

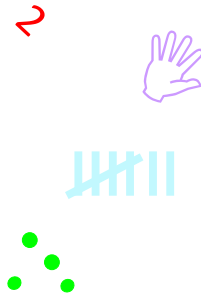
The development of automatic numerosity processing in preschoolers

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Ghent, 23/4/2008

two

5



In adults

- How many symbols ?
Faster for 333 than for 555 (Pavese & Umiltà, 1998)
- Which symbol is physically larger ?
2 3 versus 2 3
⇒ Size congruency effect (Henik & Tzelgov, 1982; Tzelgov, Meyer & Henik, 1992)
⇒ **Automatic processing of the magnitude**

In school-aged children

- Girelli, Lucangeli & Butterworth (2000)
 - Population: 1st, 3rd, 5th grades and adults
 - => Size congruity effect in all groups but 1st graders
- Rubinsten, Henik, Berger & Shahr-Shalev (2002)
 - Population: beginning 1st grade, end 1st grade, 3rd grade, 5th grade, adults
 - Size congruity effect from the end of first grade
- Mussolin & Noël (2007)
 - Size congruity effect of “small” 2-digit numbers starting in grade 2, and of “big” 2-digit numbers in grade 3

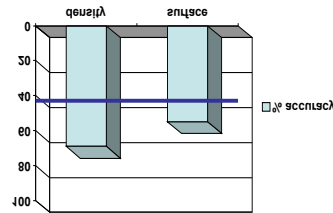
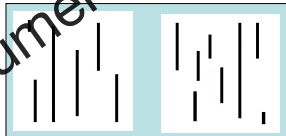
=> automatic access to number magnitude is progressively developing with age and with the size of the numbers

In preschoolers ?

- No possibility to use Arabic digits
- Using non-symbolic material => automatic access to numerosities ?

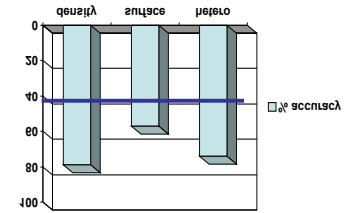
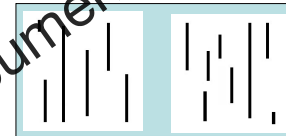
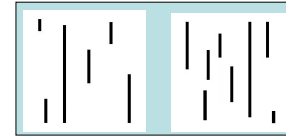
In preschoolers: numerical comparison

- Preschoolers (3 y.o): unable to choose the large number of sticks if they have the same area



Rousselle, Palmers & Noël (2004). J ECP

3 years old, study 2



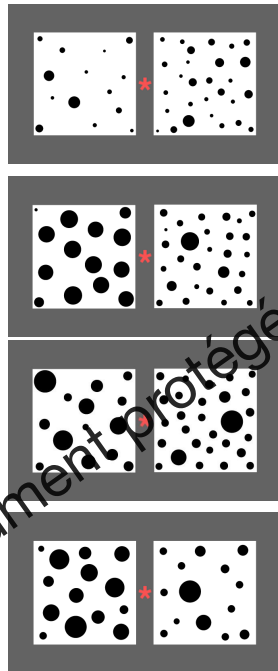
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Stroop study

- 2 collections, 2 tasks
 - Choose the collection in which there are more sticks (larger number)
 - Choose the collection which is more dark (larger area)

Stroop: study 1

- Population
 - 4-year olds (n=16)
 - 5-year olds (n=16)
 - 6-year olds (n=16)



Congruent: more black in the more numerous collection

Incongruent: more black in the less numerous collection

Neutral (= black)

Neutral numerical (= numerosities)

• Stimuli

– 40 pairs in each task

- 16 congruent (2 number ratio x 2 area ratio)
- 16 incongruent (2 number ratio x 2 area ratio)
- 8 neutral

• Numerosity pairs

- Ratio 1:2 : 6-12, 8-16, 14-28, 15-30
- Ratio 2:3 : 6-9, 10-15, 16-24, 20-30

• Other tasks

– Counting

- Point to x: show me three cats (1-2-3-4 cats)
- Trade task: one coin for one animal

– Day-night

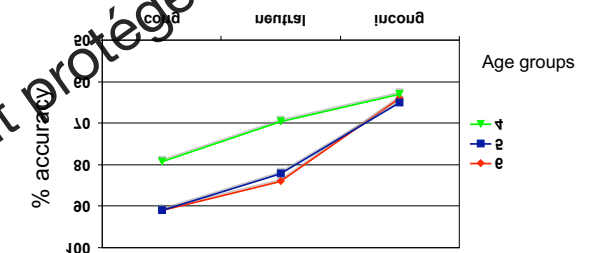
- 16 pictures of moon or sun
- Control condition: day for the sun & night for the moon
- Inhibition condition: night for the sun & day for the moon

Results - study 1

• Numerical task

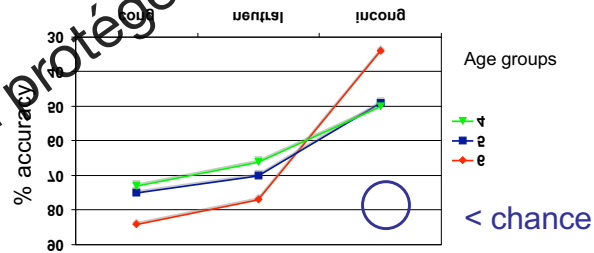
- Effect of condition ($F_{(2,44)}=32.95$, $p<.001$): Inc < NU < Cong
- Effect of age group ($F_{(2,45)}=3.94$, $p<.05$): 4 yo < 5=6 yo
- No interaction

=> area is processed automatically from 4 years of age



Results - study 1

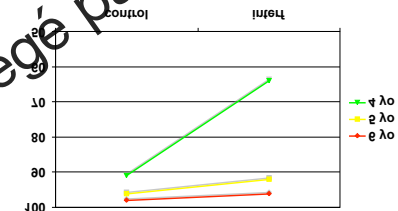
- Perceptual task
 - Effect of condition ($F_{(2,44)}=35.25, p<.001$): Inc < Neu < Contr
 - Effect of age group : ns
 - Marginal interaction ($F_{(4,88)}=2.16, p=.08$)
 - => numerosity is processed automatically from 4 years of age and tends to increase with age



Rousselle & Noël (In Press). Developmental Psychology.

Results - study 1

- Day-night
 - Effect of condition : control > interference
 - Effect of age group : 4 yo < 5 & 6 yo (RTs and accuracy)
 - Interaction: the effect of the condition decreases with age ($F_{(4,88)}=2.16, p=.08$)
 - => increasing inhibition capacities



- Yet, the sensitivity to the condition in the day-night is not significantly correlated with the size congruity effect in the two other tasks

Rousselle & Noël (In Press). Developmental Psychology.

Results - study 1

- Counting
 - Increases with age
 - No specific relationship with the congruency effect (when age is partialled out)

Study 2

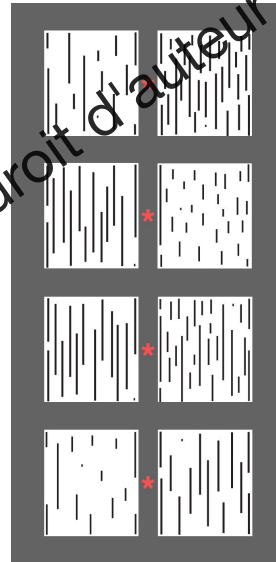
- Dots stimuli do not allow to strictly control surface area and sum of individual perimeters together
- => in neutral stimuli with same surface area, numerosity still varied with sum of the perimeters
- => has this dimension played a role ?

Congruent

Incongruent

Neutral (= black area)

Neutral numerical
(= numerosities)



Rousselle & Noël (In Press). Developmental Psychology.

Other tasks

Counting

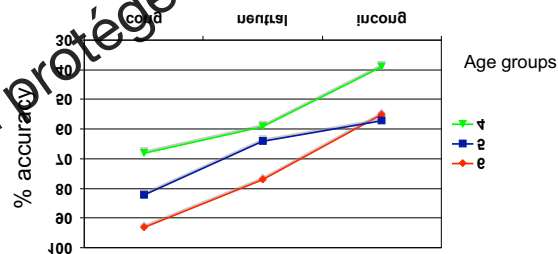
- Point to x: show me three cats (1-2-3-4 cats)
- Trade task: one coin for one animal
- + enumeration task

Results of study 2

Numerical task

- Effect of condition ($F_{(2,44)}=39.77, p<.001$): Inc < N < Cong
- Effect of age group ($F_{(2,45)}=6.83, p<.005$): 4 yo < 5 yo
- No interaction

=> area is processed automatically from 4 years of age



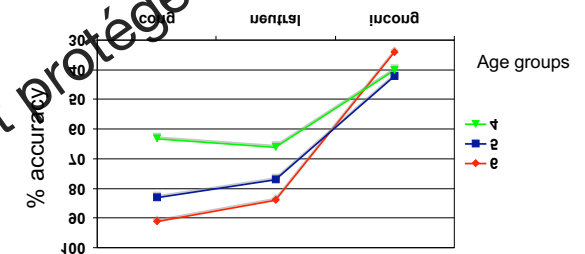
Rousselle & Noël (In Press). Developmental Psychology.

Results of study 2

Perceptual task

- Effect of condition ($F_{(2,44)}=39.77, p<.001$): Inc < N < Cong
- Effect of age group ($F_{(2,45)}=7.27, p<.005$): 4 yo < 5 yo
- Interaction ($F_{(4,88)}=2.94, p<.005$):

=> numerosity is processed automatically from 4 years of age. The influence of numerosity increases with age (congruity effect = 23%, 41% and 56% in 4,5,6 yo)



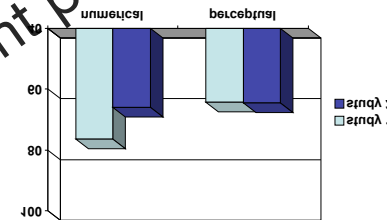
Rousselle & Noël (In Press). Developmental Psychology.

Results of study 2

- Counting
 - No specific relationship with the congruency effect

Comparison study 1 & 2

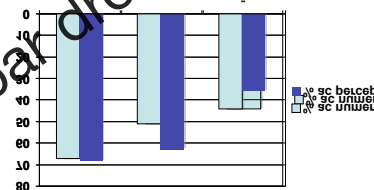
- Age is significant
- Numerical > perceptual
- Study 1 > study 2
- Task x Study ($F(1,90)=15.51, p<.001$)



Study 2 > study 1 only in the numerical task

Study 3

- 3 y.o.
 - Numerical task
 - Perform at random in the neutral task
 - Congruity effect



-perceptual tasks
-congruency effect

In conclusion

- Magnitude of collections is automatically activated from 3 y.o., and this access increases with age, independently of counting skills and inhibition capacities

Thanks for your attention !



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