About number gesture: Which contribution to verbal cardinal knowledge development?

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Fingers: a transitional tool

Acquiring the meaning of number words is a long-lasting process (Wynn, 1992)

Functional role played by fingers in numerical development

- Sustain the acquisition of the verbal number sequence and of the counting procedure
- Iconic cardinal representation
- Spontaneous use when learning to calculate

Fingers and cardinal knowledge

- Few studies
- Contradictory results:
  - Young children (2- to 5- y.o.) are **more accurate** to give a number **using number words** than using number gestures (Nicoladis, Pika & Marentette, 2010)
  - Young children (3- to 5- y.o.) who do not have full cardinal knowledge are **more accurate** labeling small sets/estimating large sets **using number gestures** compared to number words (Gunderson, Speapen, Gibson & Goldin-Meadow, 2015)

Research questions

What’s the role played by fingers in the acquisition of verbal number words?

- Is there an age at which children are more skilled to represent number on their fingers than verbally?
- Do finger-based numerical representation contribute to the development of verbal cardinal knowledge?
Longitudinal design

At each time point

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>47, 3y; 0 month</td>
<td>47, 3y; 4 months</td>
<td>47, 3y; 8 months</td>
<td>47, 4 y; 0 months</td>
</tr>
</tbody>
</table>

Give-a-number with number words
« Give-me [two] frogs »

Give-a-number with number gestures
« Give-me 🍄 frogs »

Results

Repeated measures Anova: Modality (2) x Age (4)

<table>
<thead>
<tr>
<th>&quot;Give a number&quot; tasks</th>
<th>Knowledge level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number Words</td>
<td>Number Gestures</td>
</tr>
<tr>
<td>T1</td>
<td>T2</td>
</tr>
</tbody>
</table>

Age: p < .01
Modality: ns
Age x Modality: ns

No advantage for any modality at any time point
Cardinal knowledge development

Multi-level regression analysis: \[ \text{Verbal cardinal level} = \beta_{00} + \beta_{01}(\text{Initial state}) + \beta_{10}(\text{Age}) + \beta_{20}(\text{Nb gesture cardinal level}) + \beta_{30}(\text{Interaction between Age & Nb gesture level}) + r_{0i} + \epsilon_{ti} \]

Table 1. Results of the HLM conditional model of the performances with number gesture predicting the performance with number words in ‘Give-a-Number’ task

<table>
<thead>
<tr>
<th>Fixed effects</th>
<th>Give-a-number number words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1: Prediction of the time-varying fluctuation</td>
<td>0.36***</td>
</tr>
<tr>
<td>• Performances with number gestures</td>
<td>1.79***</td>
</tr>
<tr>
<td>Level 2: Prediction of linear change</td>
<td>0.01</td>
</tr>
<tr>
<td>• Intercept of the slope</td>
<td></td>
</tr>
<tr>
<td>• Initial state of performances with number gestures</td>
<td></td>
</tr>
<tr>
<td>Deviance</td>
<td>576.37</td>
</tr>
</tbody>
</table>

*\( p < .05; **p < .01; ***p < .001 \)

Time related changes in finger-based numerical representation predict changes in verbal cardinal knowledge development

Conclusion

- Children do not reach significantly higher cardinal knowledge development with number words than with number gestures at any point between the age of 3- to 4-year-old.
- However, the development of finger-based cardinal representation positively influences the development of the cardinal meaning of number words
Thank you for attention

Thanks to:
...the children
...the parents
...the schools
which participated in this study

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