



## The virtual classroom: An ecological version of the continuous performance test - A pilot study



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## Presentation plan

- ★ ADHD
- ★ The virtual class
- ★ The equipment
- ★ The research
- ★ The futur

## Diagnose of ADHD

- ★ Psychiatrist, neurologist or general MD (interview)
- ★ Sometime includes behavior rating scales and some neuropsych testing (CPT)
- ★ 6 inattention behaviors (lose things, difficulty in sustaining attention, in respecting rules and finishing what had started)
- ★ And/Or 6 impulsivity-hyperactivity behaviors (agitation of hands or feet, always running, moving, talking or interrupting)
- ★ Behaviors appears before the age of 7
- ★ Disturbance in two or more environments (school, home, social)
- ★ Other possible explanation excluded

## Attention deficit and hyperactivity disorder

- ★ The diagnose at the Rivière-des-Prairies Hospital:
  - ★ Neuropsychological assessment (executive functions, attentional functions and impulsivity)
  - ★ Behavioral questionnaires
  - ★ Psychiatric interview with parents and child present !

## Why the Virtual class ?

- ★ Ecological: more representative of child's daily performance and behavior
- ★ To improve pre and post measures for research purposes
- ★ To open a new area of research and develop new expertise

## The virtual class

- ★ Was develop by Albert « Skip » Rizzo, professor at the University of South California
- ★ Continuous performance task while sitting in a class
- ★ Demo



## Rizzo & al., 2006

- ★ 6 children with ADHD (6-12yo), compared with 10 normal controls, showed significant (2 conditions):
  - ★ Slower correct hit reaction times (RT),
  - ★ Higher RT variability
  - ★ More omission and commission errors
  - ★ More motor movement (preliminary results)
  - ★ Effect sizes ranged from 1.05 to 2.07
  - ★ Highest one being obtained on the number of omissions

## The replication: objectives

- ★ Compare children with ADHD and control group on the VR Classroom, including head movement measures
- ★ Compare children with ADHD on traditional CPT to the VR Classroom
- ★ Compare the VR Classroom to a standard neuropsychological battery (commission and omission errors, reaction time (RT) and its standard error)
- ★ Determine ecological validity according to Barkley's criteria (1991)

## Equipment description

- ★ P4 computer
- ★ Ultra GT cordless optical mouse
- ★ HMD:
  - ★ I-Glasses PCHR-2D
  - ★ Head tracker: Intertrax2 de Intersense

## Research methodology: the participants

### ★ Participants:

- ★ 15 boys with ADHD
- ★ 7 boys in a comparison group
- ★ All aged between 9 and 13
- ★ Boys with ADHD were recruited from the Montreal area through various health agencies and Rivière-des-Prairies Hospital
- ★ Boys in comparison group were unaffected siblings of participants with ADHD

## Research methodology: the procedure

- ★ 1 minute practice, 6 minutes test
- ★ 1 condition, task with distracters
- ★ Gordon like CPT : instructed to hit the left mouse button after he viewed the letter "K" preceded by an "A" (successive discrimination task) and withhold their response to any other stimulus letter
- ★ Distracters consisted of
  - ★ Pure auditory: constant ambient classroom sounds (i.e., whispering, pencils dropping, chairs moving, etc.)
  - ★ Pure visual: paper airplane flying directly across the participant's field of view
  - ★ Mixed audio and visual: cars and school buses "rumbling by" outside the window on the left (occurring three times each), and a virtual person coming in and out of doors on the right side of the classroom, with sounds of the door "creaking open", footsteps, and hallway activity (occurring once).

## Neuropsychological battery

- ★ Stroop (D-DEFS): conditions 3-inhibition and 4-flexibility (total errors)
- ★ CPT-II (Conners): 15 minutes, task is to inhibit response to letter X (RT, RT standard error, omission and commission errors)
- ★ d2 on omission and commission errors variables
- ★ Strength Difficulties Questionnaire (SDQ): ADHD and total problems subscales
- ★ ADHD Rating Scale-IV (DuPaul) total problem subscale
- ★ Achenbach System of Empirically Based Assessment (CBCL) ADHD and total problems subscales

	GZ	F <sub>1</sub>	F <sub>2</sub>
1.	19		
2.	16		
3.	16		
4.	14	1	
5.	16	1	
6.	16		
7.	12		
8.	14		
9.	14		
10.	11	1	
11.	8	1	
12.	16	2	
13.	12		
14.	5		

193 C 6

Règle :                    rouge    bleu    vert    bleu    vert

- Nomme la couleur de l'encre.

                              rouge    bleu    rouge    vert    rouge

bleu   vert   bleu   rouge   bleu   rouge   bleu   rouge   bleu   rouge

bleu   vert   bleu   vert   rouge   vert   bleu   rouge   bleu   vert

rouge   vert   rouge   bleu   vert   rouge   vert   rouge   bleu   vert

bleu   vert   bleu   rouge   vert   bleu   rouge   vert   rouge   vert

vert   bleu   rouge   bleu   vert   rouge   bleu   vert   rouge   bleu

## Results VR Classroom

- ★ One-tailed t-tests:
  - ★ Omissions ( $p= 0.011$ ,  $d= 1.36$ )
  - ★ RT variability ( $p=0.031$ ,  $d=0.91$ )
  - ★ Slower RT and more commissions errors but these differences were not significant



## Conner's CPT

- ★ One-tailed t-tests:
  - ★ Omissions ( $p=0.0005$ ,  $d=1.76$ )
  - ★ RT ( $p=0.00013$ ,  $d=2.02$ )
  - ★ RT standard error of the mean ( $p<0.0001$ ,  $d=2.82$ )
  - ★ Commission errors were exactly the same for both groups (26 commissions)

## Head movements on VR Classroom

- ★ One-tailed t-tests:
  - ★ The amplitude of head movement from side to side ( $p=0.0005$ ,  $d=2.04$ )
  - ★ Amplitude of head movement up and down  $p= 0.001$ ,  $d=1.62$ )

## VR Classroom and CPT

- ★ Covariance analyses, when possible shared variance between both variables was removed:
  - ★ RV omission variable still significant ( $p=0.113$ )
  - ★ Earlier significant variable RV RT standard error no longer significant ( $p=0.555$ )
  - ★ CPT RT ( $p<0.0005$ )
  - ★ CPT RT standard ( $p<0.0005$ )

## VR Classroom and neuropsychological tests

- ★ Univariate analyses of covariance, when possible shared variance was removed:
  - ★ D2 and VR Classroom: VR omission still significant ( $p=0.001$ ) but the d2 omission variable no longer did ( $p=0.927$ )
  - ★ Stroop total errors on the inhibition condition and the VR omission: VR omission still significant ( $p=0.001$ ) but not the other variable ( $F=0.154$ ,  $p=0.699$ ).
  - ★ VR omission variable and total errors on flexibility condition of the Stroop test had significantly different slopes in the two groups so analysis of covariance was therefore not done.
  - ★ VR commission compared to d2 commission and total errors of the Stroop test did not significantly distinguish the two groups, once the shared variance was removed

## VR Classroom and parent ratings (ADHD group)

- ★ Bivariate one-tailed Pearson correlations:
  - ★ VR Classroom omission errors and both SDQ scales (ADHD scale,  $r=0.69$ ,  $p=0.002$ ; Total problems scale,  $r=0.602$ ,  $p=0.009$ )
  - ★ Total absolute Pitch amplitude of head movement with the SDQ ADHD scale ( $r=0.602$ ,  $p=0.009$ ) and CBCL ADHD (DSM) scale ( $r=0.508$ ,  $p=0.027$ )
  - ★ Total absolute Yaw amplitude of head movement and SDQ ADHD scale ( $r=0.460$ ,  $p=0.042$ )

## Effect sizes

	Rizzo	Replication VRClass	Conner's CPT
Omission errors	2.14	1.36	1.76
Commission errors	1.66	NS	NS
RT	1.43	NS	2.02
RT variability	1.30	0.91	2.82
Head movements	NA	2.04	NA

## Cybersickness

- ★ **Side effects:** No significant side effects were observed in either group, based on post VR testing using a cybersickness questionnaire (Laboratoire de Cyberpsychologie, 2002)

## Discussion

- ★ The study partly replicates results obtained with a previous form of the VR Classroom (Rizzo et al., 2006) on the omission, RT variability scores and head movements
- ★ This study, however, did not replicate the group difference in mean RT and in commission errors
- ★ Time ? The previous version lasted for a total of 20 minutes compared to 6 minutes for the present version
- ★ Video



## Discussion

- ★ It seems that the VR Classroom is efficient in distinguishing boys with ADHD from those without (omission and variability of RT)
- ★ Traditional CPT appears more efficient in distinguishing both groups if compared on similar variables
- ★ Since the standard CPT results, taken from the patient records, contributed to a positive diagnosis of ADHD, the CPT effect sizes are likely biased positively
- ★ It turns out that VR Classroom more often contributes new information than does the traditional CPT

## The futur

- ★ Larger number of participants
- ★ To include girls
- ★ To verify relevance of age and intelligence
- ★ Longer duration and, possibly embedding other attention tasks
- ★ VR CPT sensitivity and specificity in discriminating ADHD participant from non-ADHD
- ★ Ecological validity

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- ★ Albert « Skip » Rizzo and his collaborators at DMW
- ★ Stéphane Bouchard and his lab



## Ecological validity

- ★ Difference between ADHD and control groups: The present study included a group of non-ADHD boys, larger studies need to include several clinical comparison groups
- ★ Correlation with assessments that have previously established ecological validity: An experimental measure of a spelling test in a simulated real life classroom was done with boys of the ADHD group but results are yet to be compiled and analysed
- ★ The assessment shows similar directional changes as that of the ecological criterion when exposed to experimental manipulations known to affect the criterion such as medication: This condition was not included in the present study
- ★ Correlations between the assessment and ecological criterion such as caregiver ratings: High correlations were found between some VR variables (omission errors and pitch and yaw total amplitude of head movement) and some SDQ and CBCL subscales (parent ratings)

## Effect sizes

- ★ To compare two groups of  $n_1$  and  $n_2$  number of persons respectively, you take the value of the  $t$  test and multiply it by the square root of  $(1/n_1 + 1/n_2)$
- ★ The effect size is the difference between the means divided by the SD whereas the  $t$  test (Student) is the difference divided by the error
- ★ The  $\text{SQRT}(1/n_1 + 1/n_2)$  is the corresponding factor between the SD and the error