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## Introduction

- The number word system of German inverts units and tens compared to the Arabic notation (i.e. 28 is pronounced as “eight and twenty”). This is not the case in French, which is more transparent with respect to the Arabic number code. Evidence indicates that the linguistic structure of number words can facilitate or impede numerical development. (Zuber & al., 2009).
- In transcoding tasks more mistakes are made in non-transparent compared to transparent languages (Imbo, Vanden Bulcke, De Brauwer, & Fias, 2014)

## Hypothesis

We tested French and German adults (monolinguals & bilinguals) and children (monolinguals) with a new paradigm in which we manipulated the order of appearance of units and tens of two-digit numbers. Our main hypotheses were:

- The order of digit-appearance (tens vs units first) influences performance as a function of language transparency.**
- Children are highly influenced by the order of digit-appearance (i.e. German are slower than French-speaking children)**
- Bilingual adults are less influenced by the order of appearance than monolingual adults due to the influence of both bilinguals' languages on each other**

## Methods

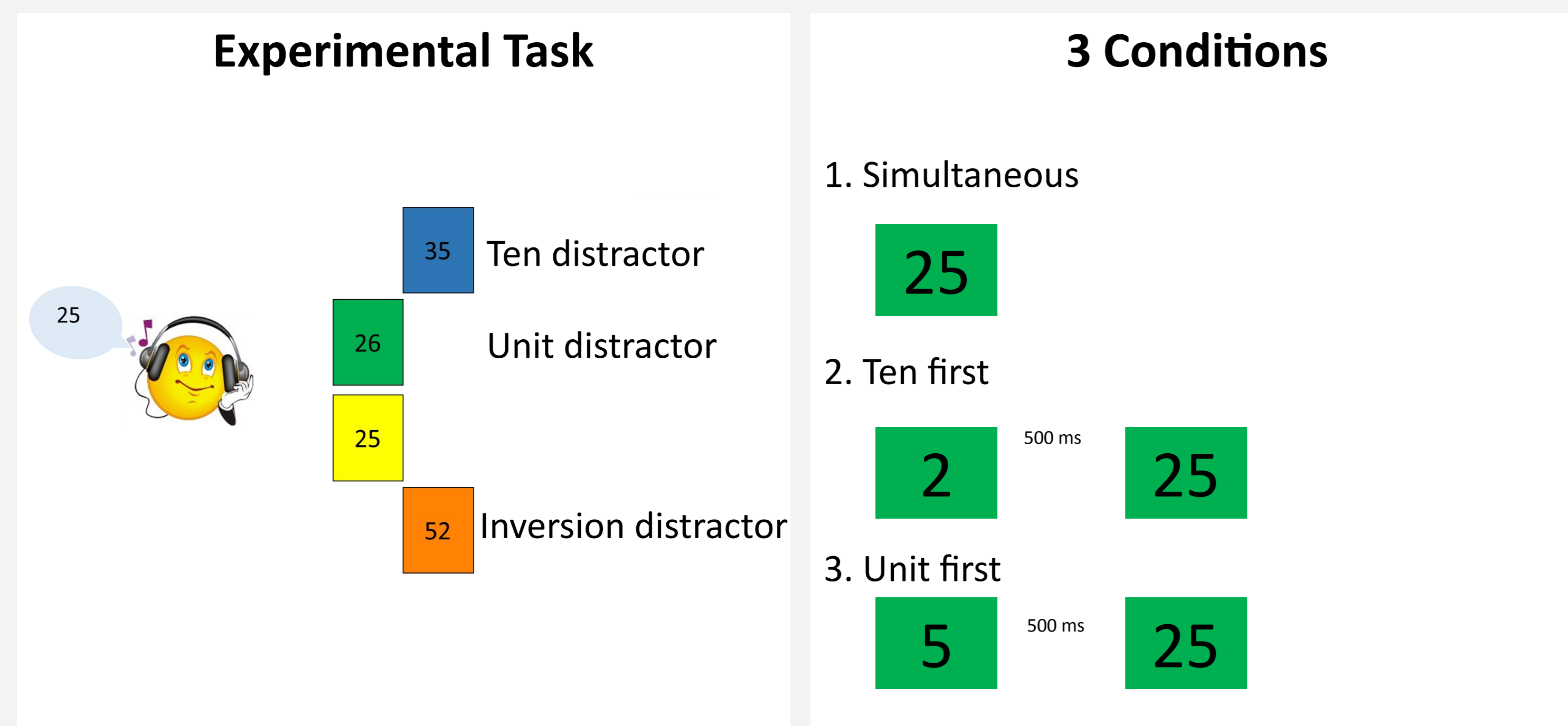
### Participants:

- 28 Belgian French-speaking 4th grade children ( $M_{age} = 10$  yo,  $SD_{age} = 0.4$ )
- 19 Belgian German-speaking 4th grade children ( $M_{age} = 10.3$  yo,  $SD_{age} = 0.6$ )
- 24 German & French-speaking bilingual Students (12 Females)
- 18 French-speaking Students (13 Females)
- 26 German-Speaking Students (15 Females)

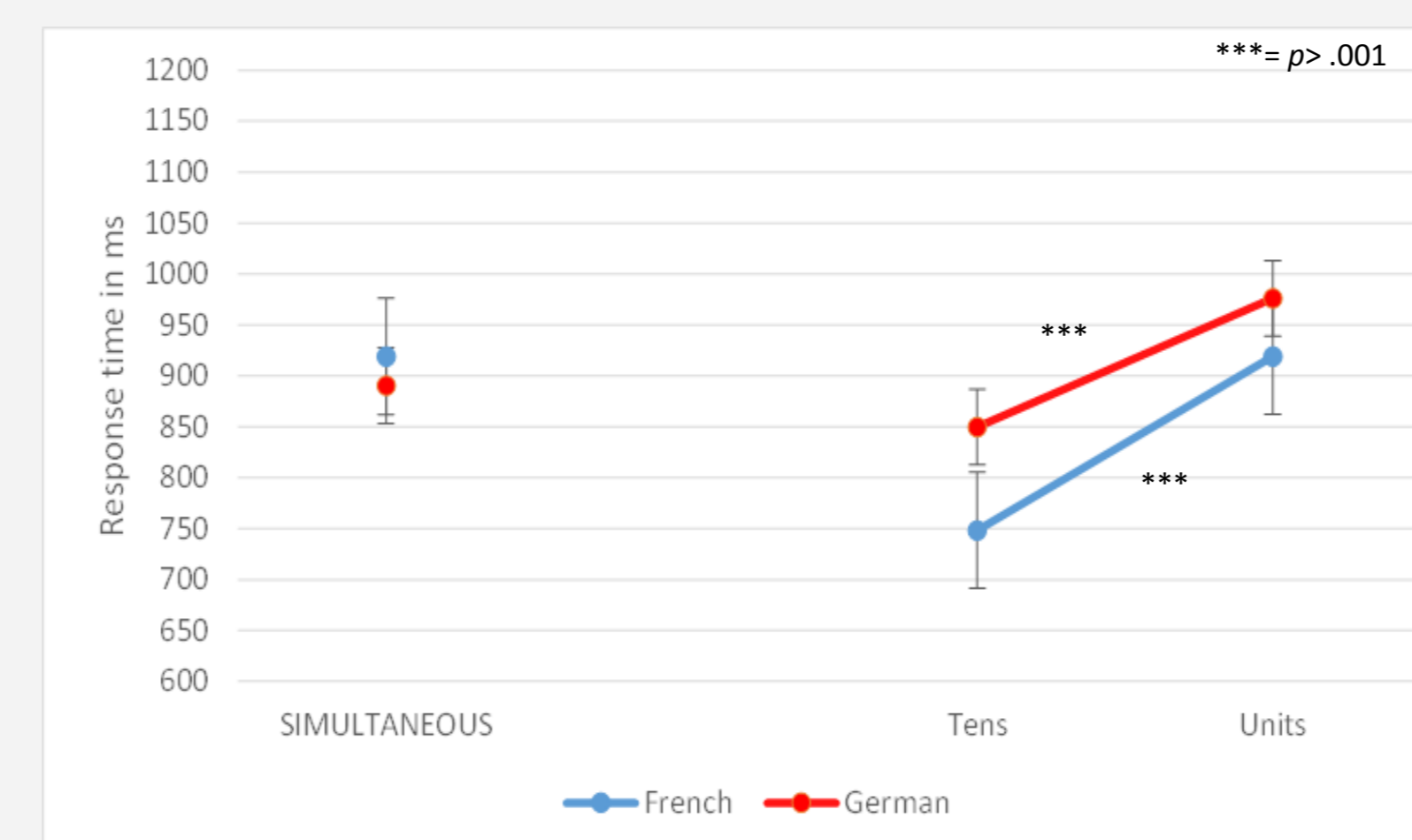
**Experimental task:** choosing the heard number among 4 alternatives

**Stimuli:** 42 Two-digit numbers, orally presented in **3 conditions:**

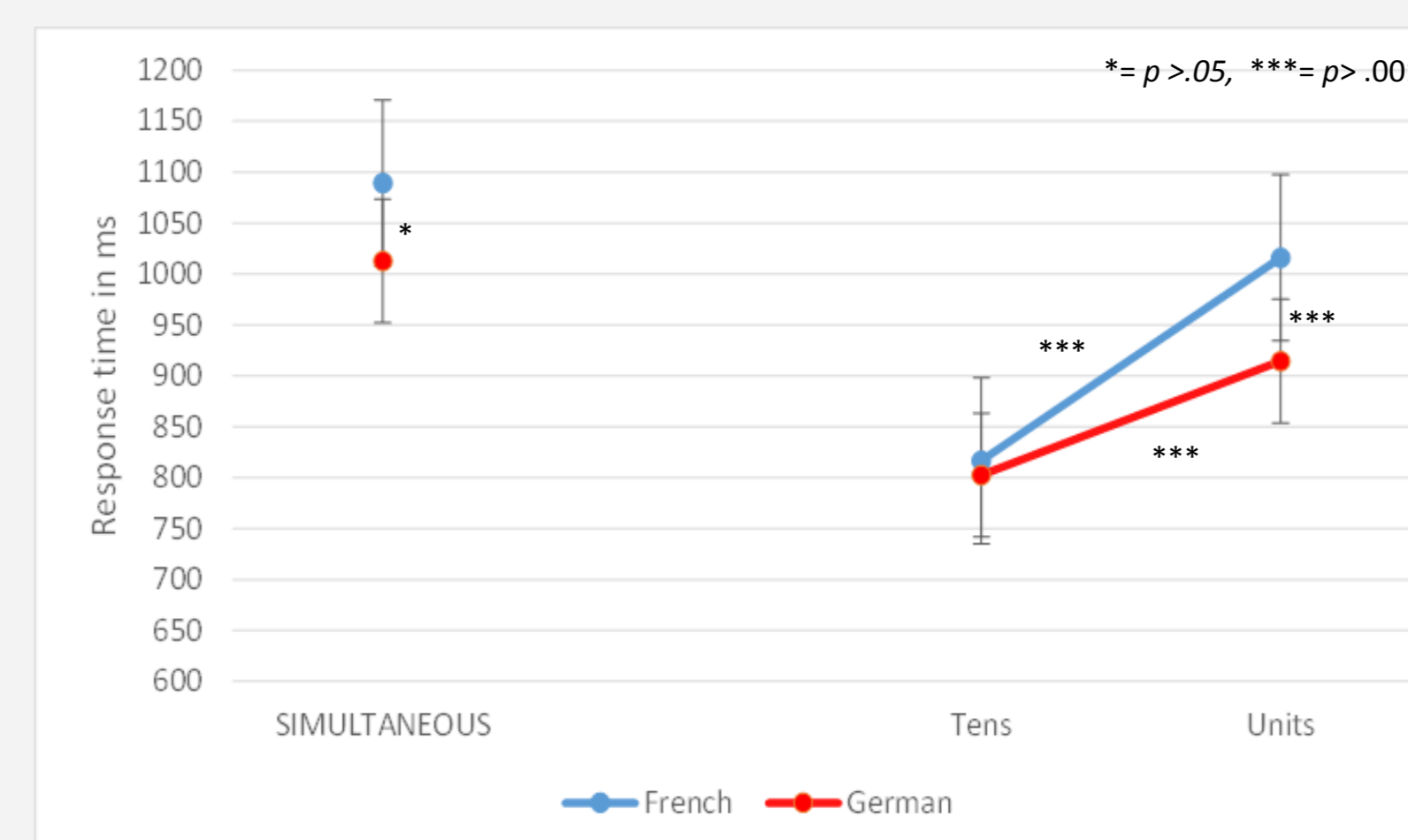
- Simultaneous appearance
- Ten first
- Unit first



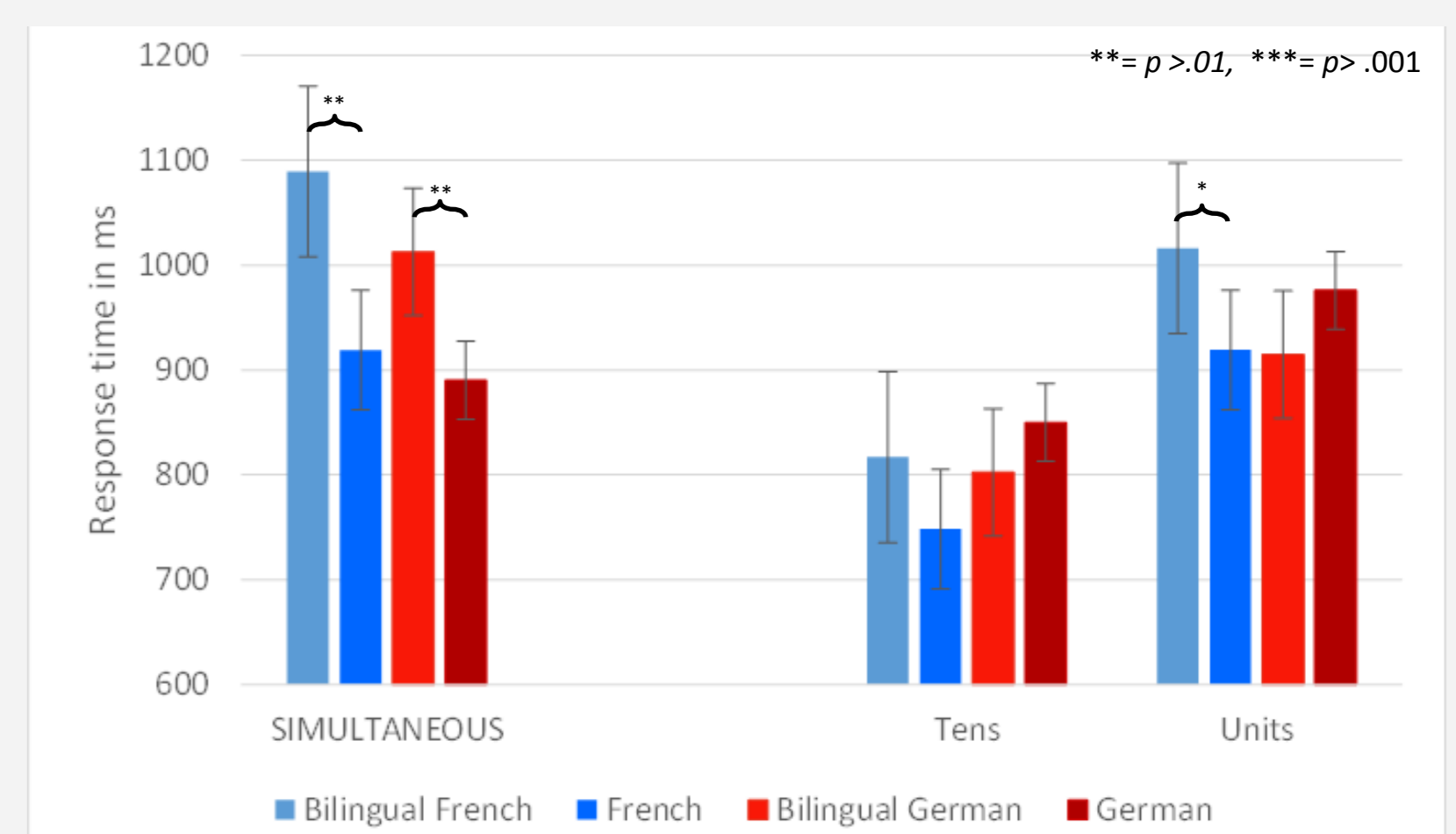
### Monolinguals



### Bilinguals

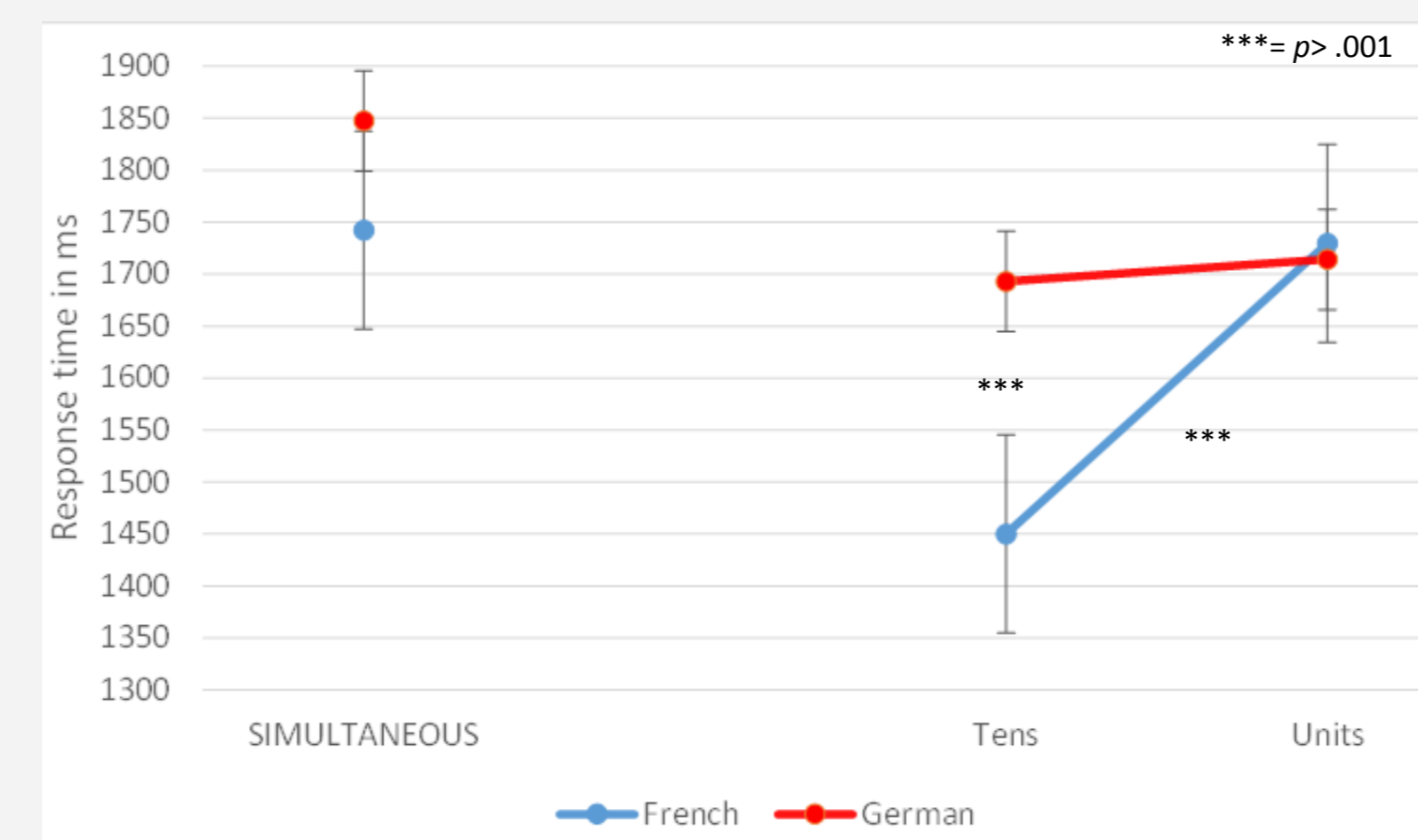


### Monolinguals VS Bilinguals



A  
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U  
L  
T  
S

C  
H  
I  
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E  
N



T-tests for adults simultaneous condition

	Unilingual	Bilingual	T-test
French	919 ms	1089 ms	$t(40) = -2.88$ $p = .006$
German	890 ms	1013 ms	$t(48) = -3.33$ $p = .002$
T-test	$t(42) = -.677$ $p = .419$	$t(23) = 2.102$ $p = .047$	

### Monolingual Children :

- German-speaking ( $M = 1751$ ms;  $SD = 43$ ms) were globally slower than French-speaking children ( $M = 1640$ ms;  $SD = 35$ ms),  $F(1,45) = 3.95$ ,  $p = .053$
- French-speaking children: Compared to the Simultaneous condition, transcoding was facilitated in the Ten condition.
- German-speaking children: Compared to the Simultaneous condition, transcoding was facilitated in the Ten and Unit conditions.

⇒ Transcoding is qualitatively different between the two languages in children.

### Bilingual Adults :

- Bilingual adults of the present population (i.e. recruited in multilingual Luxembourg) are globally faster when they perform the task in German ( $M = 909$ ms;  $SD = 32$ ms) than in French ( $M = 974$ ms;  $SD = 36$ ms),  $F(1; 23) = 4.87$ ,  $p = .038$
- While there is no differences between French and German in the tens condition, the Unit condition is processed significantly faster when performed in German.

### Monolingual Adults:

- Overall, German-speaking ( $M = 905$ ms;  $SD = 35$ ms) did not differ from French-speaking monolingual adults ( $M = 862$ ms;  $SD = 42$ ms).

### Bilingual VS Monolingual Adults:

- Bilinguals are significantly slower in the simultaneous condition, but not in the 2 decomposed (i.e. tens and in the and units) on conditions.

## Conclusion

- The present data indicates that language structure qualitatively impacts on basic numerical tasks such as transcoding.
- For children: Transcoding was systematically faster when the order of the stimuli stimulus appearance was congruent with their number word system (e.g. trente deux -> 3 then 2 for French-speaking, Zweiunddreißig -> 2 then 3 for German-speaking).
- Overall German-speaking children were slower in transcoding. In line with previous evidence (Zuber & al., 2009) we propose that this slow-down reflects the additional difficulty imposed by the inverted number word system on children numerical learning.
- Monolingual adults were faster than bilinguals (in their respective language) during the simultaneous condition. In contrast, bilinguals did not systematically differ from monolinguals during the decomposed conditions. This suggests that similar strategies (e.g. decomposition) are used by bilinguals and monolingual adults when processing sequentially presented two-digit numbers.