Effects of boys' hyperactivity and inattention behaviours on mathematics achievement

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- CONTEXT -

Students diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) have significantly lower IQ and academic performance than students without ADHD (Hartung et al., 2002). Students with inattention behaviours, compared to students with hyperactivity or hyperactivity plus inattention behaviours, obtained lower academic achievement scores in reading and mathematics (Merrell & Tymms, 2001). Stimulant's use on a long term basis by ADHD students have not shown improvement of academic achievement (Frankenberger & Cannon, 1999).

- OBJECTIVES -

Controlling for IQ and family adversity, and adding stimulant use as a moderator, objectives are to find out whether inattention and/or hyperactivity behaviours have an effect on boys' initial mathematics score at 10 years old and boys' rate of change from 10 to 14 years old.

-MEASURES -

- Boys' behaviours were reported by their kindergarten teacher (1984):

Hyperactivity scale - Cronbach alpha 0.89
1) Restless. Runs about or jumps up and down. Doesn't keep still
2) Squirmy, fidgety child

Inattention scale - Cronbach alpha 0.82
1) Has poor concentration or short attention span
2) Inattentive
3) Gives up easily
4) Stares into space

- Boys **mathematics achievement**
  - Official mathematics performance given each year (1988-1992) by the school
  - Originally a scale 0-100%, but it has been standardized for an easier comparison between these boys
  - Now a categorical variable – 5 items – (see Table 1.)

Table 1. Outcome - Mathematics score

	N	%
Excellent (90-100%)	83	8,0
Very Good (80-89%)	301	29,0
Good (70-79%)	370	35,7
Acceptable (60-69%)	203	19,6
Failure (Less than 59%)	80	7,7
	1037	100,0

-ANALYSES -

Data were analyzed using growth curve multilevel modeling (Bryk & Raudenbush, 2000; Singer & Willett, 2003). This technique allows the study of within-individual change and interindividual differences in change.

- PARTICIPANTS -

1037 boys from low socioeconomic neighbourhoods and attending one of 53 inner-city elementary schools in a large Canadian city were followed on a 12-year longitudinal study of behavioural development. The boys were aged 6 in 1984 at the first wave of data collection.

Boys' characteristics
67% No/low hyperactive or inattentive behaviour in kindergarten (1984)
11% High score on hyperactivity scale in kindergarten
11% High score on inattention scale in kindergarten
11% High score on both hyperactivity and inattention scales in kindergarten
94% Never took medication for attention problem (stimulant)
3% Boys with no/low hyperactivity and inattention take stimulant
1% of hyperactive boys take stimulant
1% of inattentive boys take stimulant
2% of hyperactive and inattentive boys take stimulant
21% Low verbal IQ (verbal IQ score ≤ 7/13)
Families' characteristics
23,3 Mean age of mother at the birth of the 1st child
26,4 Mean age of father at the birth of the 1st child
34% of mothers have less than 9 years of schooling
39% of fathers have less than 9 years of schooling
32% Not intact family
25% High score of family adversity*

* Family adversity was computed with the following variables : 1) parent's age at the birth of their first child; 2) parent's years of schooling; 3) parents' occupational status and; 4) family status

- RESULTS -

Table 2. Results of fitting a taxonomy of multilevel models for change to mathematic score data *(n=1037)*

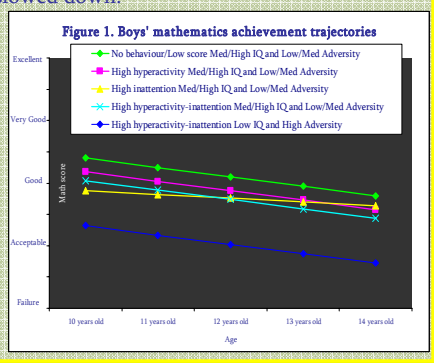
	Parameters	A. Unconditional growth model	B. Bivariate model - Hyperactivity in 1984	C. Bivariate model - Inattention in 1984	D. Bivariate model - inattention X hyperactivity in 1984	E. Multivariate model 1	F. Multivariate model 2	G. Multivariate model 3	H. Multivariate model 4	I. Final Model
Fixed effects										
Initial status π_{0i}										
Intercept	γ_{00}	3.12*** (0.0)	3.14*** (0.0)	3.18*** (0.0)	3.18*** (0.0)	3.28*** (0.0)	3.14*** (0.0)	3.28*** (0.0)	3.40*** (0.0)	3.40*** (0.0)
IQ	γ_{01}								**-0.49*** (0.1)**	**-0.50*** (0.1)**
Adversity	γ_{02}								**-0.23*** (0.1)**	**-0.22*** (0.1)**
Hyperactivity 1984	γ_{03}		**-0.17* (0.1)**			**-0.26** (0.1)**		**-0.26** (0.1)**	**-0.22* (0.1)**	**-0.22* (0.1)**
Inattention 1984	γ_{04}			**-0.54*** (0.1)**		**-0.64*** (0.1)**		**-0.61*** (0.1)**	**-0.50*** (0.1)**	**-0.52*** (0.1)**
hyper X inat 1984	γ_{05}				**-0.53** (0.1)**	**-0.56*** (0.1)**		**-0.56*** (0.1)**	**-0.36*** (0.1)**	**-0.36*** (0.1)**
Hyper X Medication	γ_{06}						-0.36 (0.4)			
Inatt X Medication	γ_{07}						**-0.76* (0.2)**	**-0.35*(0.2)**	-0.23 (0.2)	
Hyper-inatt X Medication	γ_{08}						-0.25 (0.2)			
Rate of change π_{1i}										
Intercept	γ_{10}	-0.14*** (0.0)	-0.14*** (0.0)	-0.15*** (0.0)	-0.14*** (0.0)	-0.15*** (0.0)	-0.14*** (0.0)	-0.15*** (0.0)	-0.15*** (0.0)	-0.15*** (0.0)
Hyperactivity 1984	γ_{11}		0.01 (0.0)							
Inattention 1984	γ_{12}			**0.08* (0.0)**		**0.09* (0.0)**		**0.09* (0.0)**	**0.09* (0.0)**	**0.09* (0.0)**
hyper X inat 1984	γ_{13}				0.02 (0.0)					
Hyper X Medication	γ_{14}						-0.09 (0.1)			
Inatt X Medication	γ_{15}						0.05 (0.1)			
Hyper-inatt X Medication	γ_{16}						-0.11 (0.1)			
Variance components										
Level 1 Within-person	σ^2_{ε}	0.56***	0.56***	0.56***	0.56***	0.56***	0.56***	0.56***	0.56***	0.56***
Level 2 In initial status	σ^2_{0i}	0.61***	0.61***	0.59***	0.59***	0.54***	0.61***	0.54***	0.47***	0.47***
In rate of change	σ^2_{1i}	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***
Covariance	σ_{0i1i}	-0.04***	-0.04***	-0.03***	-0.04***	-0.03***	-0.04***	-0.03***	-0.03***	-0.03***
Goodness of fit										
Deviance (2 Log-Likelihood)		13717.8	13714.4	13687.2	13681.1	13631.7	13697.6	13630.0	13533.2	13534.0

***p≤.000; **p<.001; *p≤.05

All variables are dichotomized into Low or High condition

- Boys' mathematics performance decrease significantly over time.
- Mathematics trajectory of boys with frequent hyperactive behaviours is similar to mathematics trajectory of boys with high degree of hyperactive-inattentive behaviours. However, both differ from trajectory of boys with frequent inattention behaviours.
- Boys with frequent inattention behaviours have lower initial mathematics scores at 10 years old, but their decrease in mathematics performance over time is slowed down.
- Boys with high scores on hyperactivity, inattention and hyperactivity-inattention scales obtain lower initial mathematics scores than boys that are low on these behaviours. This initial effect is increased when boys have a lower IQ and experience high degree of family adversity (see Figure 1).

Figure 1. Boys' mathematics achievement trajectories



- Taking medication for attention problems have no significant effect on mathematics achievement. The interaction medication-inattention was significant only when IQ and adversity were not taken into account (see Table 2. Models G and H).

- DISCUSSION -

- As expected, boys with frequent hyperactive, inattentive and hyperactive-inattentive behaviours obtained lower initial mathematics scores than boys that are low on these behaviours. Inattentive boys obtained initially lower mathematics scores, but their performance over time declined less rapidly than the performance of the others boys.
- While previous research have found an effect between stimulant and academic achievement, our results show that medication for attention problems do not affect mathematics achievement trajectories.
- Hyperactivity is an externalized behaviour, thus easier than inattention to identify. Identified earlier, children with hyperactivity behaviours may obtain help from school services rapidly, while inattentive children have to wait longer to receive the same services. However, once these children are offered these services, they may be more inclined to use them, explaining the slow down of the decrease in math performance.