89
Digital imitation performance	-0,09	0,04	-1,95	<b>.05</b>
Interaction	0,05	0,02	3,28	<b>.001</b>
Initial state	-0,03	0,03	-0,98	0,33

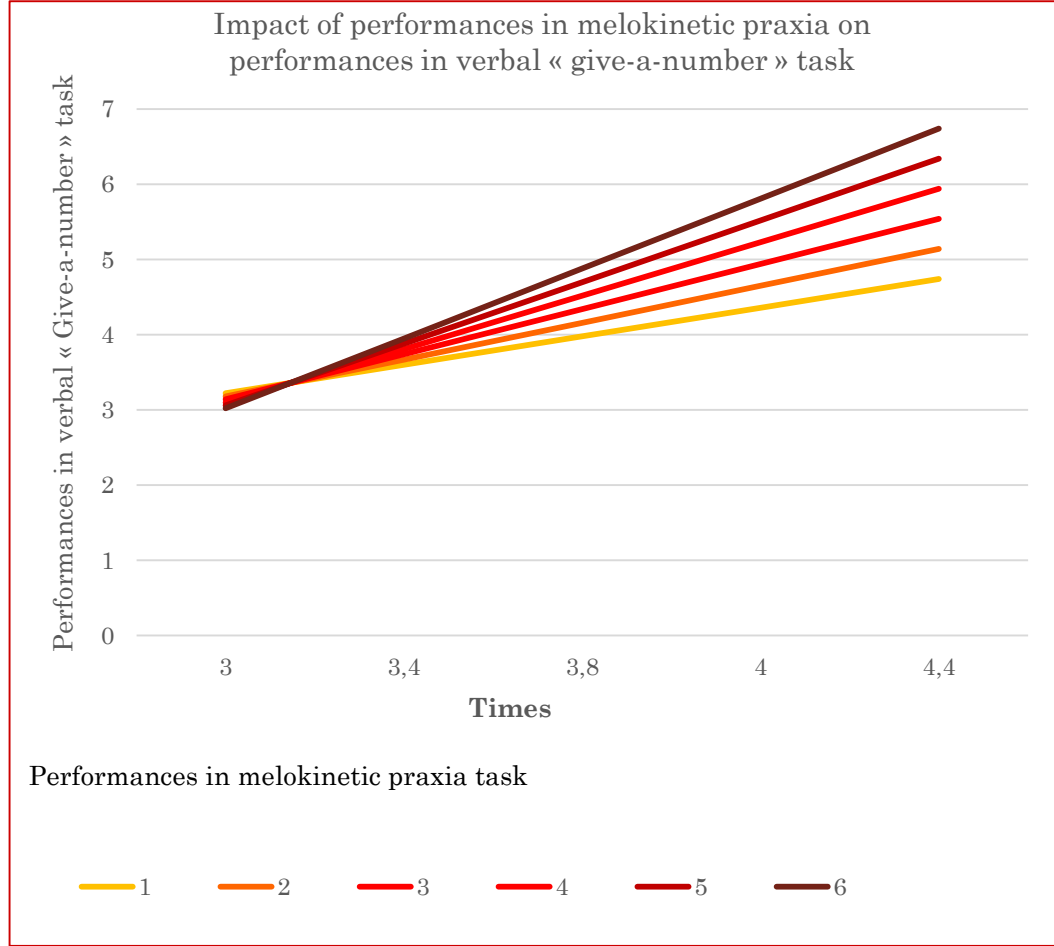


# Impact of non-numerical digital skills

Impact of melokinetic praxia performances on verbal performances in « Give-a-number » task

$$\text{«VGaN»} = \beta_{00} + \beta_{01} * (MP - T2_i) + \beta_{10} * (TIMES_{ti}) + \beta_{20} * (MP_{ti}) + \beta_{30} * (TIMES * MP_{ti}) + r_{0i} + e_{ti}$$

	Coefficient	SE	t	p
Intercept	2,99	0,1	30,97	<.001
Times	0,27	0,15	1,83	<u>.07</u>
Digital gnosis performance	-0,15	0,08	-1,83	<u>.07</u>
Interaction	0,11	0,03	3,81	<b>&lt;.001</b>
Initial state	-0,04	0,07	-0,54	.59

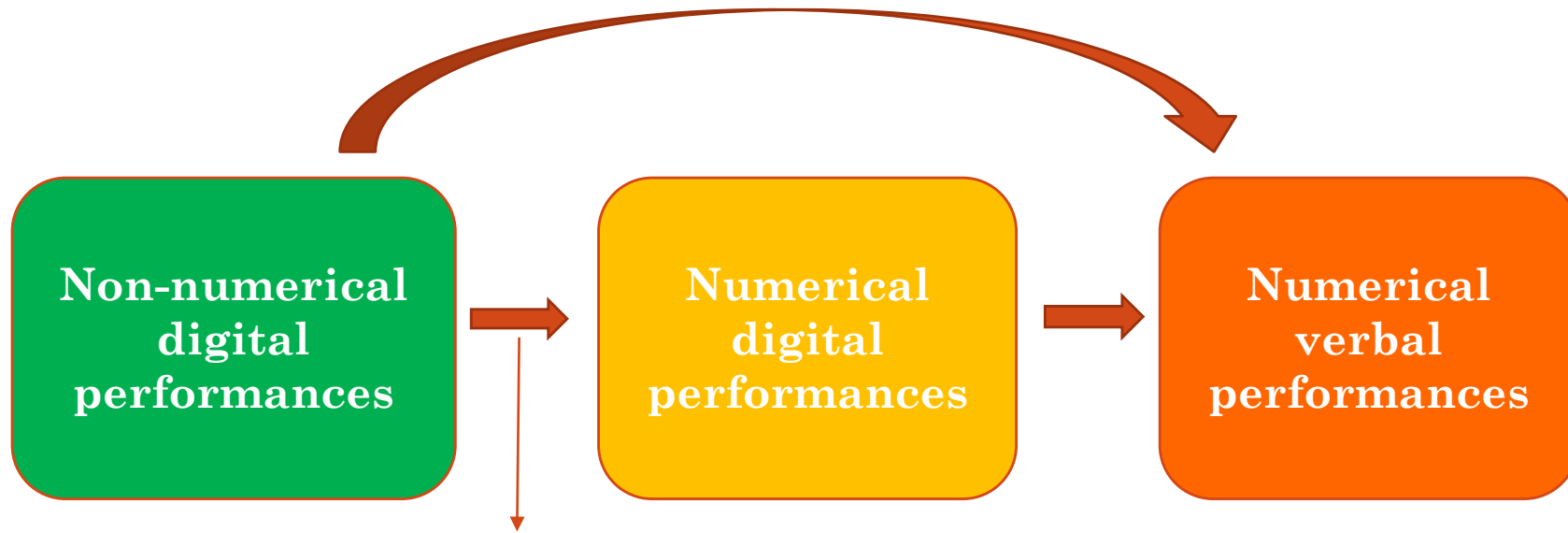




# Impact of non-numerical digital skills

- Digital gnosis performance has less impact on verbal give-a-number performance than components of dexterity, such as dissociation skills or coordination skills
- Dissociation skills and coordination skills
  - Over time, the more efficient children are at dissociating and coordinating their fingers, the more efficient they are at understanding cardinality in verbal modality.

# Impact of non-numerical digital skills



Just marginally significant interaction between times and praxia performances

## In conclusion

- Numerical digital performances play a role in the numerical verbal performances and this impact is modulated by the time
- Some non-numerical digital skills play a role in the verbal performance
  - Not digital gnosis skills
  - But dexterity skills (dissociation and coordination components)
- In general, the older the child is, the more this influence increases.

# Future questions

## Soon...

- Do numerical digital skills explain non-numerical digital skills ?
- Is this pattern of results observed in other tasks known to assess the cardinality, such as equivalence judgement tasks in verbal and digital modalities ?
- Is this pattern of results observed in numerical tasks associated with the comprehension of cardinality, such as function of succession tasks ?
- ...

## A little less soon...

- What is the impact of dissociation and coordination skills on performance in arithmetic ?
- What is the impact of these digital skills in pathological populations ?
- ...



Thanks a lot to Laurence Rousselle and Marie-Pascale Noël

**Thank you for your attention !**

