Kinematic measures of inhibition in children with ADHD

Irene Valori

irene.valori.1@phd.unipd.it

27th November 2020



Università degli Studi di Padova

DPSS Dipartimento di Psicologia dello Sviluppo e della Socializzazione





Project Kinematics of Action Selection and Repetitive Behaviours

Aims:

- Feasibility of using a wereable accelerometer to analyse kinematic indices
- Some neuropsychological mechanisms of action selection: Inhibition, Sense of Agency, Reward
- In populations with typical and atypical development (i.e. ASD, ADHD)

Team:



Teresa Farroni Letizia Della Longa



Alessia Angeli



Gustavo Marfia



Inhibition in children with ADHD

Attention Deficit Hyperactivity Disorder (ADHD)

- Inattentiveness,
- And/or hyperactivity and impulsiveness.
- Lower cortical inhibition than healthy subjects.

Dutra, Baltar, & Monte-Silva (2016)

• Co-occurrent motor difficulties in about 50% of individuals with ADHD

Farran, et al. (2020)





Inertial sensors

(Cahill-Rowley and Rose, 2017)

Leap Motion (Niechwiej-Szwedo et al., 2018)

Kinematic analysis

Motion capture systems



Beneath movements



Materials and methods

Participants: 13 children with ADHD (6-13 years old)



Whitin-subjects design: repeated measures (160 trials per participant)

Variables

Participant	Age	Condition	Time before the stimulus	Accuracy	Reaction Time (RT)	Movement Duration(MD)	%Time to Peak Velocity(TPV)
N=13	Age Min. : 6.000 1st Qu.: 7.000 Median :10.000 Mean : 8.953 3rd Qu.:10.000 Max. :13.000	Condition : O Dominant :1322 NotDominant: 426	StimulusRandomTime Min. : 0.0 1st Qu.: 463.5 Median : 933.5 Mean : 971.1 3rd Qu.:1486.8 Max. :1999.0	Evaluation anticipation: 0 correct :1647 incorrect :101 omission : 0	timeSR_RT Min. :-0.006 1st Qu.: 0.518 Median : 0.628 Mean : 0.672 3rd Qu.: 0.782 Max. : 1.709	timeRA_MD Min. :0.2220 1st Qu.:0.4130 Median :0.5385 Mean :0.5894 3rd Qu.:0.7090 Max. :1.9960	tpv_RA Min. : 5.053 1st Qu.:27.776 Median :42.807 Mean :43.225 3rd Qu.:55.803 Max. :94.913

Independent variables

Dependent variables

Research questions

- Which kinematic indices (RT + MD + TPV) distinguish between correct/incorrect responses in dominant/non-dominant trials (Accuracy x Condition)?
- 2. Does the Age affect these mechanisms?
- 3. Does the time before the «Go» stimulus (StimulusRandomTime) affect kinematic parameters and accuracy?
- 4. (Future perspectives with a control group): Which are the differences (if any) between children with ADHD or typical development (Group)?

					D	OMELLŐF ET AL.						
					Т	TABLE 1 Means and standard errors for kinematic outcomes as a function of age group together v					th main effects of age and task	
					Age group							
					ł	Kinematic parameters	Adult	10-year	6-year	Main effect of age	Main effect of task	
	Wrist 3D distance (mm)	258 ± 7.2ª	315 ± 5.9 ^b	369 ± 7.2°		F = 58.1, p < .	.001, η ² μ	o = 0.34	F	= 7.7, p < .001,	$\eta^2 p = 0.12$	
	Index 3D distance (mm)	359 ± 6.4ª	409 ± 5.4 ^b	437 ± 6.4°		F = 39.3, p < .	001, η ² μ	o = 0.26	F	= 12.8, p < .002 $\eta^2 p = 0.18$	1,	
						Wrist peak velocity place- ment (ms)	388 ± 10.9ª	328 ± 11.4	345 ± 10.9	$F=7.2, p < .001, \eta^2 p = 0.06$	F = 0.8, p = .48, n.s.	
		Separate	e mixed desig	n 3 x 5 (3	1	Index peak velocity (mm/s)	1,128 ± 38.2*	1,366 ± 40.2	1,363 ± 38.5	$F=11.9, p < .001, \eta^2 p = 0.10$	F = 0.5, p = .76, n.s.	
		and aro	age groups x 5 task conditions)		Index peak vek ment (ms)	Index peak velocity place- ment (ms)	361 ± 11.3*	277 ± 11.5	290 ± 11.4	$F = 18.8, p < .001, \eta^2 p = 0.12$	F = 1.1, p = .35, n.s.	
						Time diff Index-Wrist peak vel place (ms)	-27 ± 5.6*	-51 ± 5.8	-55 ± 5.7	$F=6.9, p < .001, \eta^2 p = 0.06$	F = 0.7, p = .59, n.s.	
		ANOVA	s of volations botwoon			Wrist acceleration/decel- eration phase (%)	46/54	45/55	41/59°	$F = 8.5, p < .001, \eta^2 p = 0.07$	F = 1.9, p = .10, n.s.	
	From the	 Analyses 	of relations be	relations between		Index acceleration/decel- eration phase (%)	43/57*	38/62 ^b	35/65°	$F=22.5, p < .001, \eta^2 p = 0.17$	F = 0.8, p = .48, n.s.	
		paramet	eters were performed tely within each age group earson's product-moment			Wrist average velocity (mm/s)	299 ± 9.3*	411 ± 9.7 ^b	360 ± 9.3	$F = 33.6, p < .001, \eta^2 p = 0.23$	F = 0.5, p = .71, n.s.	
		separate				Index average velocity (mm/s)	423 ± 15.8"	541 ± 16.4	525 ± 15.8	$F = 15.7, p < .001, \eta^2 p = 0.14$	F = 1.4, p = .23, n.s.	
		using Pe				Wrist 3D distance (mm)	260 ± 4.5* 366 ± 5.2*	305 ± 5.5 403 ± 5.3 ^b	307 ± 4.5	$F = 36.6, p \le .001, \eta^2 p = 0.25$ $F = 46.5, p \le .001, \eta^2 p = 0.29$	F = 3.4, p = .02, n.s. F = 1.2, p = .29, n.s.	
]		and part	ial correlations	correlations (with		Grasp phase						
I		Bonferroni correction)				Grasp duration	77 ± 22.5	64 ± 24.3	254 ± 22.6°	$F = 18.9, p < .001, \eta^2 p = 0.15$	F = 1.5, p = .19, n.s.	
						Transport-to-fit duration	1,461 ± 91	1,618 ± 92	2,280 ± 93°	$F=22.4, p < .001, \eta^2 p = 0.17$	$F=9.8, p < .001, \eta^2 p = 0.15$	
e	extant				Time transporting peg to goal (ms)	752 ± 31	691 ± 31	776 ± 32	F = 1.9, p = .14, n.s.	F = 2.7, p = .04, n.s.		
I						Total peg rotation time (ms)	574 ± 48	659 ± 49	774 ± 49	F = 4.2, p = .05, n.s.	F = 12.2, p < .001, $\eta^2 p = 0.14$	
	kinematic					Wrist transport-to-fit MUs (n)	6.5 ± 0.7	7.5 ± 0.8	13.3 ± 0.8°	$F=22.1, p < .001, \eta^2 p = 0.16$	$F=5.5, p < .001, \eta^2 p = 0.09$	
	•					Index transport-to-fit MUs (n)	7.8 ± 0.7	9.7 ± 0.8	15.4 ± 0.8°	$F=21.5, p < .001, \eta^2 p = 0.16$	$F=9.8, p < .001, \eta^2 p = 0.15$	
	iterature					Wrist average velocity (mm/s)	181 ± 6.5 ^d	212 ± 6.5	193 ± 6.5	$F = 5.8, p < .005, \eta^2 p = 0.05$	$F = 11.3, p \le .001,$ $\eta^2 p = 0.17$	
I						Index average velocity (mm/s)	251 ± 9.0	273 ± 9.4	239 ± 9.1	F = 3.1, p = .05, n.s.	$F=9.4, p < .001, \eta^2 p = 0.14$	
						Wrist 3D distance (mm)	258 ± 7.2*	315 ± 5.9 ^b	369 ± 7.2°	$F = 58.1, p \le .001, \eta^2 p = 0.34$	$F = 7.7, p < .001, \eta^2 p = 0.12$	
						Index 3D distance (mm)	359 ± 6.4"	409 ± 5.4"	437 ± 6.4*	F = 39.3, p < .001, η*p = 0.26	F = 12.8, p < .001,	

 $\eta^2 p = 0.18$

Spearman's rank correlation rho













Reaction Time Movement Duration %Time to Peak Velocity

Model selection and comparison

(mb0 <- glmmTMB(Accuracy ~ (1|Participant), data = adhd1, family=binomial()))

- (mb1 <- glmmTMB(Accuracy ~ Condition + (1|Participant), data = adhd1, family=binomial()))
- (mb2 <- glmmTMB(Accuracy ~ Condition + timeSR_RT + (1|Participant), data = adhd1, family=binomial()))
- (mb3 <- glmmTMB(Accuracy ~ Condition + timeRA_MD + (1|Participant), data = adhd1, family=binomial()))
- (mb4 <- glmmTMB(Accuracy ~ Condition + tpv_RA + (1|Participant), data = adhd1, family=binomial()))
- (mb5 <- glmmTMB(Accuracy ~ Condition * timeSR_RT + (1|Participant), data = adhd1, family=binomial()))
- (mb6 <- glmmTMB(Accuracy ~ Condition * timeRA_MD + (1|Participant), data = adhd1, family=binomial()))
- (mb7 <- glmmTMB(Accuracy ~ Condition * tpv_RA + (1|Participant), data = adhd1, family=binomial()))



Model selection and comparison: Invented!



(model <- ?? (Accuracy * timeSR_RT * timeRA_MD *
tpv_RA ~ Condition + Age + StimulusRandomTime +
(1|Participant), data = adhd1, family=??()))</pre>

Open questions

- Which type of statistical analysis to address the research questions
- How to determine sample size



Thank you!

Irene Valori irene.valori.1@phd.unipd.it