Kinematic measures of inhibition in children with ADHD

Irene Valori

irene.valori.1@phd.unipd.it

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UNIVERSITÀ DEGLI STUDI DI PADOVA

DPSS
Dipartimento di Psicologia dello Sviluppo e della Socializzazione

NUIEVE
RICERCA E APPRENDIMENTO MULTISENSORIALE

PSICOSTAT

STATISTICS IS HARD

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

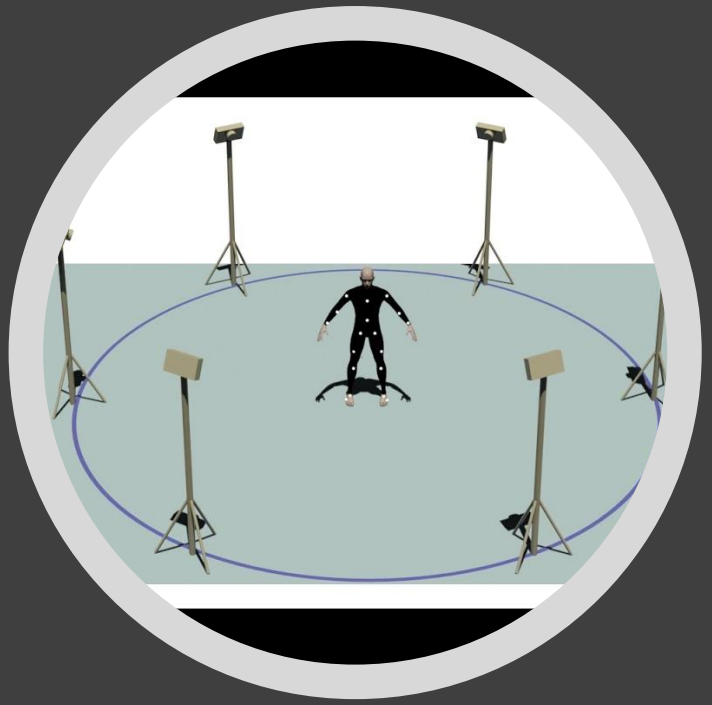
Farran, et al. (2020)

Inertial sensors

(Cahill-Rowley and Rose, 2017)

Leap Motion

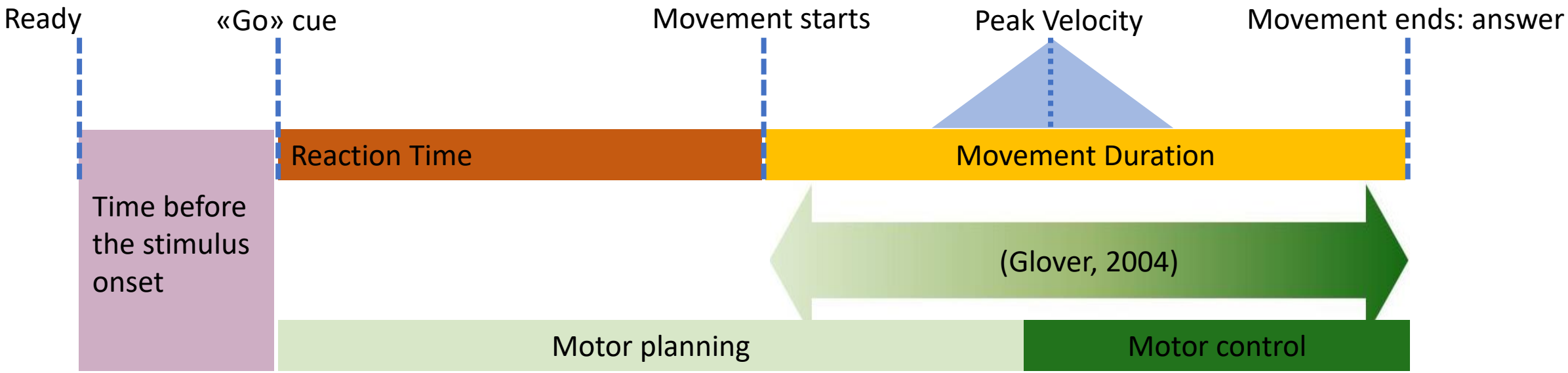
(Niechwiej-Szwedo et al., 2018)



Motion capture systems

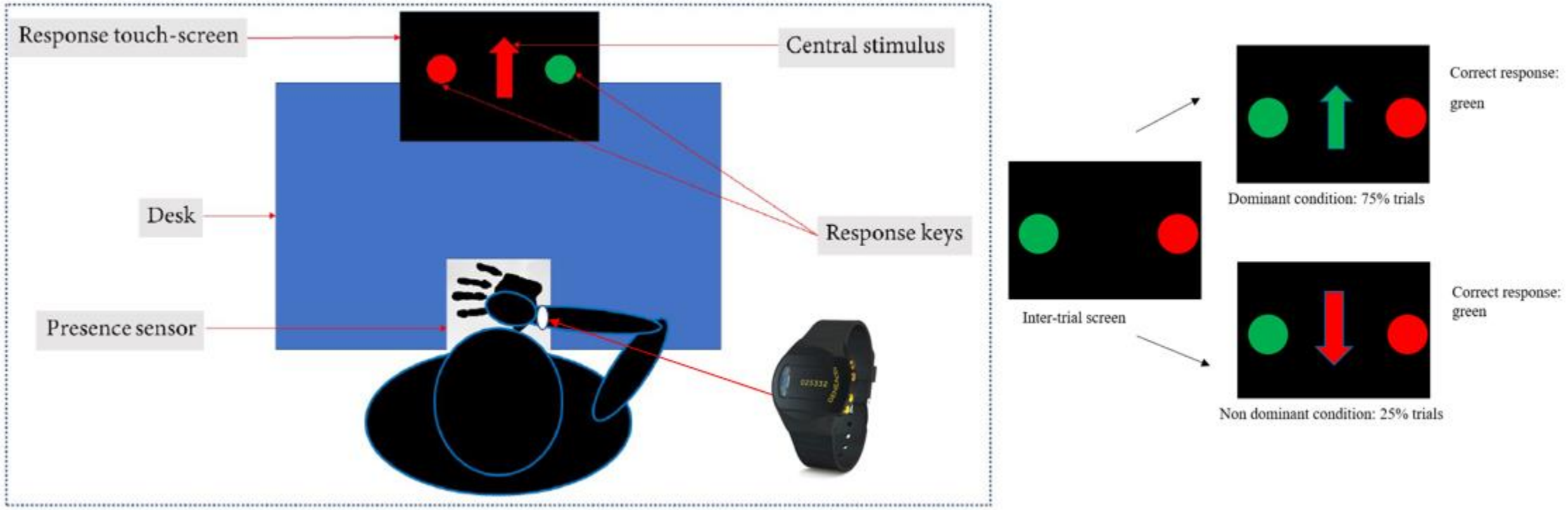
Kinematic analysis

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
N=13	Age Min. : 6.000 1st Qu.: 7.000 Median :10.000 Mean : 8.953 3rd Qu.:10.000 Max. :13.000	Condition : 0 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

Independent variables

Accuracy	Reaction Time (RT)	Movement Duration(MD)	%Time to Peak Velocity(TPV)
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

Dependent variables

Research questions

1. 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)?

TABLE 1 Means and standard errors for kinematic outcomes as a function of age group together with main effects of age and task

Kinematic parameters	Age group: Adult	10-year	6-year	Main effect of age	Main effect of task
Wrist peak velocity placement (ms)	388 ± 10.9[a]	328 ± 11.4	345 ± 10.9	$F = 7.2, p < .001, \eta^2p = 0.06$	$F = 0.8, p = .48$, n.s.
Index peak velocity (mm/s)	1,128 ± 38.2[a]	1,366 ± 40.2	1,363 ± 38.5	$F = 11.9, p < .001, \eta^2p = 0.10$	$F = 0.5, p = .76$, n.s.
Index peak velocity placement (ms)	361 ± 11.3[a]	277 ± 11.5	290 ± 11.4	$F = 18.8, p < .001, \eta^2p = 0.12$	$F = 1.1, p = .35$, n.s.
Time diff Index-Wrist peak vel place (ms)	−27 ± 5.6[a]	−51 ± 5.8	−55 ± 5.7	$F = 6.9, p < .001, \eta^2p = 0.06$	$F = 0.7, p = .59$, n.s.
Wrist acceleration/deceleration phase (%)	46/54	45/55	41/59[c]	$F = 8.5, p < .001, \eta^2p = 0.07$	$F = 1.9, p = .10$, n.s.
Index acceleration/deceleration phase (%)	43/57[a]	38/62[b]	35/65[c]	$F = 22.5, p < .001, \eta^2p = 0.17$	$F = 0.8, p = .48$, n.s.
Wrist average velocity (mm/s)	299 ± 9.3[a]	411 ± 9.7[b]	360 ± 9.3	$F = 33.6, p < .001, \eta^2p = 0.23$	$F = 0.5, p = .71$, n.s.
Index average velocity (mm/s)	423 ± 15.8[a]	541 ± 16.4	525 ± 15.8	$F = 15.7, p < .001, \eta^2p = 0.14$	$F = 1.4, p = .23$, n.s.
Wrist 3D distance (mm)	260 ± 4.5[a]	305 ± 5.5	307 ± 4.5	$F = 36.6, p < .001, \eta^2p = 0.25$	$F = 3.4, p = .02$, n.s.
Index 3D distance (mm)	366 ± 5.2[a]	403 ± 5.3[b]	438 ± 5.3[c]	$F = 46.5, p < .001, \eta^2p = 0.29$	$F = 1.2, p = .29$, n.s.
Grasp phase					
Grasp duration	77 ± 22.5	64 ± 24.3	254 ± 22.6[c]	$F = 18.9, p < .001, \eta^2p = 0.15$	$F = 1.5, p = .19$, n.s.
Transport-to-fit phase					
Transport-to-fit duration (ms)	1,461 ± 91	1,618 ± 92	2,280 ± 93[c]	$F = 22.4, p < .001, \eta^2p = 0.17$	$F = 9.8, p < .001, \eta^2p = 0.15$
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.
Total peg rotation time (ms)	574 ± 48	659 ± 49	774 ± 49	$F = 4.2, p = .05$, n.s.	$F = 12.2, p < .001, \eta^2p = 0.14$
Wrist transport-to-fit MUs (n)	6.5 ± 0.7	7.5 ± 0.8	13.3 ± 0.8[c]	$F = 22.1, p < .001, \eta^2p = 0.16$	$F = 5.5, p < .001, \eta^2p = 0.09$
Index transport-to-fit MUs (n)	7.8 ± 0.7	9.7 ± 0.8	15.4 ± 0.8[c]	$F = 21.5, p < .001, \eta^2p = 0.16$	$F = 9.8, p < .001, \eta^2p = 0.15$
Wrist average velocity (mm/s)	181 ± 6.5[d]	212 ± 6.5	193 ± 6.5	$F = 5.8, p < .005, \eta^2p = 0.05$	$F = 11.3, p < .001, \eta^2p = 0.17$
Index average velocity (mm/s)	251 ± 9.0	273 ± 9.4	239 ± 9.1	$F = 3.1, p = .05$, n.s.	$F = 9.4, p < .001, \eta^2p = 0.14$
Wrist 3D distance (mm)	258 ± 7.2[a]	315 ± 5.9[b]	369 ± 7.2[c]	$F = 58.1, p < .001, \eta^2p = 0.34$	$F = 7.7, p < .001, \eta^2p = 0.12$
Index 3D distance (mm)	359 ± 6.4[a]	409 ± 5.4[b]	437 ± 6.4[c]	$F = 39.3, p < .001, \eta^2p = 0.26$	$F = 12.8, p < .001, \eta^2p = 0.18$

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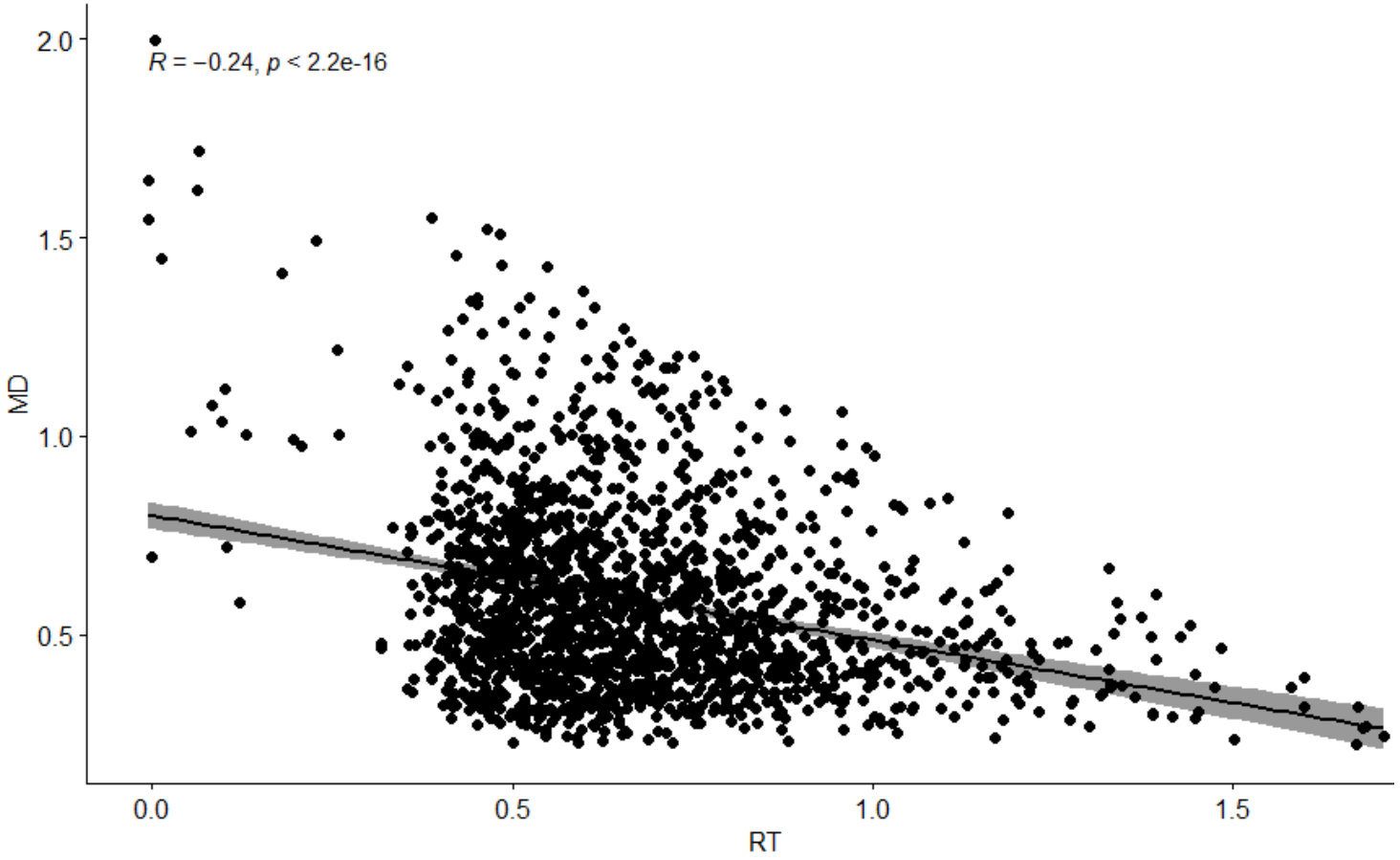
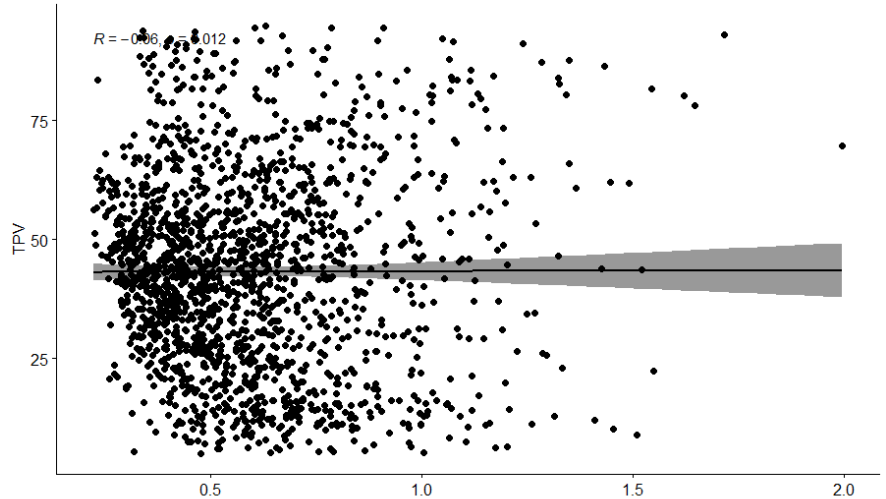
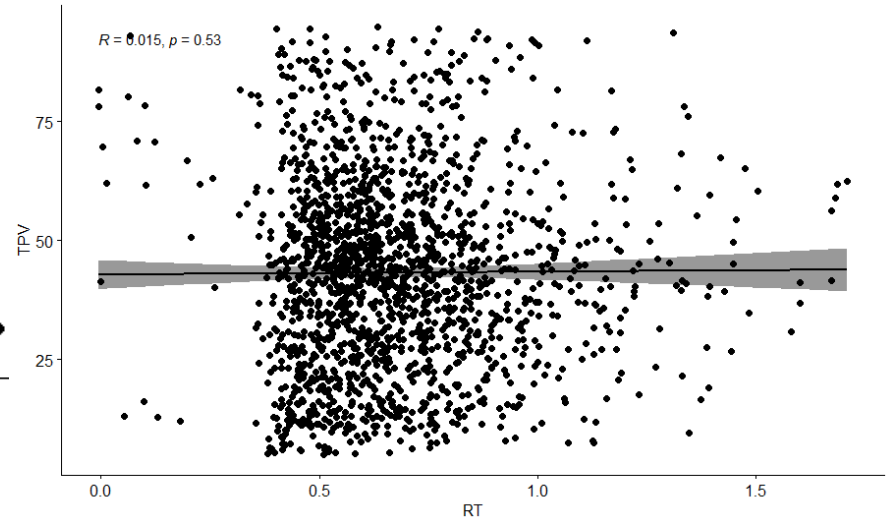
- Separate mixed design 3 × 5 (3 age groups× 5 task conditions) ANOVAs
- Analyses of relations between parameters were performed separately within each age group using Pearson's product-moment and partial correlations (with Bonferroni correction)

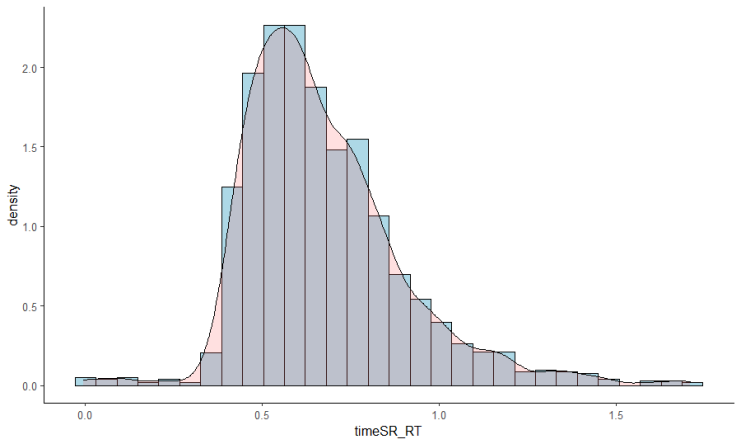
From the extant kinematic literature

Spearman's rank correlation rho

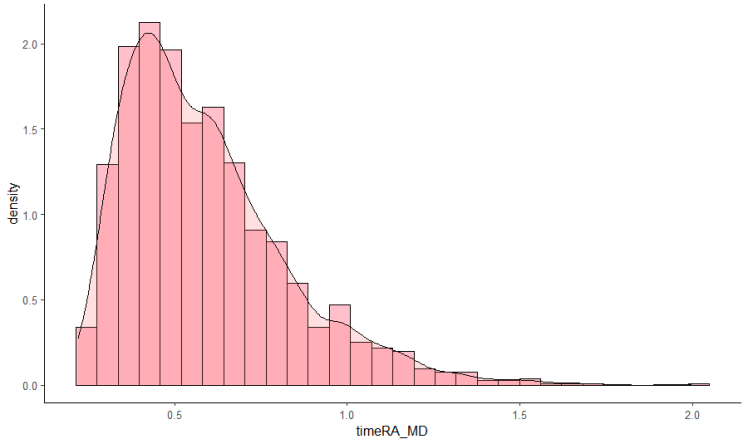




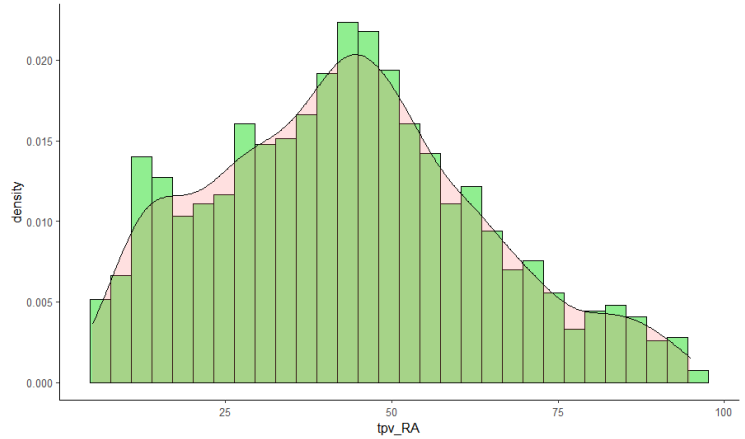




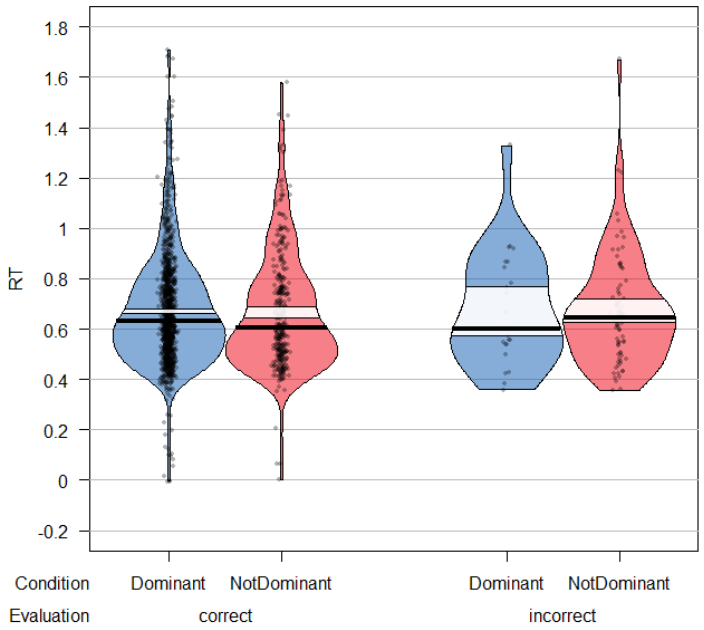
Reaction Time



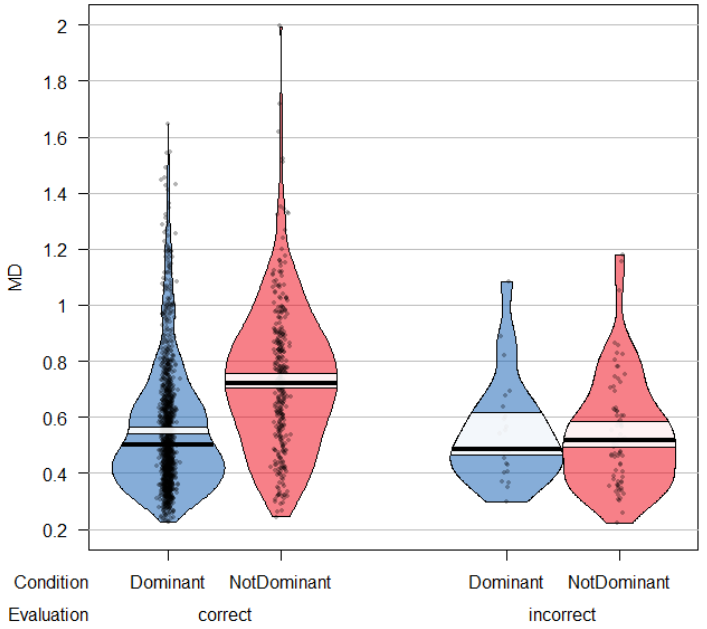
Movement Duration



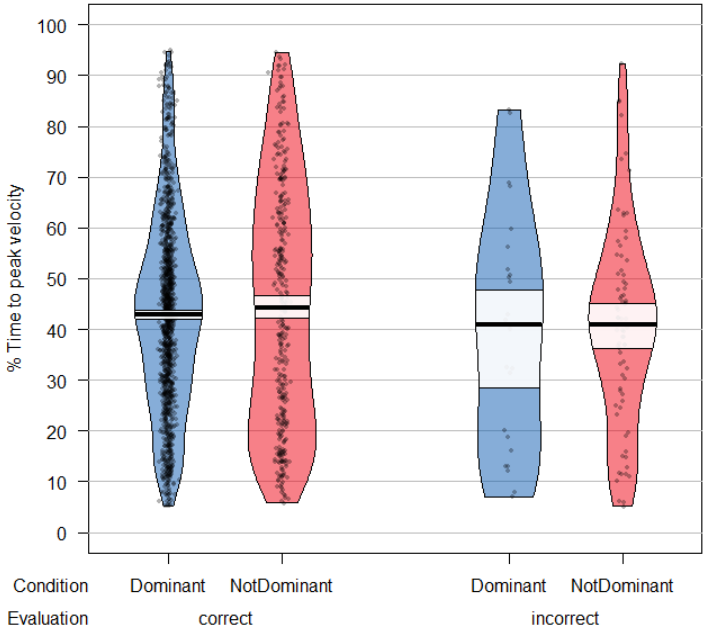
%Time to Peak Velocity



Reaction Time

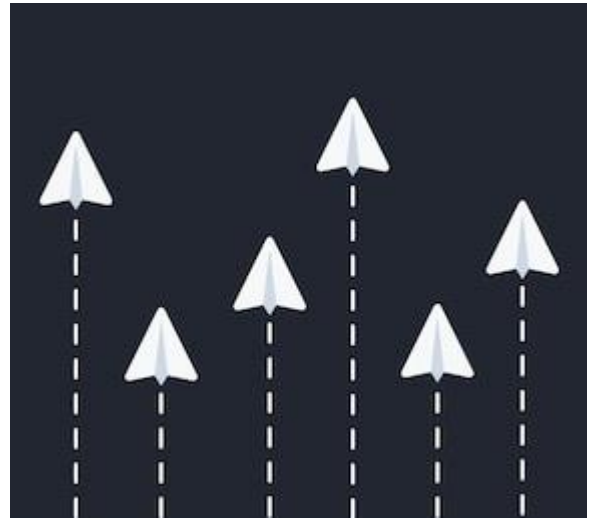


Movement Duration



%Time to Peak Velocity

Model selection and comparison

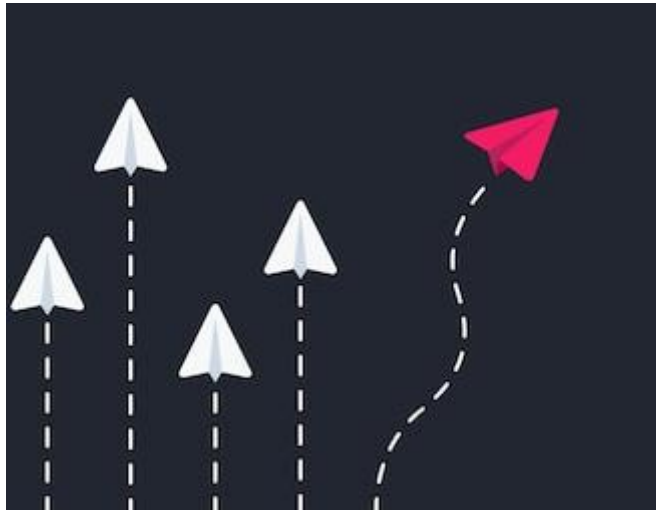


- (mb0 <- glmmTMB(Accuracy ~ (1|Participant), data = adhd1, family=binomial()))
- (mb1 <- glmmTMB(Accuracy ~ Condition + (1|Participant), data = adhd1, family=binomial()))
- (mb2 <- glmmTMB(Accuracy ~ Condition + timeSR_RT + (1|Participant), data = adhd1, family=binomial()))
- (mb3 <- glmmTMB(Accuracy ~ 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()))

- ……..

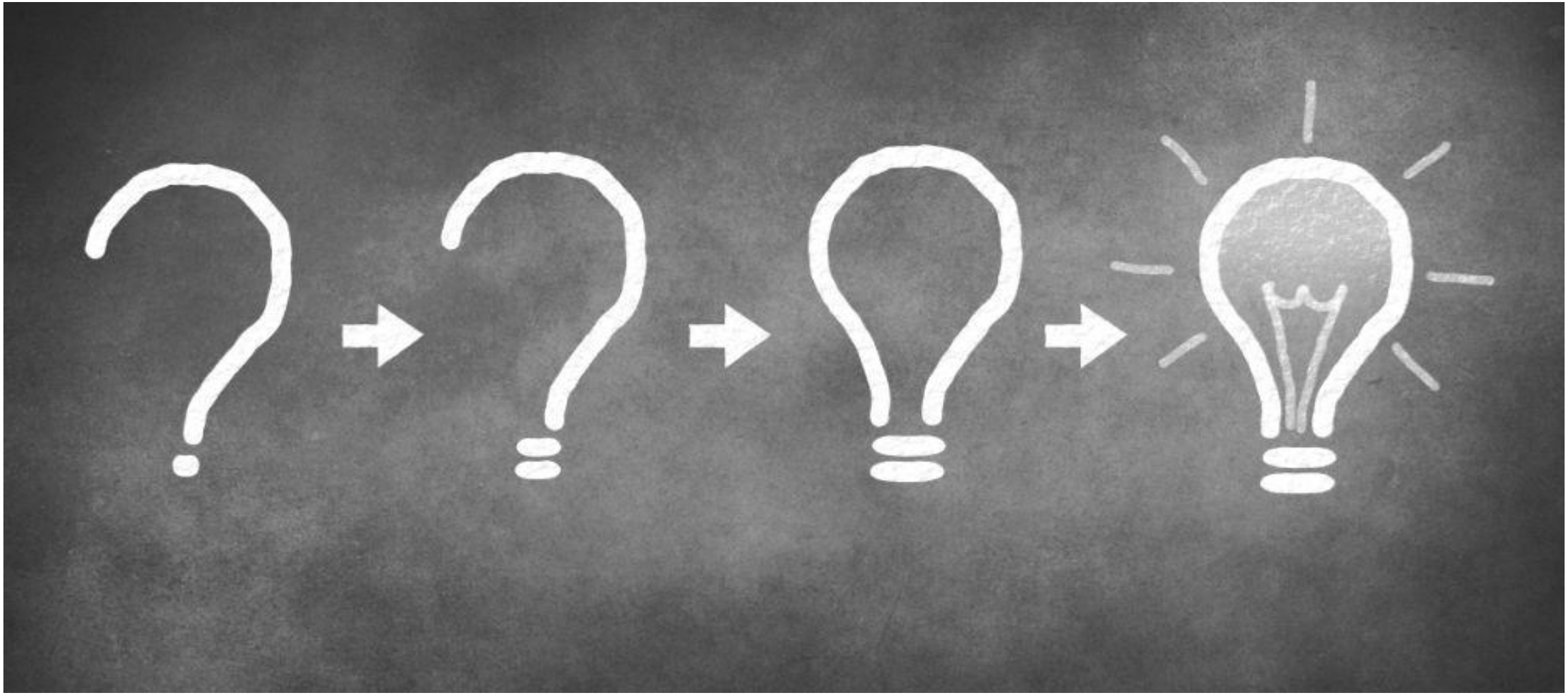
Model selection and comparison: Invented!



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

Open questions

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



Thank you!

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