3D human motion analyses to bring out fine motor skills as predictors of early mathematic skills development.

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Introduction

The children use their fingers as support for their early numerical skills development (Fayol & Seron, 2005). Then, the fingers are used in order to support the learning of the **verbal number sequence** (Alibali & Dirusso, 1999) and the **counting procedure** (Gelman & Gallistel, 1978). Moreover, they could facilitate the acquisition of the **cardinality** (the association between a number word and the quantity) (Gunderson, Speapen, Gibson & Goldin-Meadow, 20015) and the first **arithmetical skills** (Baroody, 1987).

An increasing number of authors questionned the fonctional role of the fingers in young children. It has been shown that **finger gnosia** (Noël, 2005) are good predictors of the children's early arithmetical skills development. Very few studies had questionned the influence of the fine motor skills on the early mathematical skills. If the influence of the **dexterity** on early arithmetical skills has been demonstrated (Asakawa & Sugimura, 2014) the respective contribution of **finger coordination and finger dissociation** (two components of the fine motor skills) to early mathematical skills has never been examined.

Are the finger skills (finger gnosia, finger dissociation and finger coordinaton) good predictors of early mathematical skills development after the age was taken into account ?

Method

Participants

16 preschoolers (Age = 49.31months ± 7.37)

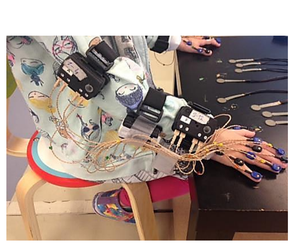
- First or second Grade in mainstream belgian schools
- Typical development
- Subset knowers (who do not fully mastered the cardinal principal)

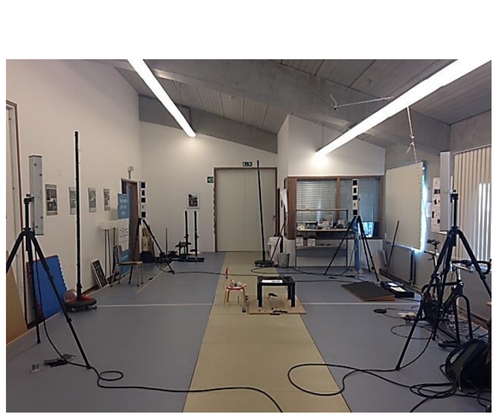
Material

Early numerical skills assessment

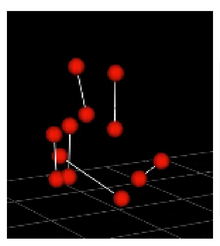
- **Numerical verbal chain** : stable & conventional part
- **Counting** skills : « How many ice-creams? »
- **Cardinality** : Give-a-number task
  Verbal condition « Give-me three pingouins »
  Digital condition « Give-me pingouins »
- **Arithmetical** skills: verbal problems supported by pictures

Fine motor skills assessment





Imitation tasks



*Example of configuration for the **finger dissociation** assessment*

*Example of movement for the **finger coordination** assessment*

Results

Statistical analyses

Stepwise multiple regression analysis were performed on each numerical task with age, finger gnosia, finger dissociation and finger coordination as preditors.

Verbal number sequence and counting procedures

Model	Coeff.	*t*	*p value*	
Verbal number sequence				
Model 0 • Age	.69	*3.62*	*.003*	*$F(1,14) = 13.12, p<.01, R^2=.48$*
Counting skills				
Model 0 • Age	.43	*1.77*	*.01*	*$F(1,14) = 3.12, p<.01, R^2=.18$*

Give-a-number task with number word

Model	Coeff.	*t*	*p value*	
Model 0 • Age	.52	*2.30*	*.04*	*$F(1,14) = 5.27, p=.04, R^2=.27$*
Model 1 • Age • Gnosia	.68 .49	*3.26* *2.34*	*.006* *.03*	*$F(2,13) = 6.22, p=.01, R^2=.49$*
Model 2 • Age • Gnosia • Coordination	.49 .52 .44	*2.48* *2.85* *2.31*	*.03* *.01* *.04*	*$F(3,12) = 7.30, p<.005, R^2=64$*

Give-a-number task with number gesture

Model	Coeff.	*t*	*p value*	
Model 0 • Age	.62	*2.92*	*.01*	*$F(1,14) = 8.55, p<.01, R^2=.38$*
Model 1 • Age • Gnosia	.77 .49	*4.13* *2.61*	*.01* *.02*	*$F(2,13) = 9.44, p<.01, R^2=.59$*

Arithmetical skills

Model	Coeff.	*t*	*p value*	
Model 0 • Age	.20	*2.56*	*.04*	*$F(1,14) = 6.54, p=.02, R^2=.32$*
Model 1 • Age • Coordination	.35 .48	*1.60* *2.22*	*.006* *.03*	*$F(2,13) = 6.66, p=.01, R^2=.51$*
Model 2 • Age • Coordination • Gnosia	.49 .52 .48	*2.72* *2.97* *2.90*	*.03* *.01* *.04*	*$F(3,12) = 9.78, p=.002, R^2=71$*

Conclusion

Finger skills don't explain a significant part of the variance in the knowledge of the **verbal number sequence** or in the **counting procedures**.

In line with previous studies, **finger gnosia** was found as the best significant predictor in the verbal and digital give-a-number task after the age.

Finally, **finger coordination** came out as the best predictor of early arithmetical skills, after the age, even if finger gnosia still contribute to explain an additional part of variance.

For future research, we could :
→Increase the sample size
→Work with children with mathematical disability