Université de Liège

How and when children master the numerical content conveyed by verbal numbers and number gestures ?

Line Vossius[1], Marie-Pascale Noël[2] & Laurence Rousselle[1]

[1]University of Liège, Research unit on childhood

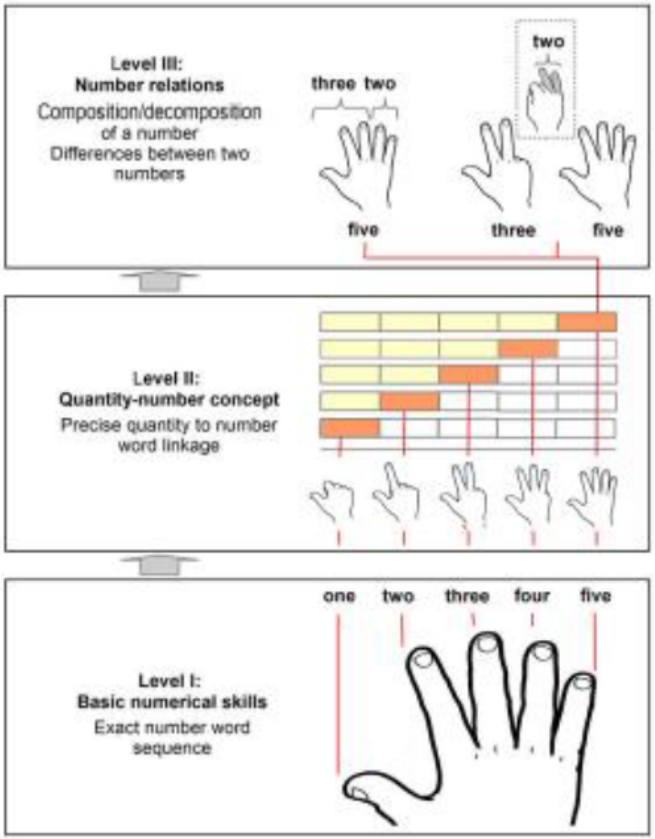
[2]Catholic University of Louvain

Group of contacts

Courtrai, April 2016

Fingers

- Many studies show that gestures support verbal number knowledge
  Luca & Pesenti, 2011; Goldin-Meadow, Levine & Jacobs, 2014; Roesch & Moeller, 2015)



(Roesch & Moeller, 2015)

Fingers

- Many studies about fingers in counting
  - Finger pointing and finger counting allow children- to keep a visual track in the recitation of the verbal numerical chain (Fuson, Richards & Briars, 1982; Saxe & Kaplan, 1981; Alibali & Di Russo, 1999)

- Many studies about fingers in arithmetics
  - Fingers are usually used by young children to resolve arithmetic tasks (Fuson, 1982)
  - Finger gnosia are a good predictor of performance in arithmetics and problem solving (Fayol, Barrouillet & Marinthe, 1998; Noël, 2005)

- BUT… Fingers in the understanding of the cardinality concept are less studied in children

Cardinality

- The learning of cardinal meaning of number words is long and works through different stages (Wynn, 1990, 1992)
  - The first four number words are mastered in order one at a time (Carey, 2009; Sarnecka & Lee, 2009)
    - Children are first « one-knowers », then « two-knowers », « three-knowers » and « four-knowers)
  - Then, children learn that the last number word reached when counting a set represents the size of this set (Gelman & Gallistel, 1978)
    - Children become « Cardinal-Principle » knowers
- This learning takes one year and starts at around the age of 3 years

Cardinal number gesture

- Two contradictory studies
  - Nicoladis, Pika & Marentette (2010)
  - Gunderson, Speapen, Gibson & Goldin-Meadow (2015)

Cardinal number gestures

Nicoladis, Pika & Marentette (2010)	Gunderson, Speapen, Gibson & Goldin-Meadow (201
pulation : 44 children – Groups based on the age (2- to 5-ars old)	Population : 155 children – Groups based on knowledge-level (assessed in *Give-a-number* task)
sks : *How many* & *Give-a-number,*	Tasks: *What's on this Card-Gesture* & *What's on this Car Speech*
nclusion : Children are more accurate with number rds than number gestures in both tasks	**Conclusion : Children who are not yet CP-knowers are more accurate labelling small sets/estimating large sets with gestures than with words**
nits : Not an universal advantage for number words through the groups of age	Limits : • Digital training before the tasks could influence the results

Cardinal number gestures

Nicoladis, Pika & Marentette (2010)	Gunderson, Speapen, Gibson & Goldin-Meadow (201
pulation : 44 children – Groups based on the age (2- to 5-ars old)	Population : 155 children – Groups based on knowledge-level (assessed in *Give-a-number* task)
sks : *How many* & *Give-a-number*	Tasks: *What's on this Card-Gesture* & *What's on this Car Speech*
nclusion : Children are more accurate with number rds than number gestures in both tasks	**Conclusion : Children who are not yet CP-knowers are more accurate labbeling small sets/estimating large set with gestures than with words**
nits : Not an universal advantage for number words through the groups of age	Limits : • Digital training before the tasks could influence the results

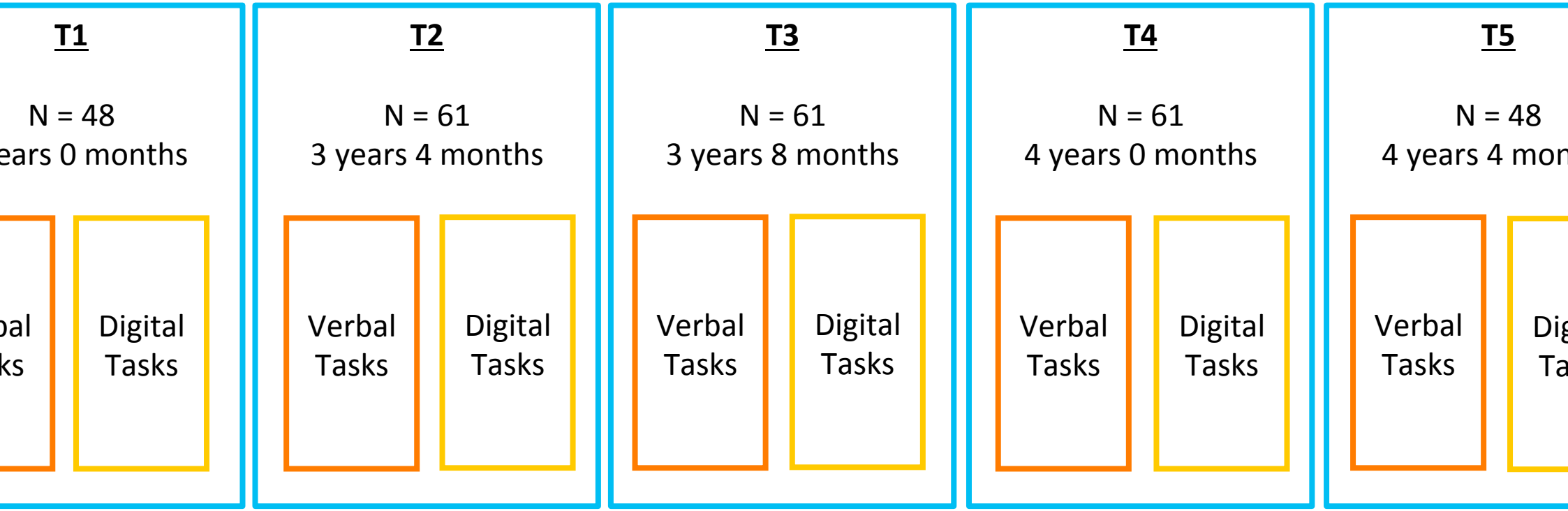
NO longitudinal study assessing developmental trajectories

Our study

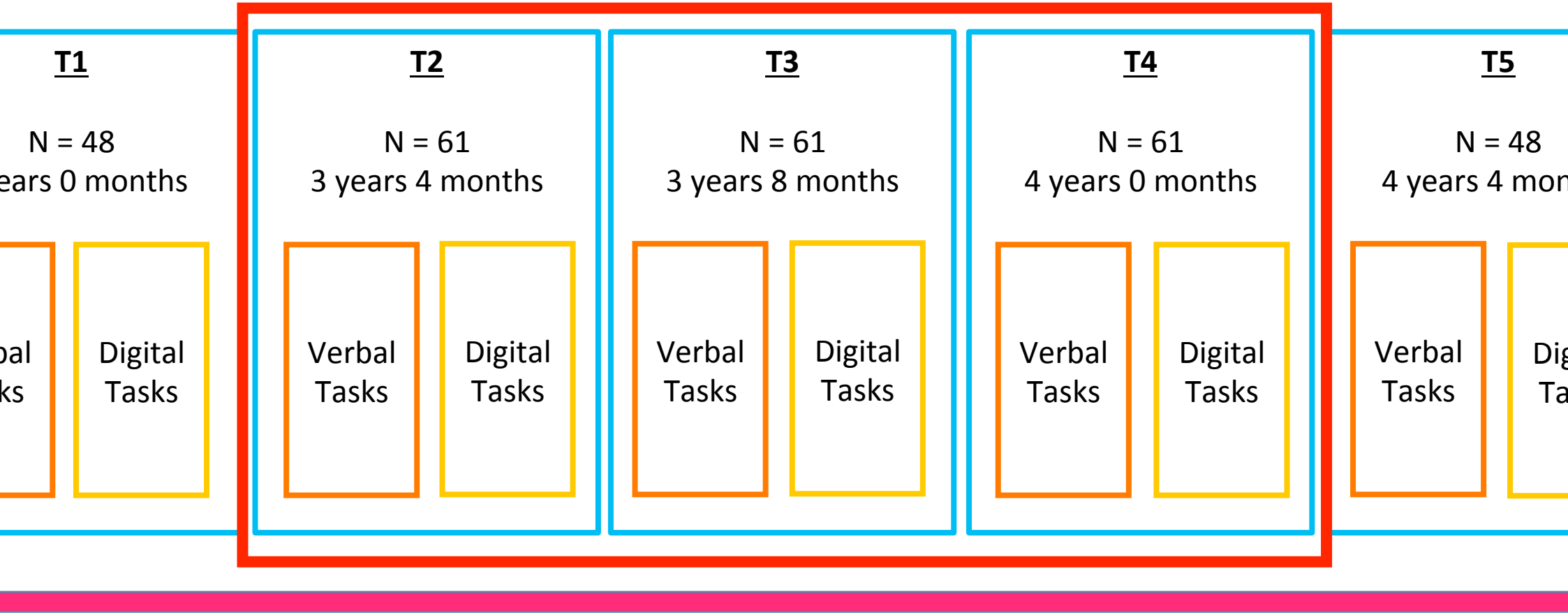
How and when children come to master the numerical content conveyed by numbers?

At some point in the development, is there an advantage for the undertsanding of number gestures or verbal numbers?

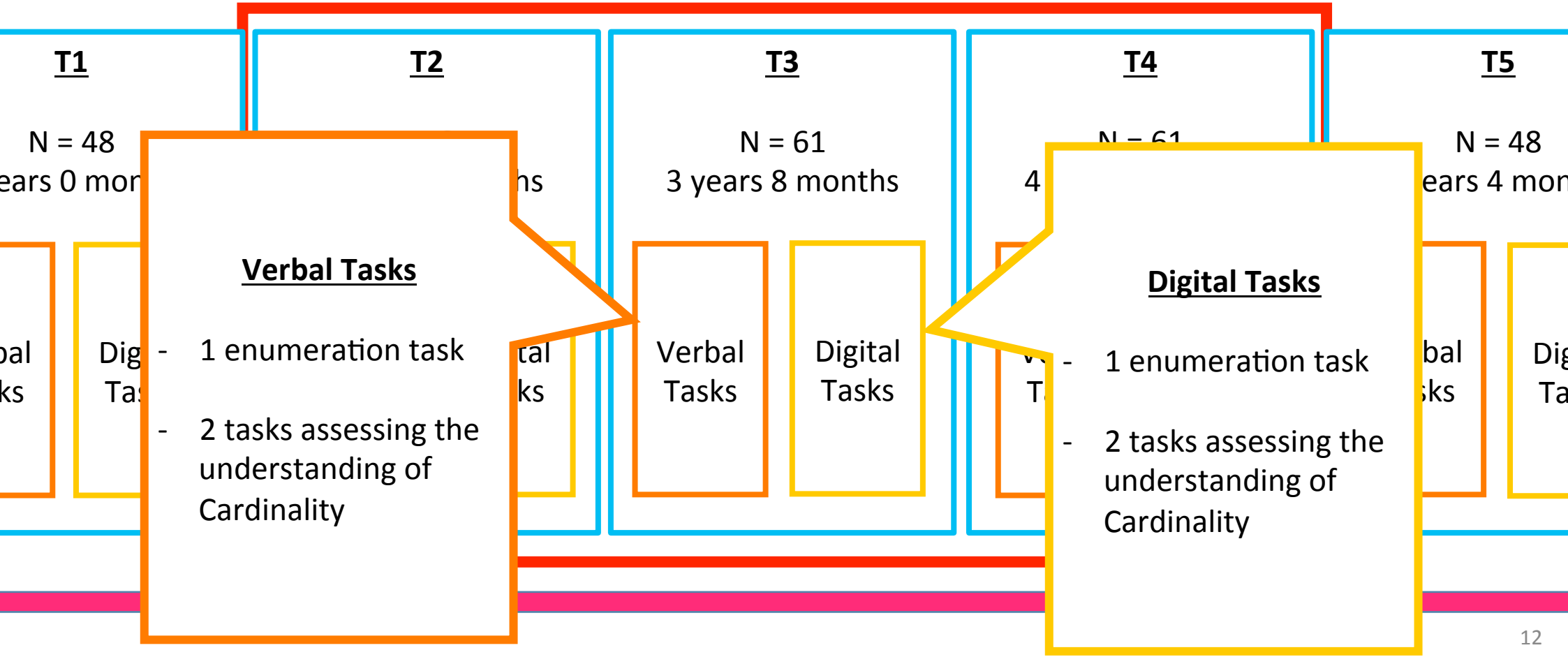
Experimental design



Experiment design

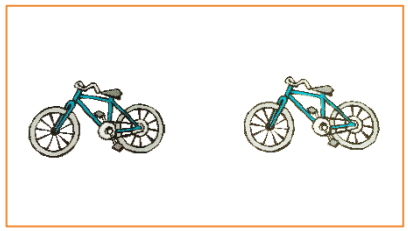


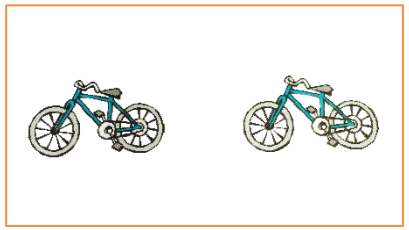
Experiment design



Enumeration task

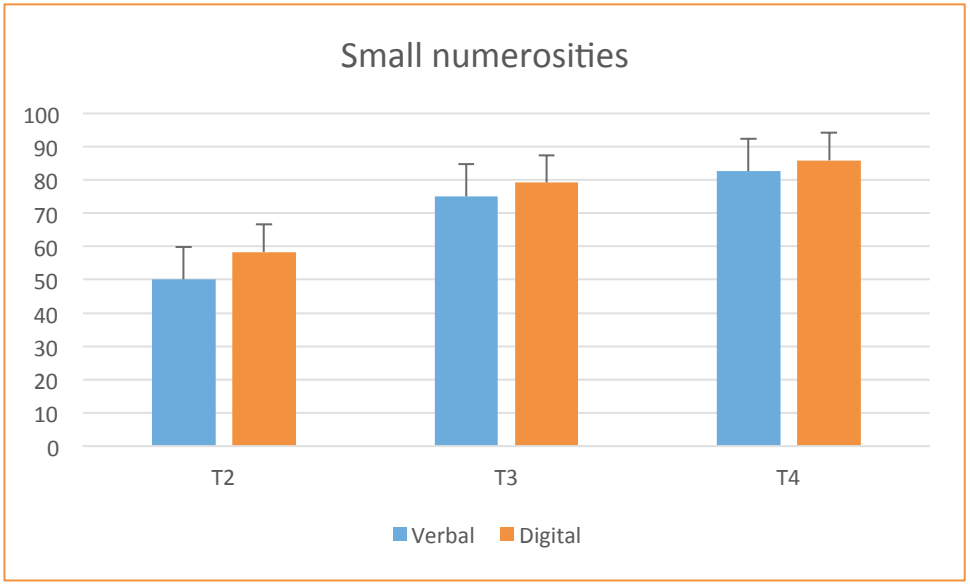
Verbal Tasks	Digital Tasks
n you tell me how many … ?»	*« Can you show me how many … with your fingers ? »*
• *2 items with small numerosities (2 & 3)* • *2 items with large numerosities (6 & 7)*	• *2 items with small numerosities (2 & 3)* • *2 items with large numerosities (6 & 7)*

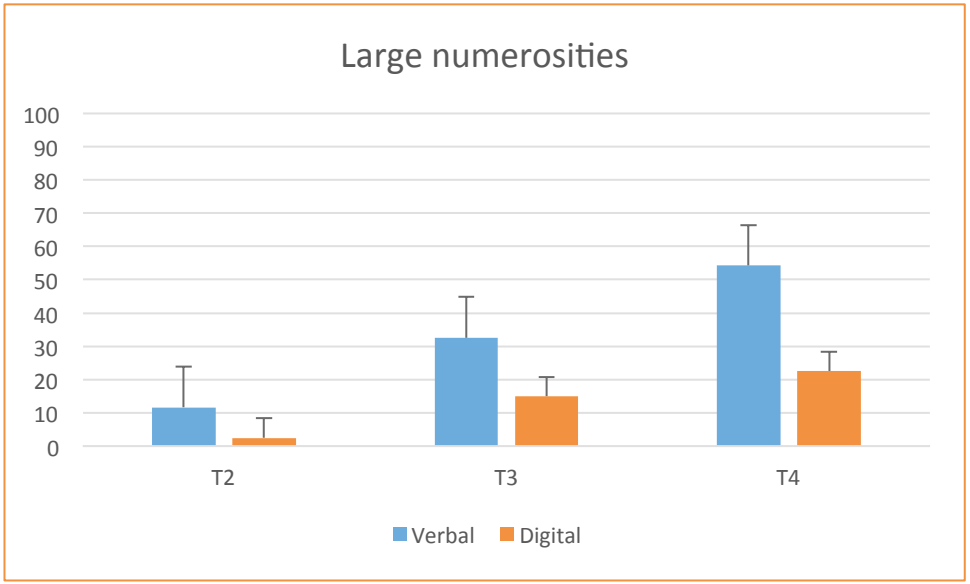




Enumeration task

n = 60





- TIME effect ($p < .01$)
- No MODALITY effect ($p > .10$) and no significant interaction

- TIME effect ($p < .01$), MODALITY ($p < .01$) and significant interaction TIME x MODALITY

Enumeration task

n = 60

Correlations between performance through the Verbal and the Digital modalities in the enumeration task

Digital \ Verbal		Small num.			Large num.		
		T2	T3	T4	T2	T3	T4
Small num.	T2	0,40					
	T3		0,05				
	T4			0,26			
Large num.	T2				0,33		
	T3					0,34	
	T4						0,31

Enumeration task

- Small numerosities : Children exhibit similar performance to tell *How many* with number gestures as with verbal numbers.

- Large numerosities : Children show better performance to tell *How many* with verbal numbers than with number gestures.

sessement of the understanding of cardinal meaning

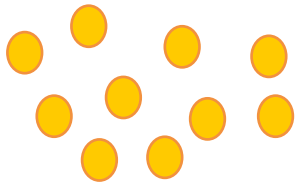
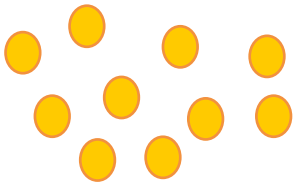
Verbal Tasks	Digital Tasks
Give-a-number » task *Can you give me **/THREE/** token? »*	• **« Give-a-number » task** *« Can you give me*  *token? »*
Equivalence judgement » task *Here are some apples in the box. Puppy says that there are **/THREE/** apples in this box. Is it true or wrong ? »*	• **« Equivalences judgement » task** *« Here are some apples in the box. Puppy shows that t are*  *apples in this box. Is it true or wrong ? »*

ssessement of the understanding of cardinal meaning

Verbal Tasks	Digital Tasks
Give-a-number » task *Can you give me **/THREE/** dots ? »*	• **« Give-a-number » task** *« Can you give me*  *dots ? »*
Equivalence judgement » task *Here are some appels in the box. Puppy says that there are **/THREE/** appels in this box. Is it right or wrong ? »*	• **« Equivalences judgement » task** *« Here are some appels in the box. Puppy shows that t are*  *apples in this box. Is it right or wrong ? »*

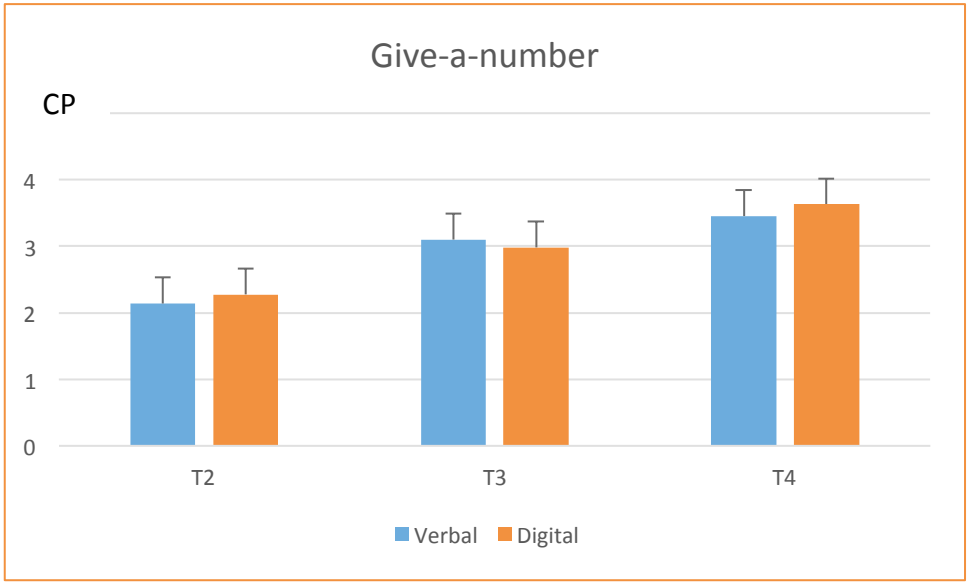
→ High correlations between both tasks

« Give-a-number » task

Verbal Tasks	Digital Tasks
*n you give me **/THREE/** token? »* 	*« Can you give me*  *token? »* 
• *The child received 10 token*	• *The child received 10 token*
• *Cardinal development level = the largest numerosity accurately identified by the child two out of three times*	• *Cardinal development level = the largest numero accurately identified by the child two out of three times*
• *5 levels : 5 knowers groups* • *1-knowers group* • *2-knowers group* • *3-knowers group* • *4-knowers group* • *CP-knowers group*	• *5 levels : 5 knowers groups* • *1-knowers group* • *2-knowers group* • *3-knowers group* • *4-knowers group* • *CP-knowers group*

« Give-a-number » task

n = 51



- TIME effect ($p < .01$);
- No MODALITY effect ($p > .10$), no significant interaction

« Give a number » task

n = 51

Correlations between knowers groups in Verbal modality and in Digital modality in the « Give-a-number » task

Digital \ Verbal		T2	T3	T4
	T2	0,44		
	T3		0,47	
	T4			0,72

« Give-a-number » task

- Children do not master the cardinality better in one specific modality compared to the other when giving a number of objects.

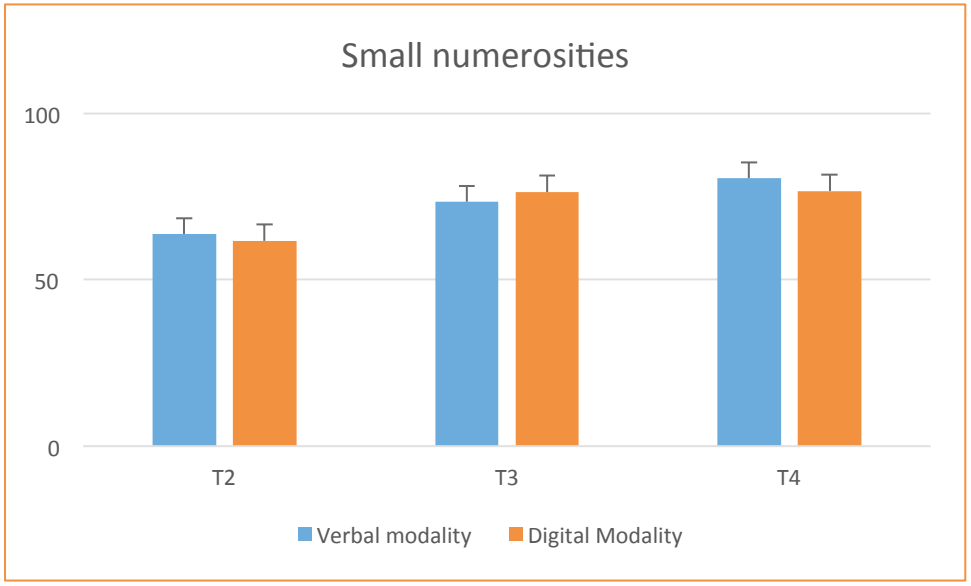
- The cardinal meaning understanding with number gestures and verbal number words develop in parallel and probably support each other

Equivalence judgement task

Verbal Tasks	Digital Tasks
*re are some apples in the box. Puppy says that there **'THREE/** apples in this box. Is it right or wrong ? »* • *4 items with small numerosities (2 & 3)* • *4 items with large numerosities (6 & 7)* 	*« Here are some apples in the box. Puppy shows that the are*  *apples in this box. Is it right or wrong ? »* • *4 items with small numerosities (2 & 3)* • *4 items with large numerosities (6 & 7)* 

Equivalence judgement task

n = 61



- TIME effect ($p < 0,01$)
- No MODALITY effect ($p > 0,10$) and no significant interaction

Equivalence judgement task

n = 61

Correlations between performances in Verbal modality and in Digital modality in the equivalence judgement task

Digital \ Verbal		Small num.		
		T2	T3	T4
Small num.	T2	0,45		
	T3		0,58	
	T4			0,40

Equivalence judgement task

- For small numerosities, there is no advantage, at any time point, to judge of the cardinal meaning of number gesture or verbal number words.

→

Discussion

Thank you for you attention !

Tasks assessing Cardinality understanding

- n = 51

Correlations in both tasks assessing the understanding of Cardinality

(N = 51)			Performances in Equivalence judgement task					
			V			D		
			T2	T3	T4	T2	T3	T4
Knowers groups in « Give-a-number » task	V	T2	0,41	0,33	0,40	0,23	0,34	0,34
		T3	0,28	0,50	0,33	0,17	0,40	0,30
		T4	0,45	0,38	0,43	0,20	0,26	0,30
	D	T2	0,33	0,44	0,57	0,46	0,42	0,28
		T3	0,27	0,34	0,50	0,37	0,20	0,05
		T4	0,40	0,44	0,50	0,16	0,17	0,23