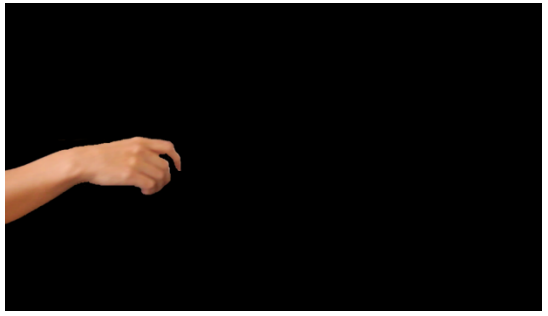
How social is the cerebellum? Neuropsychological and neurostimulation findings

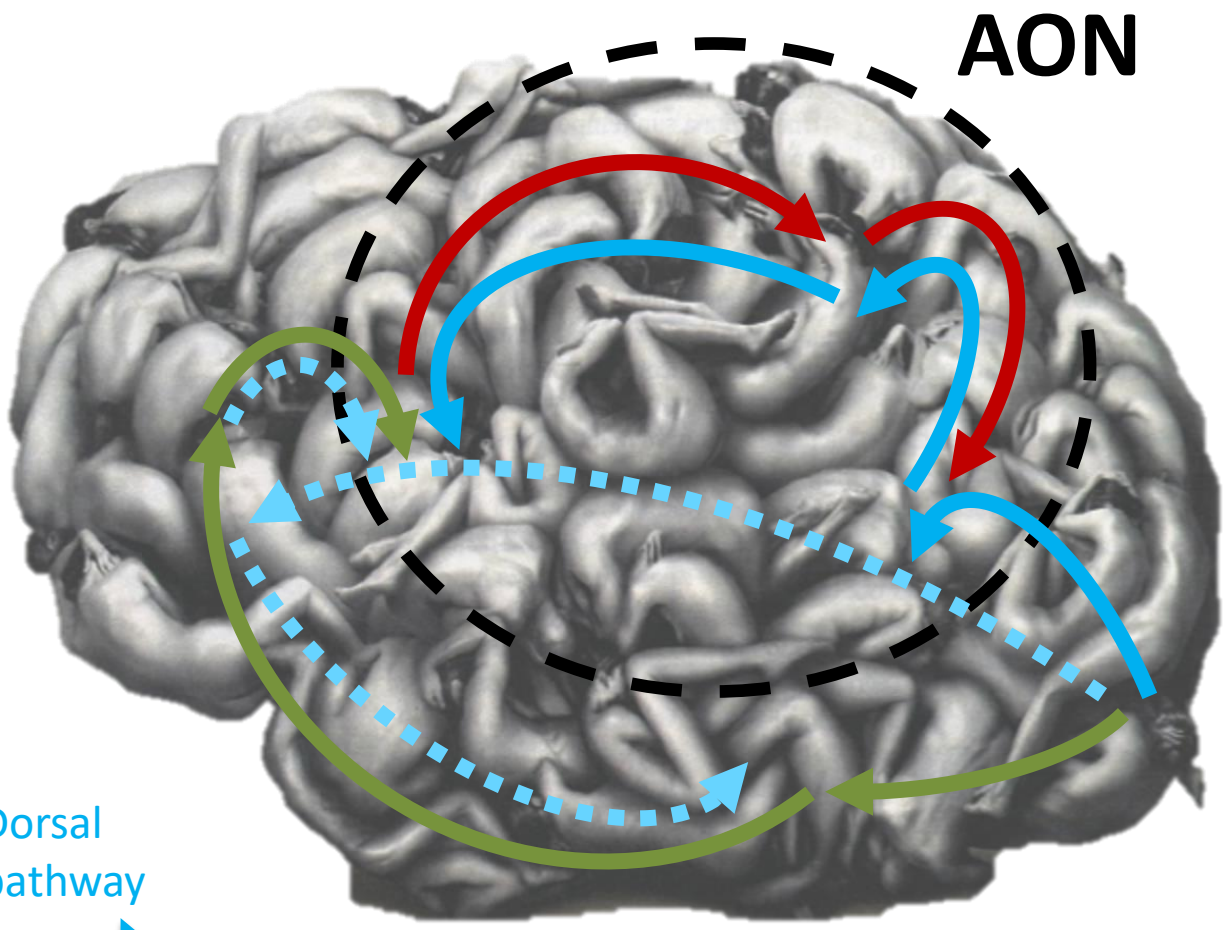
Cosimo Urgesi
University of Udine & IRCCS E. Medea, Italy

We understand intentions

from observing movements



Context-embedded predictions

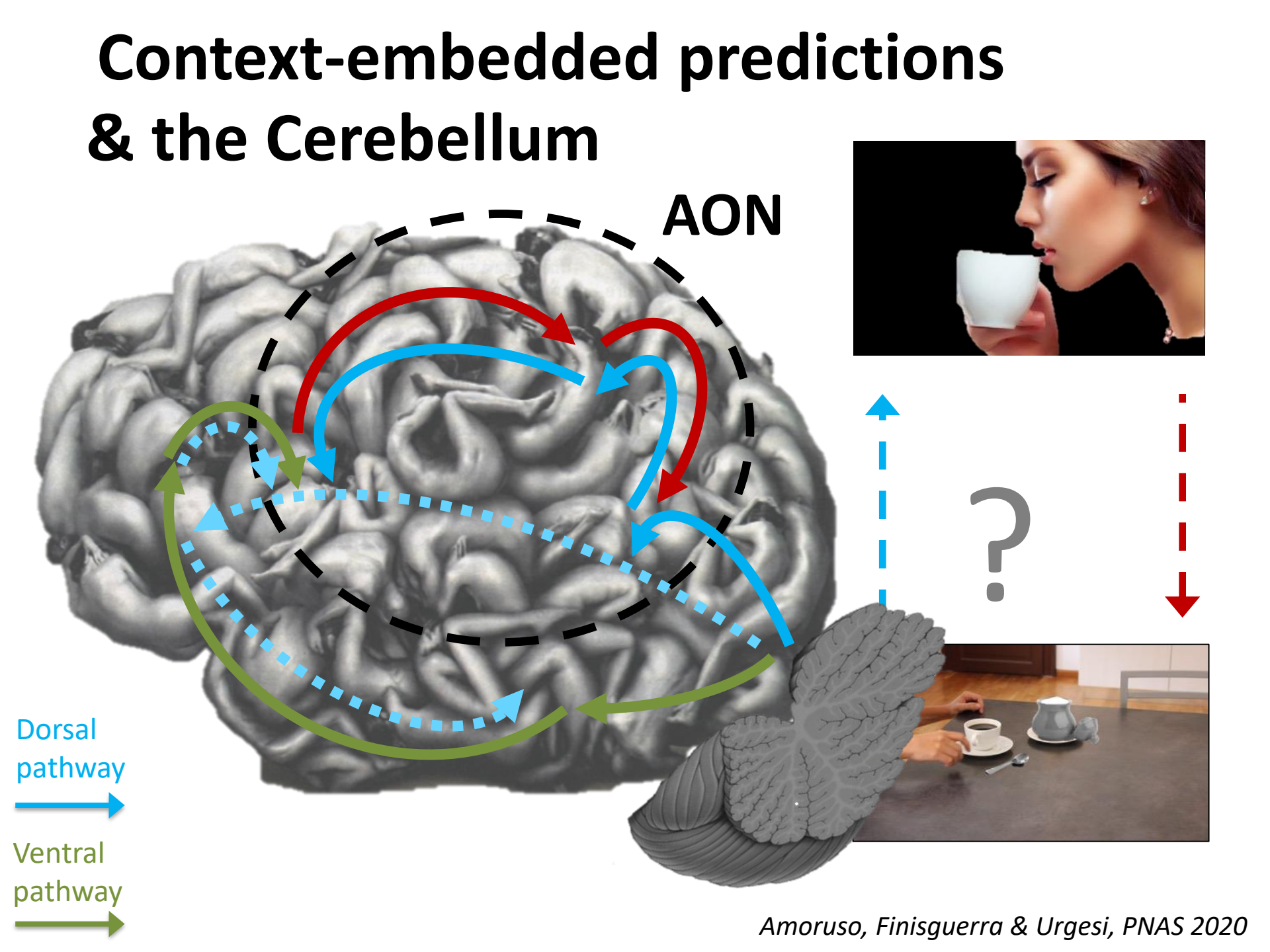


Dorsal pathway

Ventral pathway

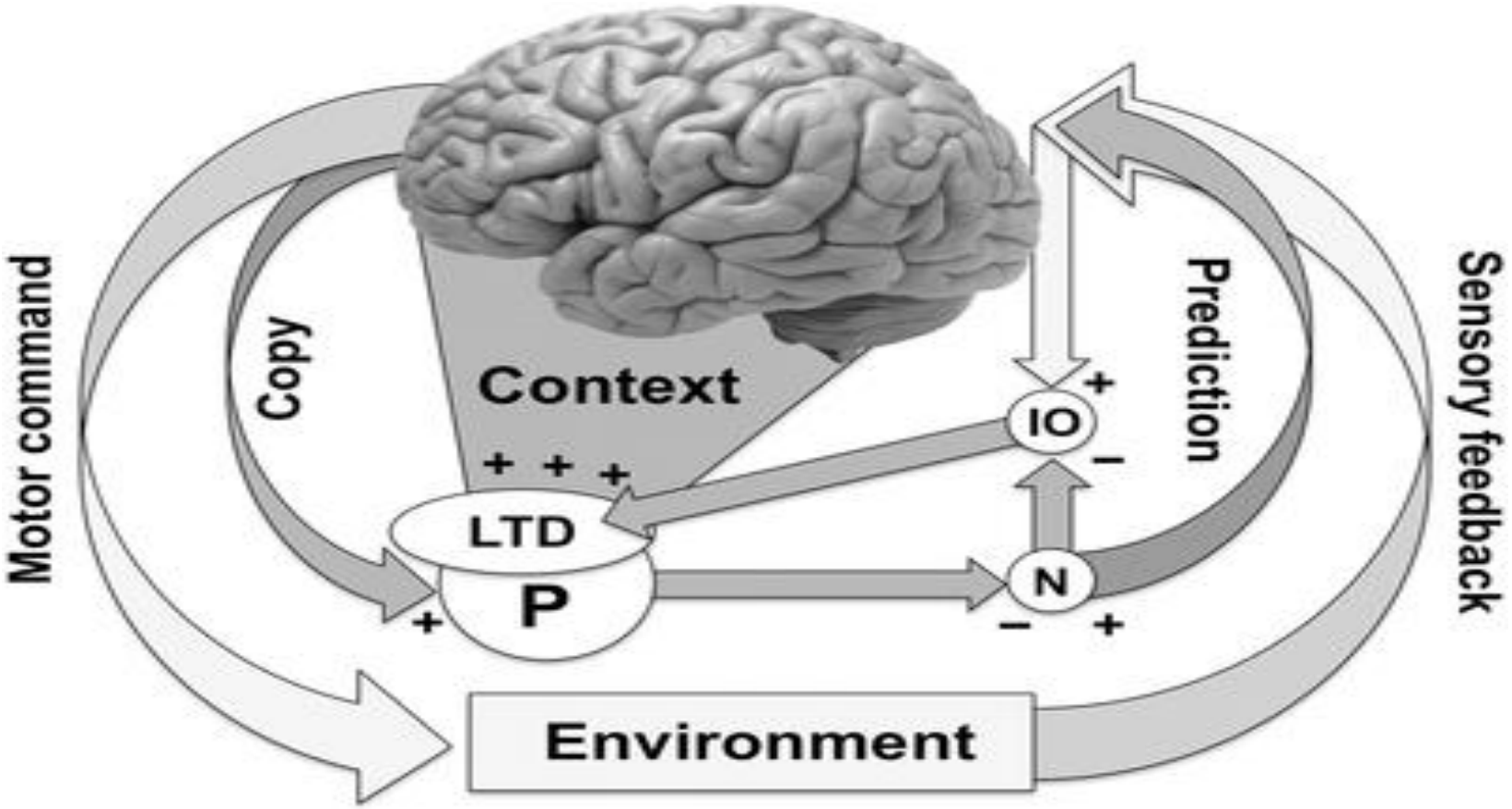
Amoruso, Finisguerra & Urgesi, PNAS 2020

Context-embedded predictions & the Cerebellum



Amoruso, Finisguerra & Urgesi, PNAS 2020

The Predictive Cerebellum

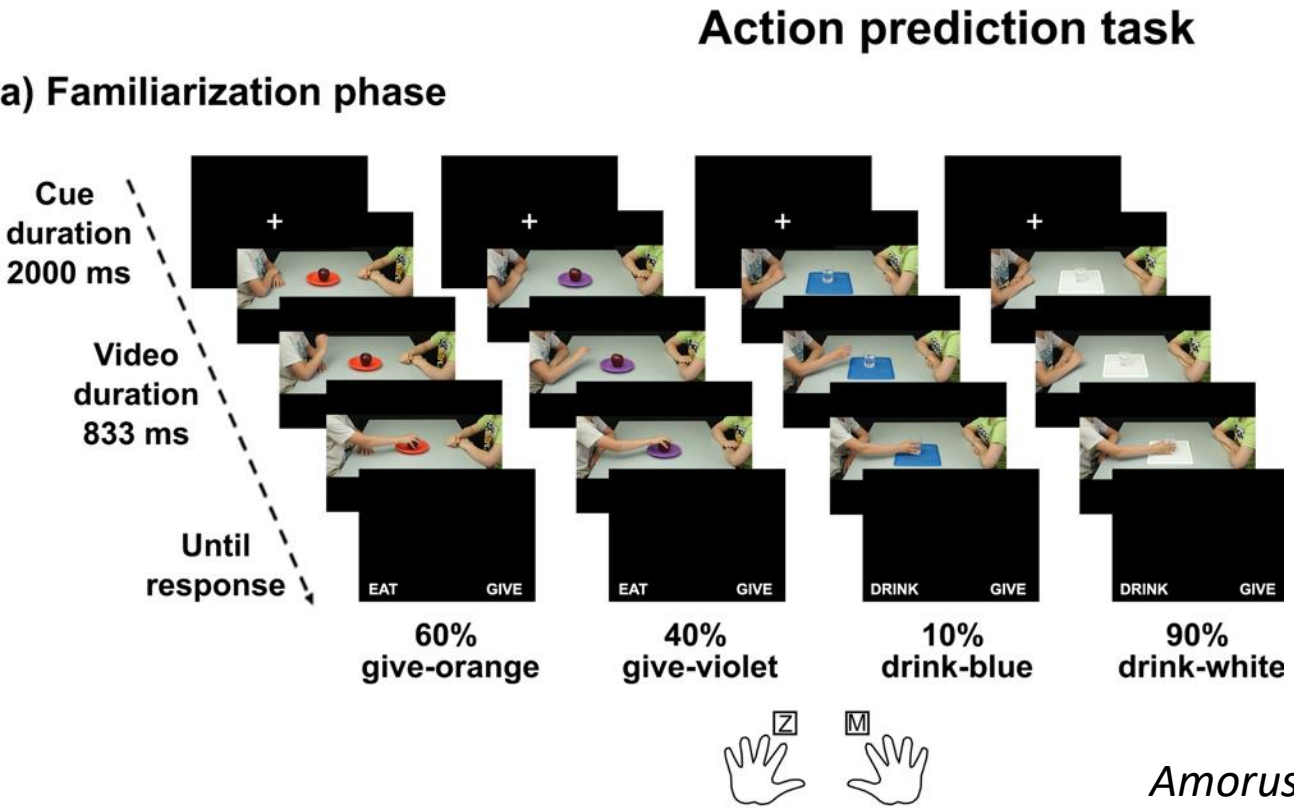


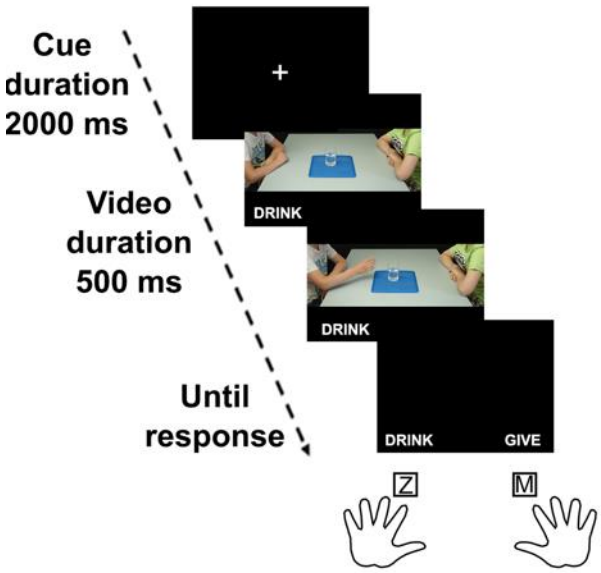
Moberget & Ivry, 2016

Cerebellar Cognitive Affective Syndrome

Schmahmann & Janet, 1998

Learning & Using ACTION-Context associations





Amoruso et al., Proc. R. Soc. B, 2019

VENERDÌ 1 OTTOBRE 2021

10.30 Implicit learning prevails over explicit learning during prediction of possible outcomes under perceptual uncertainty
Valentina Bianco (Udine)

The Cerebellum
https://doi.org/10.1007/s12311-020-01168-w

ORIGINAL ARTICLE

Cerebellar Damage Affects Contextual Priors for Action Prediction in Patients with Childhood Brain Tumor

Niccolò Butti[1] · Claudia Corti[1] · Alessandra Finisguerra[2] · Alessandra Bardoni[3] · Renato Borgatti[4] · Geraldina Poggi[3] · Cosimo Urgesi[1,5]

Acquired cerebellar damage

Table 1 Demographic and clinical variables of brain tumor participants

	STT group ($N = 21$) M(SD)/N(%)	ITT group ($N = 21$) M(SD)/N(%)	t/ χ^2	p value
Demographic variables				
Sex (males)	8 (38.1%)	13 (61.9%)	2.38	0.12
Age at evaluation (months)	165 (46)	152 (45)	0.90	0.37
Clinical variables				
Age at diagnosis (months)	79 (50)	98 (45)	1.30	0.20
Time since diagnosis (months)	86 (40)	54 (39)	2.61	*0.01*
Tumor type			14.25	*< 0.01*
Medulloblastoma	3 (14.3%)	14 (66.5%)		
Astrocytoma	4 (19.0%)	4 (19.0%)		
Ependymoma	4 (19.0%)	1 (5.0%)		
Other	10 (47.7%)	2 (9.5%)		
Neurosurgery (yes)	20 (95.2%)	15 (71.4%)	3.36	0.07
Radiotherapy (yes)	15 (71.4%)	17 (80.9%)	0.53	0.47
Chemotherapy (yes)	16 (76.2%)	19 (90.5%)	1.54	0.21
Hydrocephalus (yes)	7 (33.3%)	7 (33.3%)	0.00	1.00
Cognitive functioning				
FSIQ	87 (18)	87 (19)	0.79	0.99
VIQ	98 (14)	97 (11)	0.19	0.85
PRIQ	94 (20)	97 (22)	0.42	0.68

STT supra-tentorial tumor, *ITT* infra-tentorial tumor, *M* mean, *SD* standard deviation, *FSIQ* full-scale intelligent quotient, *VIQ* verbal intelligent quotient, *PRIQ* rerceptual reasoning intelligent quotient. Independent sample *t* test (two-tailed) was used to compare the two patient groups for continuous variable and χ^2 for categorical variables. Significant comparisons are highlighted in italic

Cortex, in press

Cerebellum and social prediction: from neuropsychological assessment to rehabilitation in virtual reality

Cosimo Urgesi[a,b#], Niccolò Butti [a,c#*], Alessandra Finisguerra[d], Emilia Biffi[e], Enza Maria Valente [f,g], Romina Romaniello [a], Renato Borgatti [f, h]

Congenital cerebellar malformations

	CM	CND	TD
Demographic information			
N (male: female)	18:8	17:9	17:9
Age (years)	11.5 (2.7)	11.3 (3.0)	11.4 (3.1)
Clinical information			
IQ	67 (23)	73 (16)	
Primary malformation	Molar tooth sign (10); vermis hypoplasia (9); vermis and hemispheres hypoplasia (5); hemispheres hypoplasia (left) and dysplasia (right) (1); rhomboencephalosynapsis (1)	Cortical dysmorphism (1); Anterior mesencephalic bulging and thick corpus callosum (1); corpus callosum agenesis (2); mega cisterna magna (1); corpus callosum agenesis and frontal polymicrogyria (1); thalamic hamartoma and UBOs (1); aberrant supracallosal longitudinal bundle (1); none (18)	
Syndromic/genetic diagnosis	Joubert syndrome (10); Dandy-Walker malformation (1); OPHN1 mutation (1); ITPR1 mutation (1); unknown (13)	Myhre syndrome (1); 16p11.2 deletion syndrome (2); SOX5 deletion (1); neurofibromatosis type 1 (1); SCN8A-related disorder (1); unknown (20)	

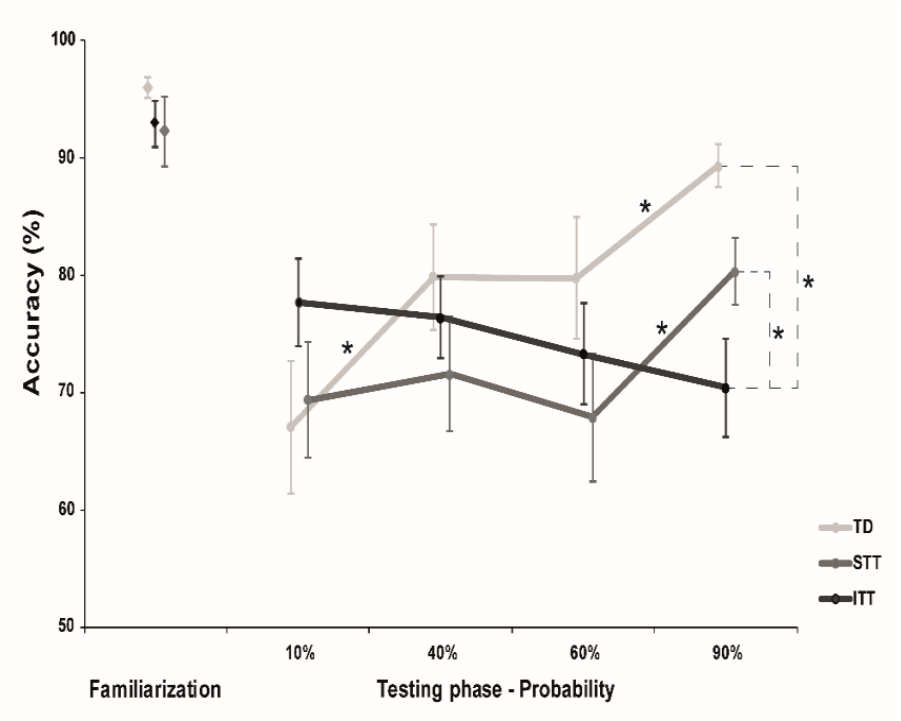
The Cerebellum
https://doi.org/10.1007/s12311-020-01168-w

ORIGINAL ARTICLE

Cerebellar Damage Affects Contextual Priors for Action Prediction in Patients with Childhood Brain Tumor

Niccolò Butti[1] · Claudia Corti[1] · Alessandra Finisguerra[2] · Alessandra Bardoni[3] · Renato Borgatti[4] · Geraldina Poggi[3] · Cosimo Urgesi[1,5]

Acquired cerebellar damage

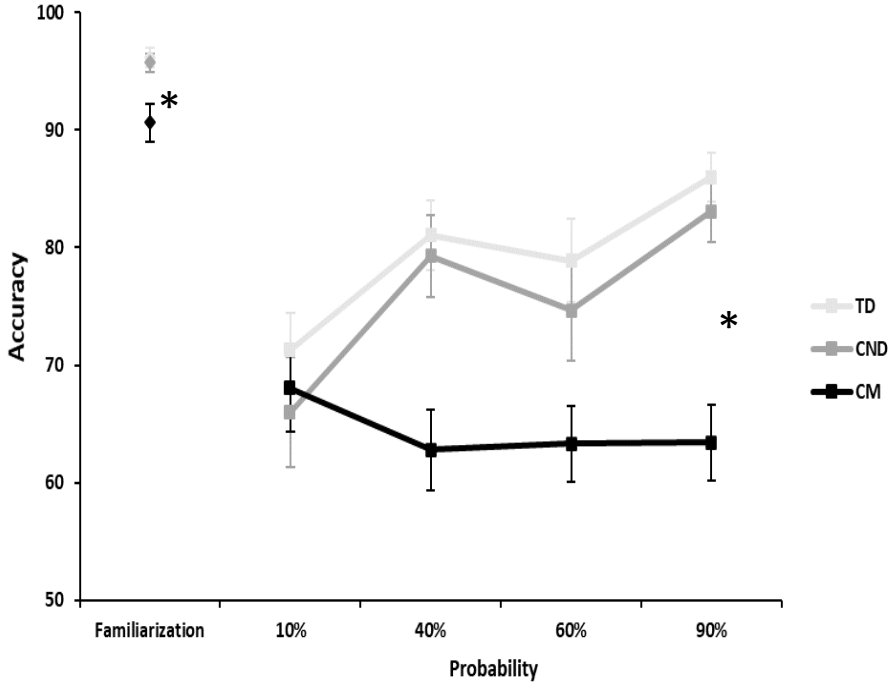


Cortex, in press

Cerebellum and social prediction: from neuropsychological assessment to rehabilitation in virtual reality

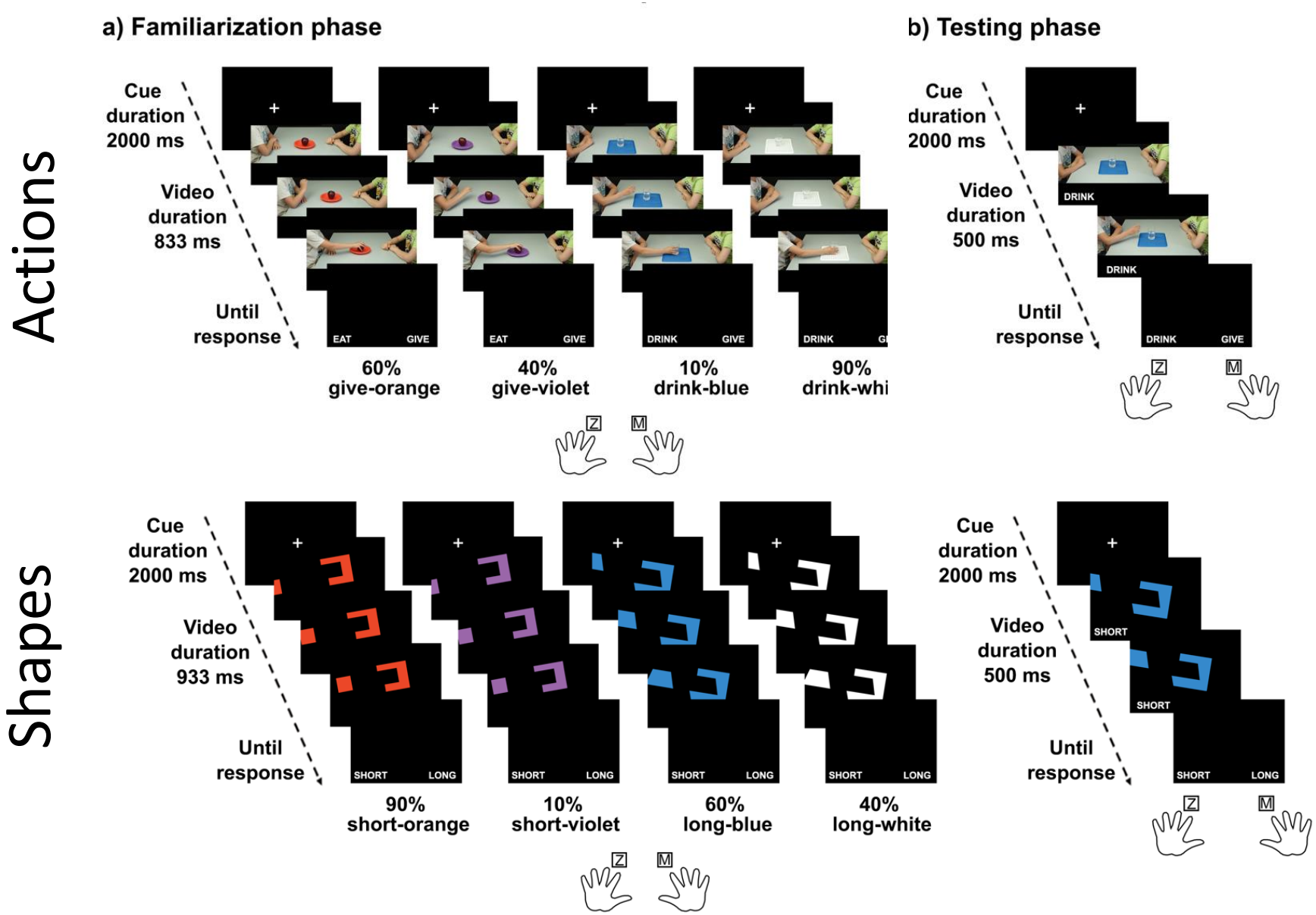
Cosimo Urgesi[a,b#], Niccolò Butti [a,c#*], Alessandra Finisguerra[d], Emilia Biffi[e], Enza Maria Valente [f,g], Romina Romaniello [a], Renato Borgatti [f, h]

Congenital cerebellar malformations



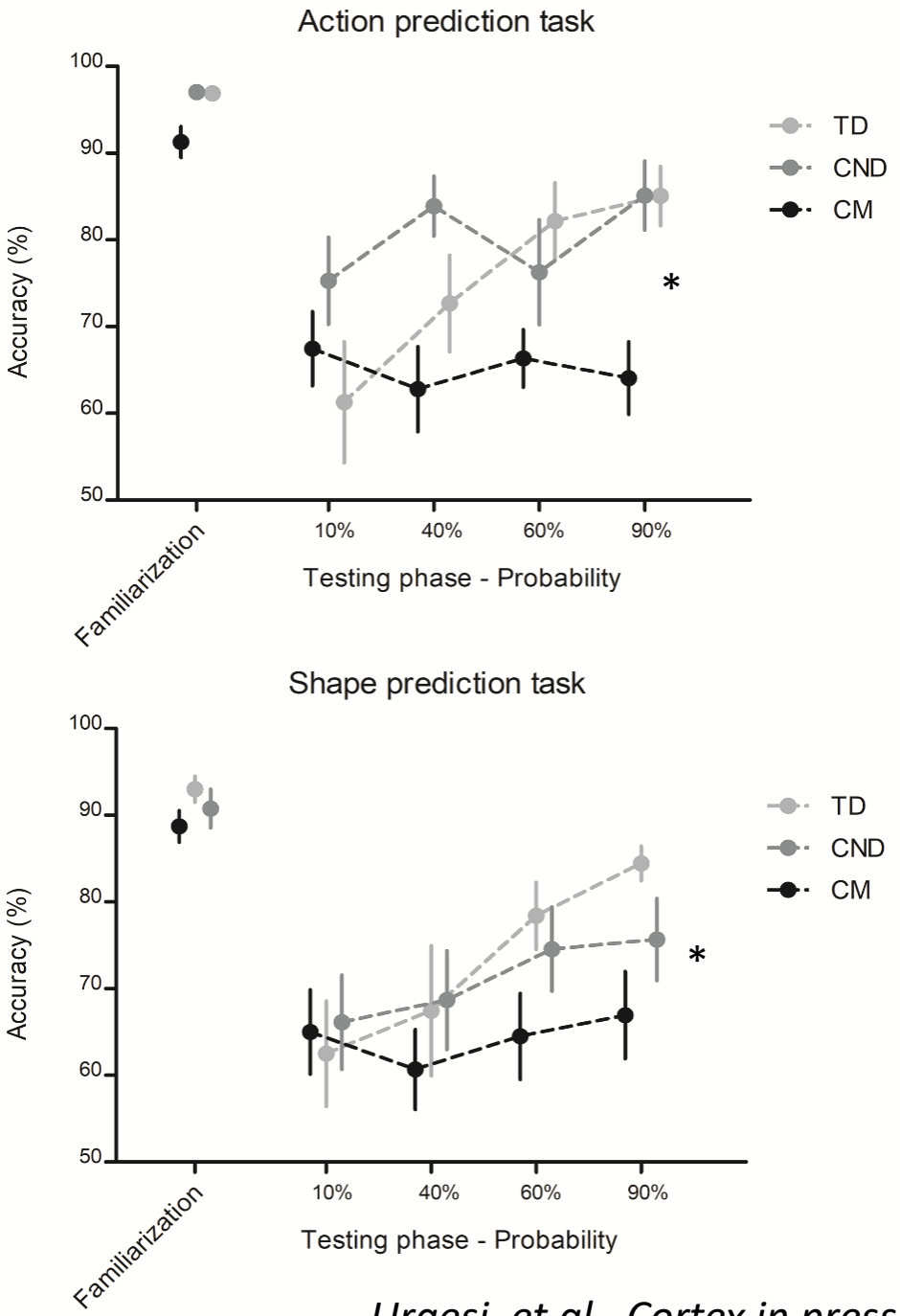
No evidence of contextual prior use in cerebellar patients

Domain general computation?



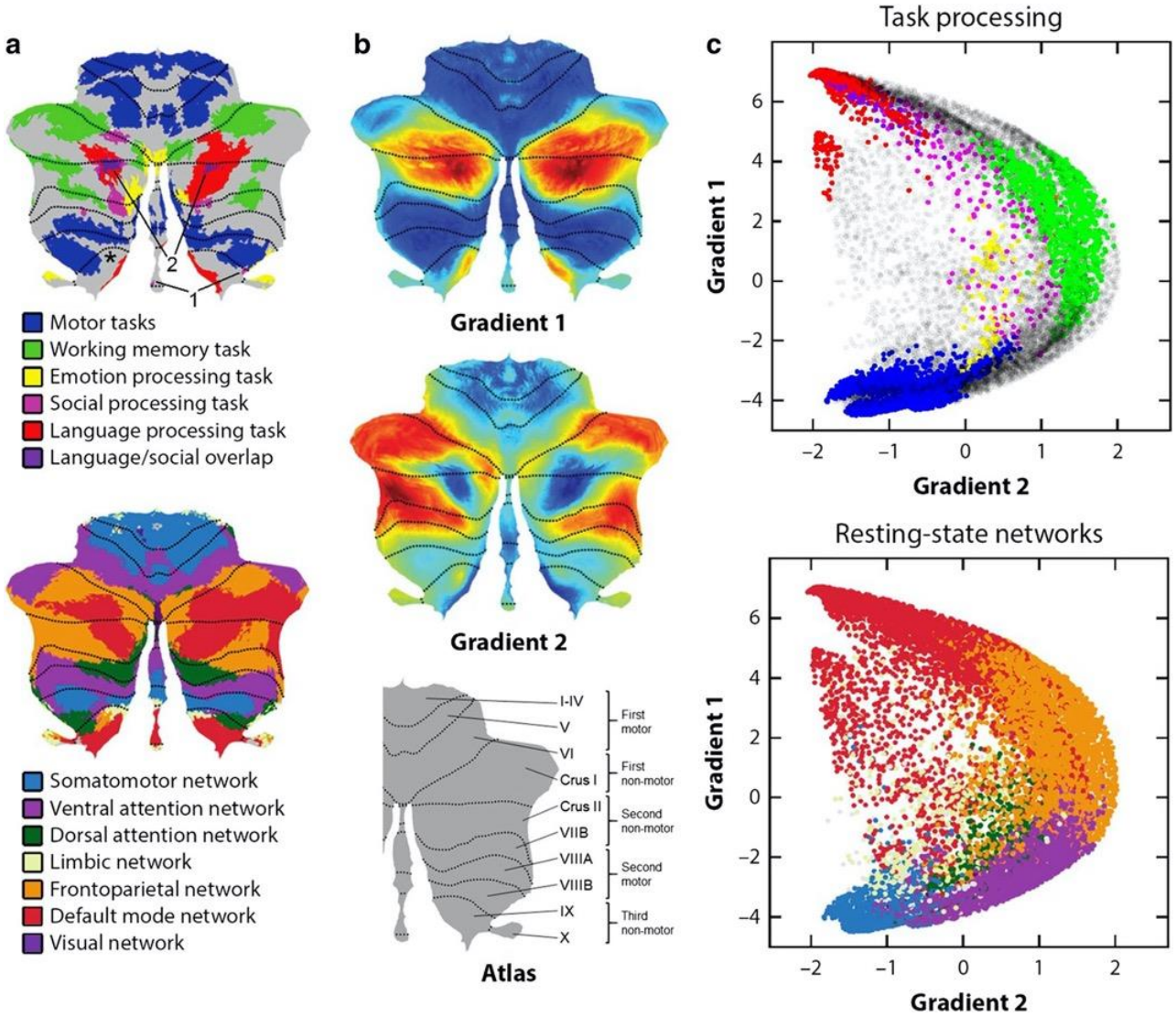
Domain general computation?

	CM	CND	TD
Demographic information			
N (male: female)	12:6	13:5	12:6
Age (years)	12.6 (2.8)	12.8 (3.4)	11.1 (2.9)
Clinical information			
IQ	71 (27)	78 (16)	107 (10)
Primary malformation	Molar tooth sign (6); vermis hypoplasia (7); vermis and hemispheres hypoplasia (3); hemispheres hypoplasia (left) and dysplasia (right) (1); rhomboencephalosynapsis (1)	Corpus callosum agenesis (2); thick corpus callosum (1); thalamic hamartoma and UBOs (1); aberrant supracallosal longitudinal bundle (2); none (12)	
Syndromic/genetic diagnosis	Joubert syndrome (6); Dandy-Walker malformation (1); unknown (11)	16p11.2 deletion syndrome (1); SOX5 deletion (1); neurofibromatosis type 1 (1); SCN8A-related disorder (1); Floating-Harbor syndrome (1); unknown (13)	



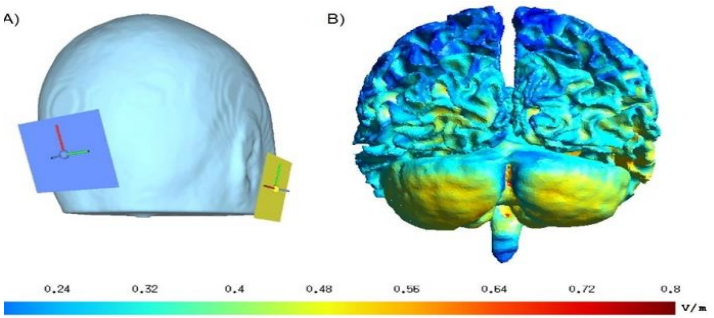
Urgesi, et al., Cortex in press

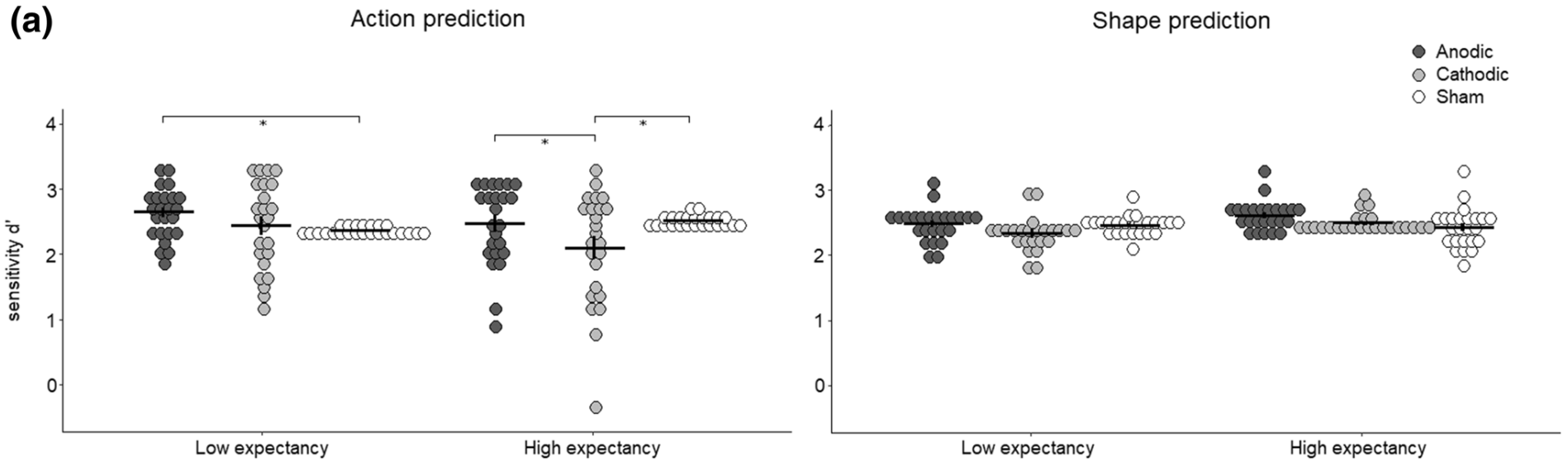
Domain general computation…
…in multiple cerebro-cerebellar loops



Van Overwalle et al., Cerebellum, 2020

Cerebellar tDCS





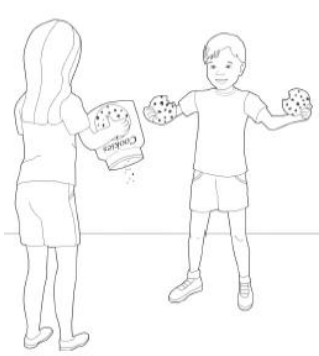
Oldrati et al., Brain Struct Funct. 2021

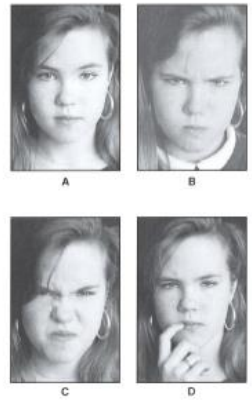
SABATO 2 OTTOBRE 2021

12.05 Boosting social prediction abilities with cerebellar stimulation: evidence from tDCS studies in healthy adults and in patients with cerebellar malformation

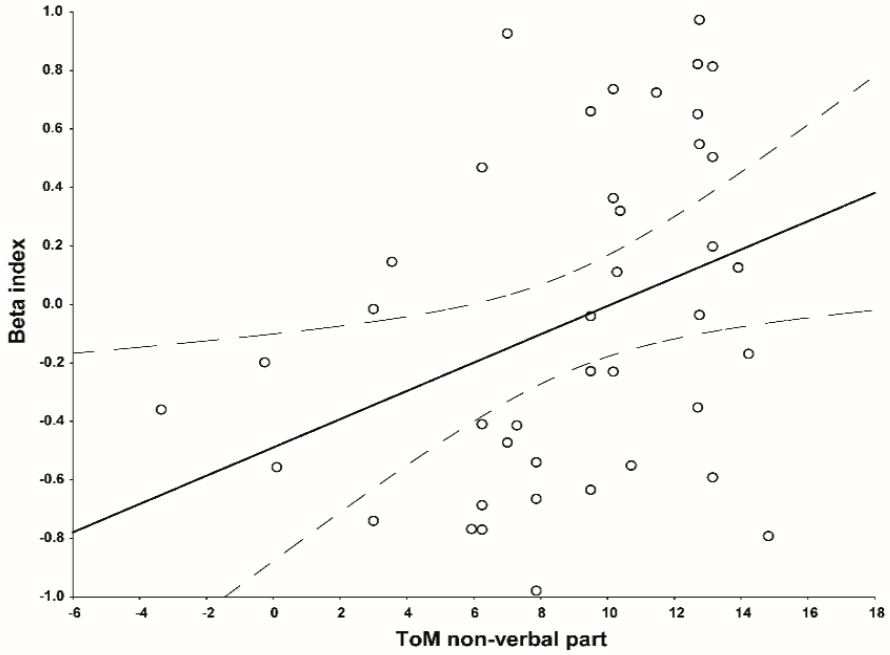
Alessandra Finisguerra, V. Oldrati, N. Butti, E. Ferrari, C. Urgesi (Udine)

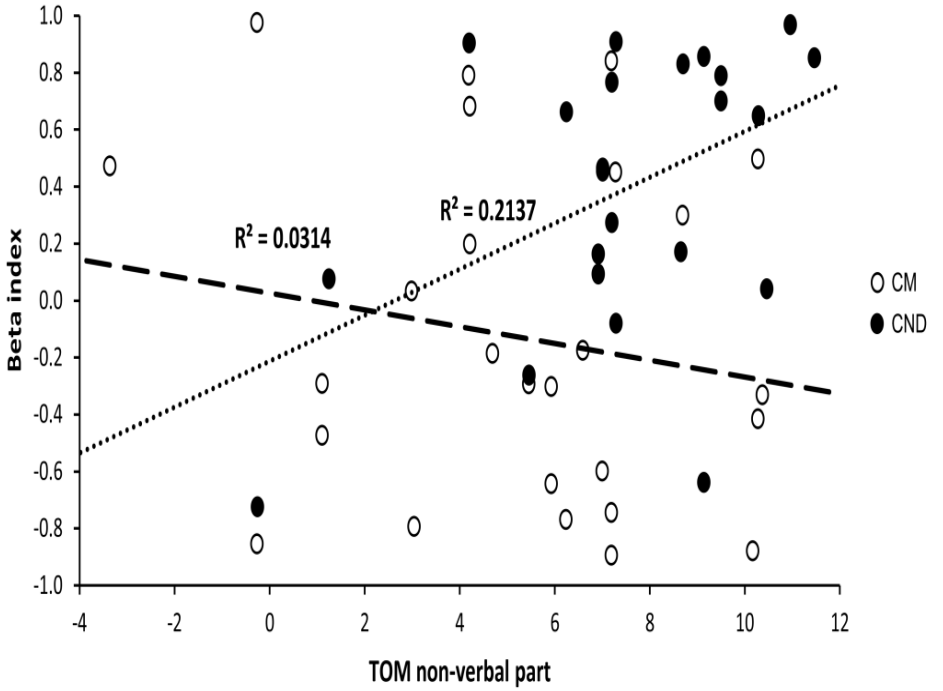
NEPSY-II
SECOND EDITION





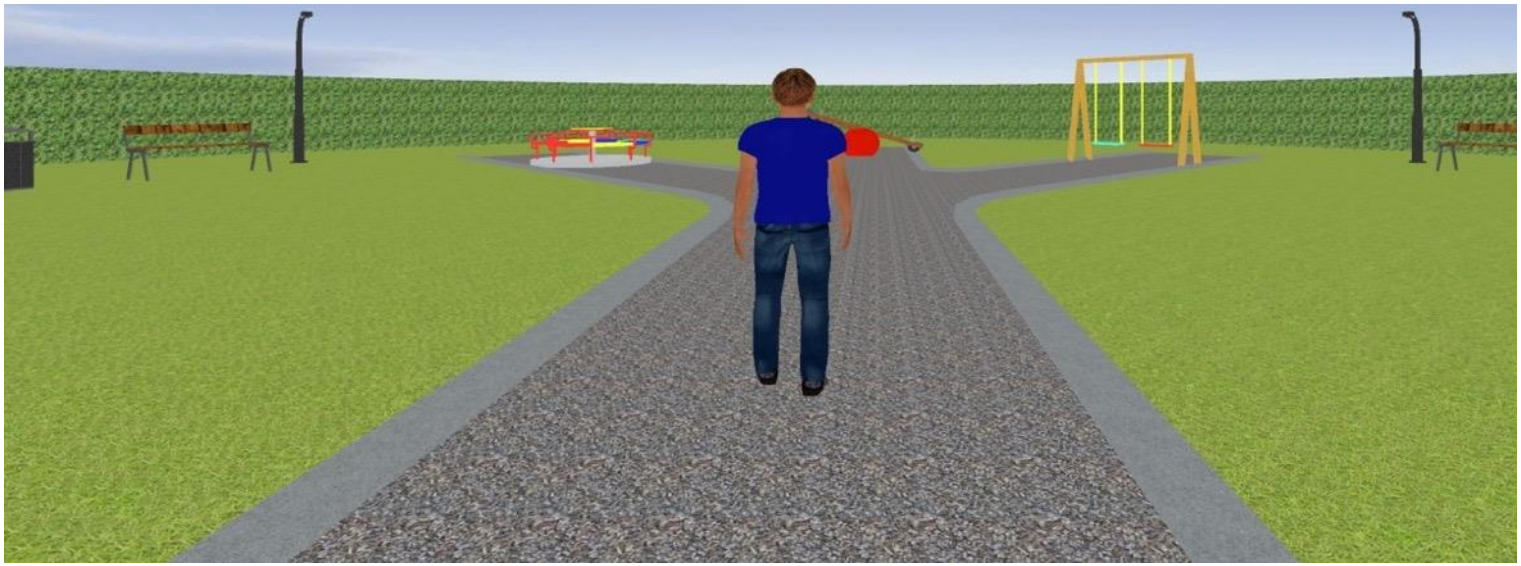
Effects on social cognition?





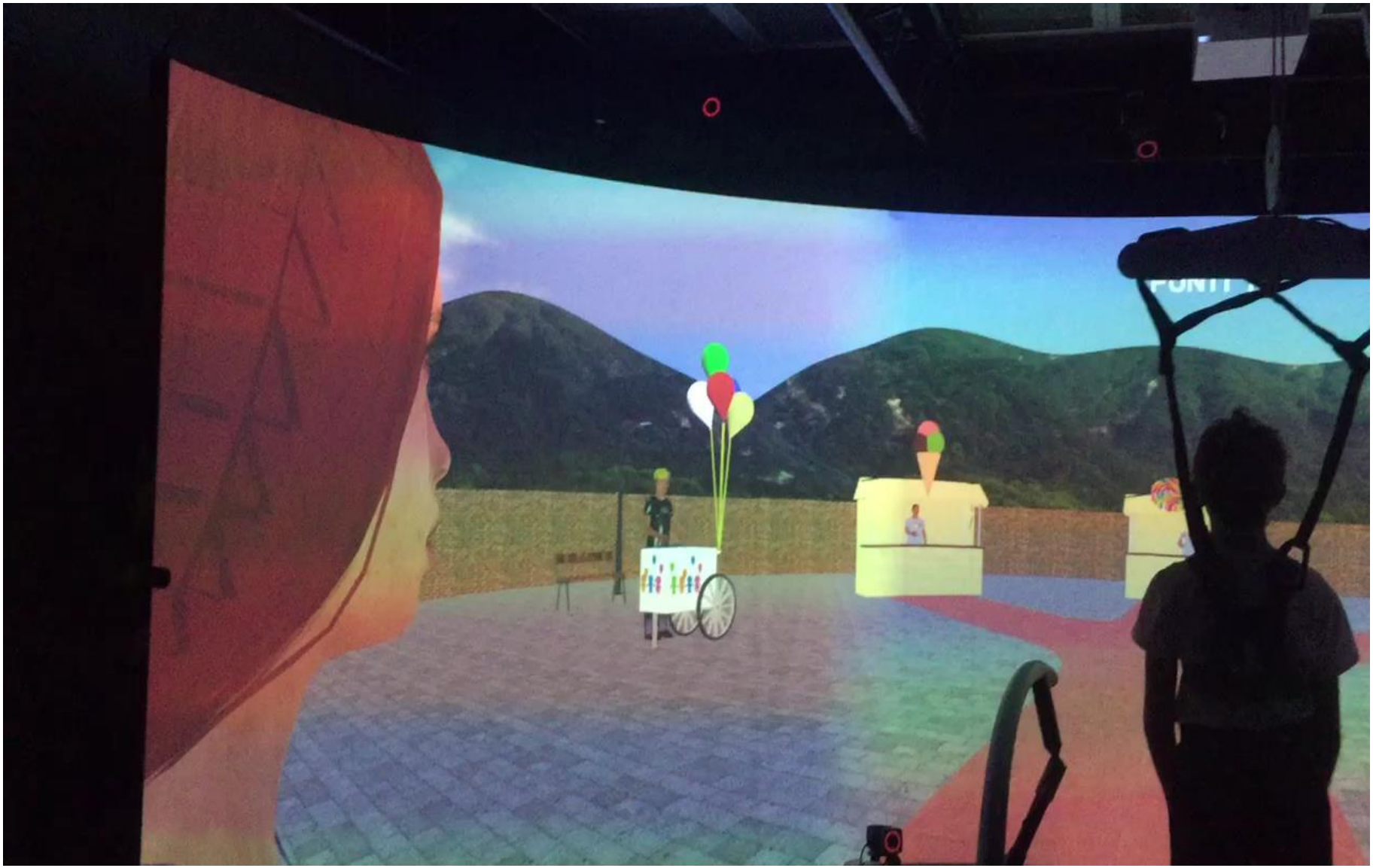
Use of Contextual priors correlates with ToM in non-cerebellar patients

Virtual Reality Social Prediction Improvement and Rehabilitation Intensive Training (VR-SPIRIT)



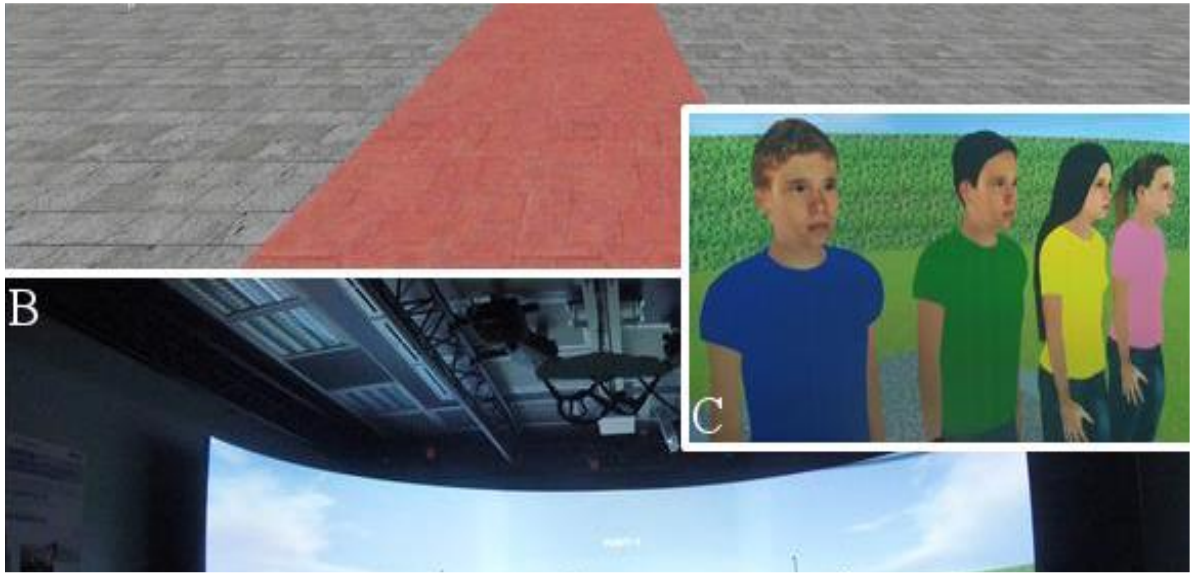
http://www.isrctn.com/ISRCTN22332873

VR-Spirit – Prediction game



Motor training

VR-Spirit design



NEPSY-II
CBCL and TACQOL
VR Social Prediction Evaluation
Action prediction Task

Experimental Group :
Social Prediction training + motor game

Control Group:
Four motor games +
Navigational training

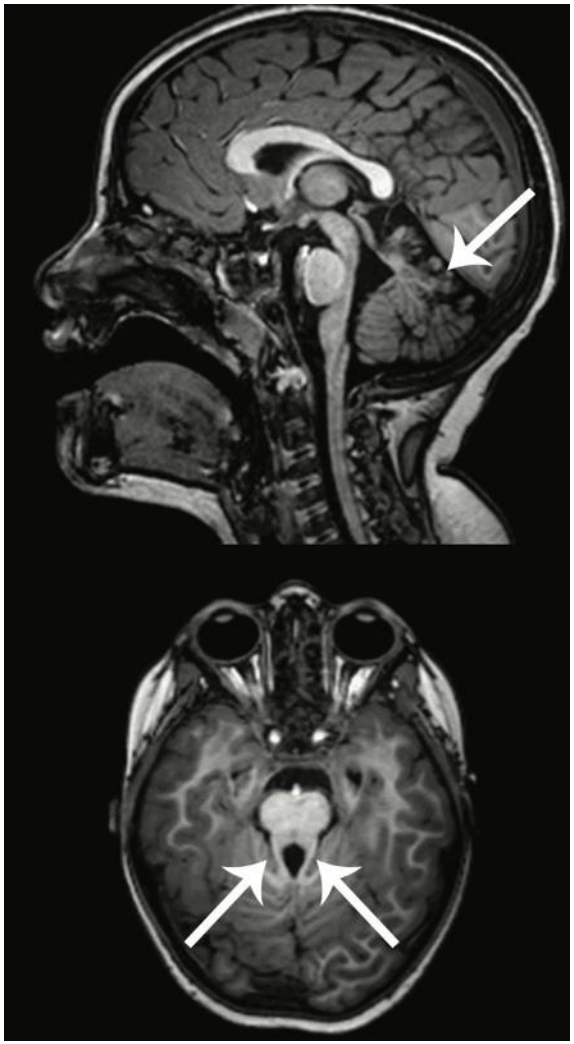
NEPSY-II
VR Social Prediction Evaluation
Action prediction Task
Feasibility questionnaire

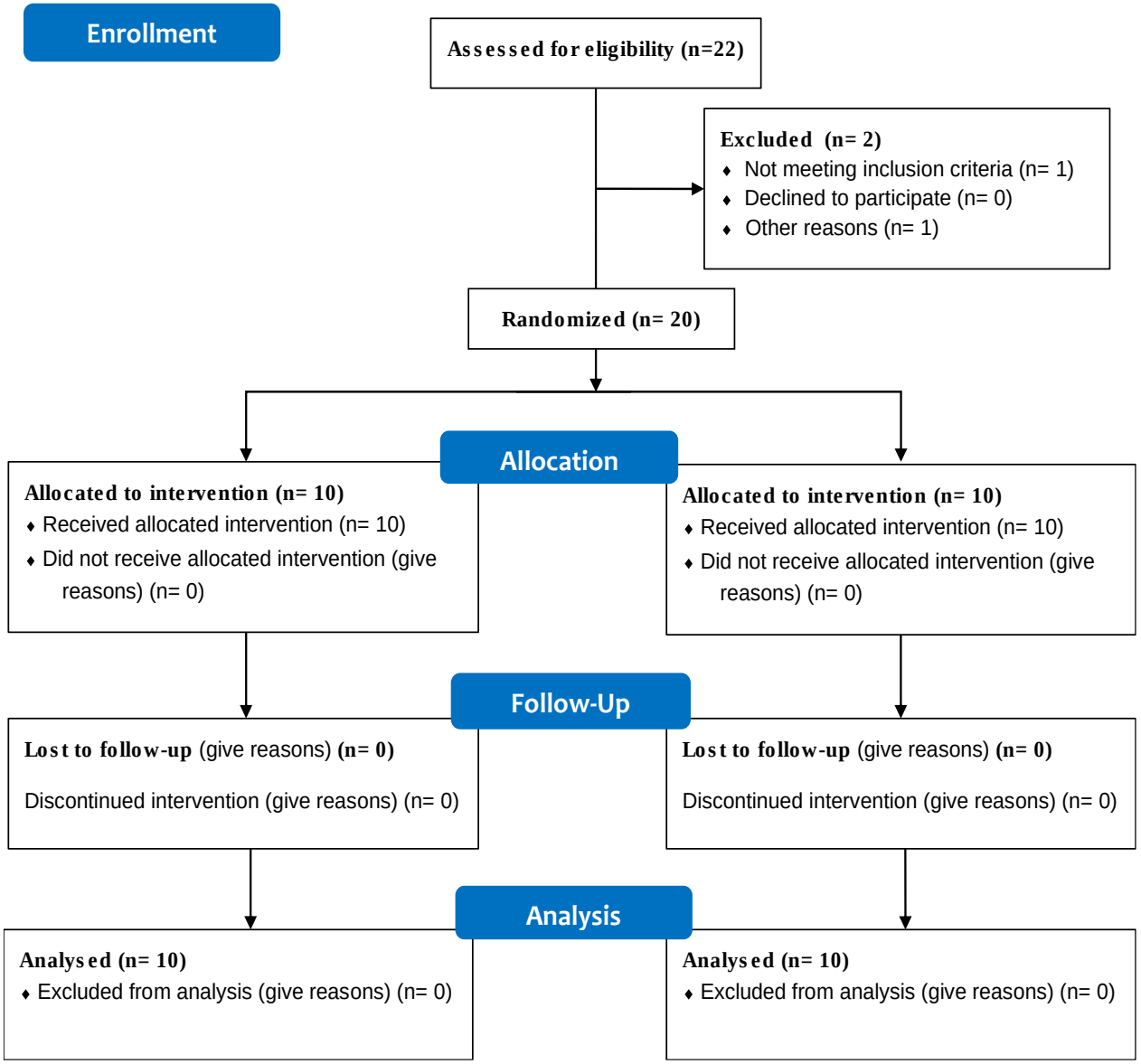
NEPSY-II
CBCL and TACQOL
Action prediction Task

T0 → **T1 VR-INTERVENTIONS** → **T2** → **T3 FOLLOW UP**

Butti et al., Trials, 2020

VR-SPIRIT Preliminary results

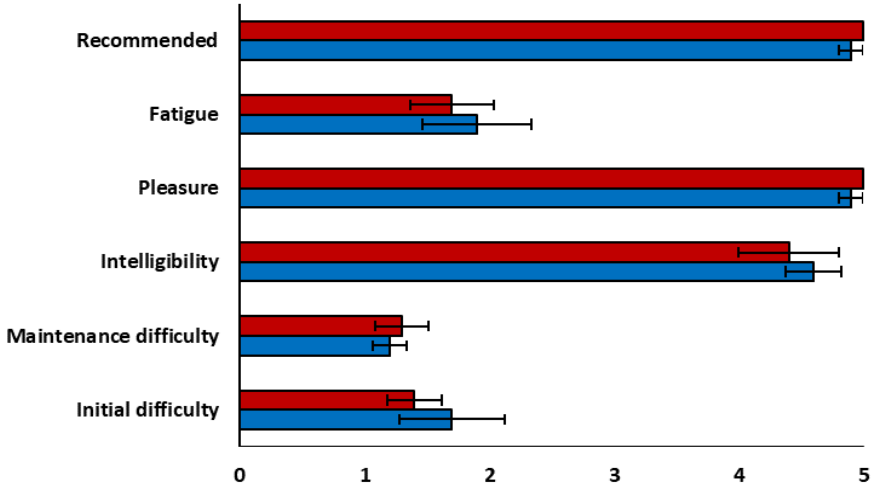




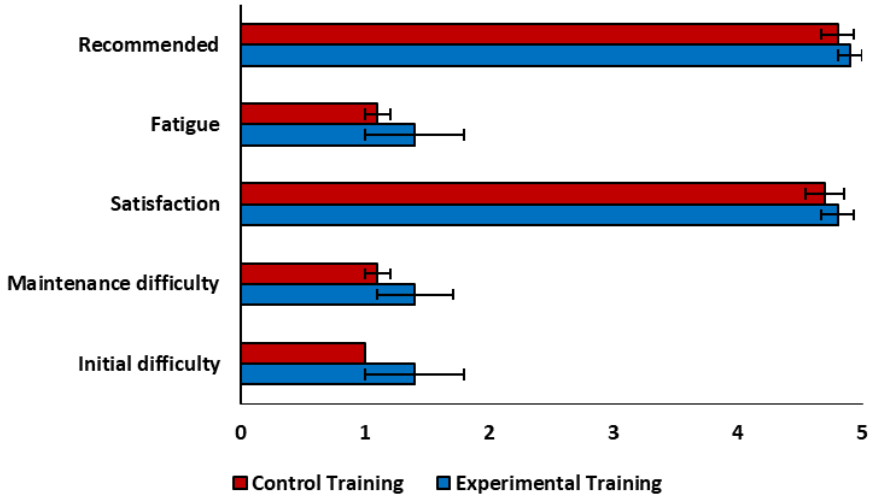
VR-SPIRIT Preliminary results

Feasibility

Self-report

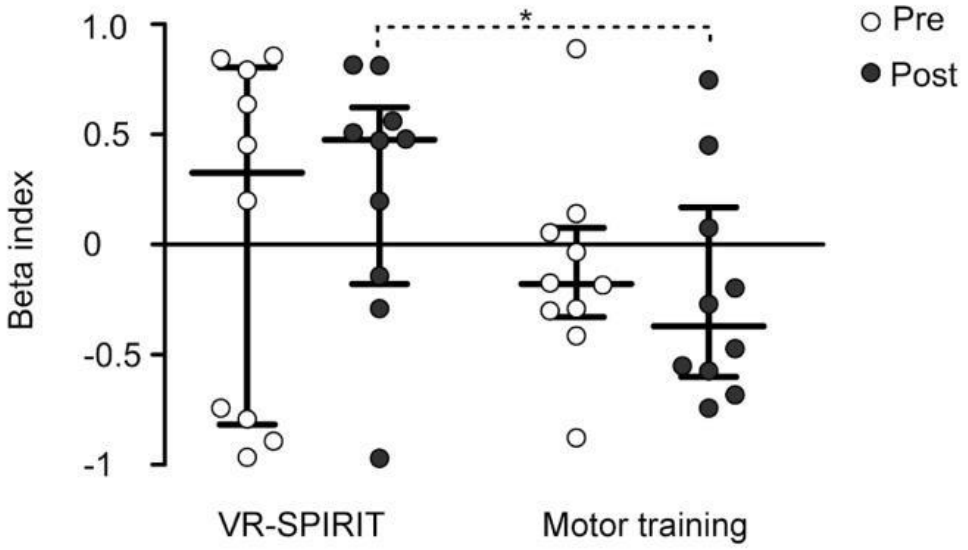


Parent-report

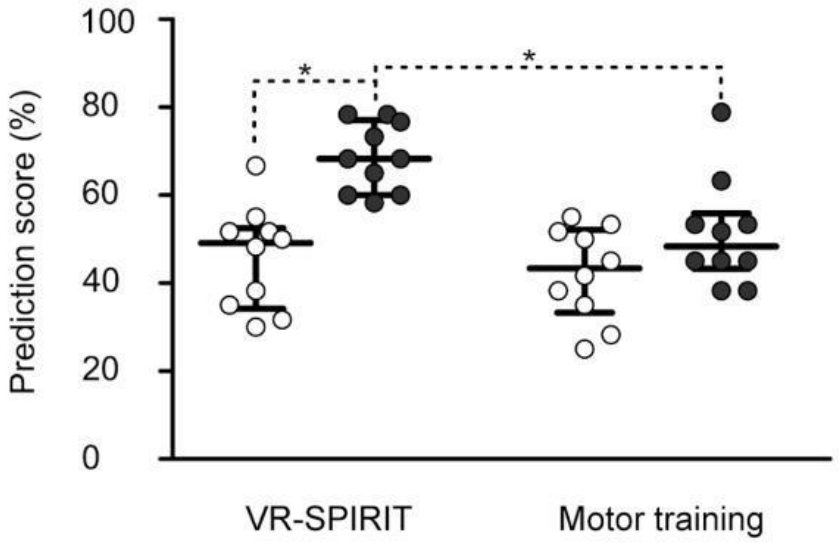


VR-SPIRIT Preliminary results
Efficacy

Action prediction



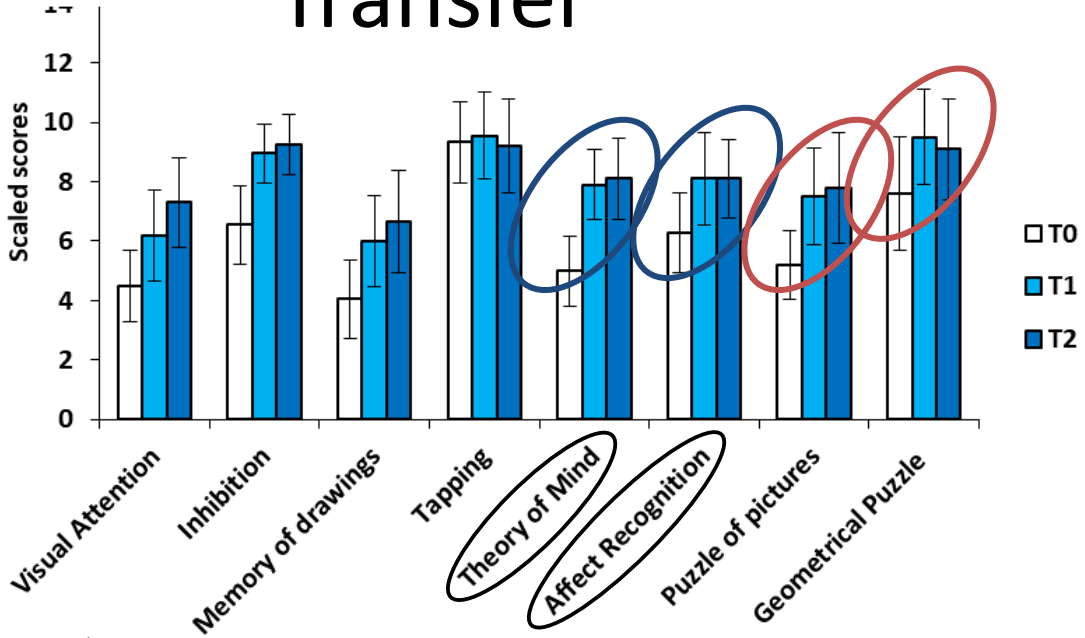
VR Scenario



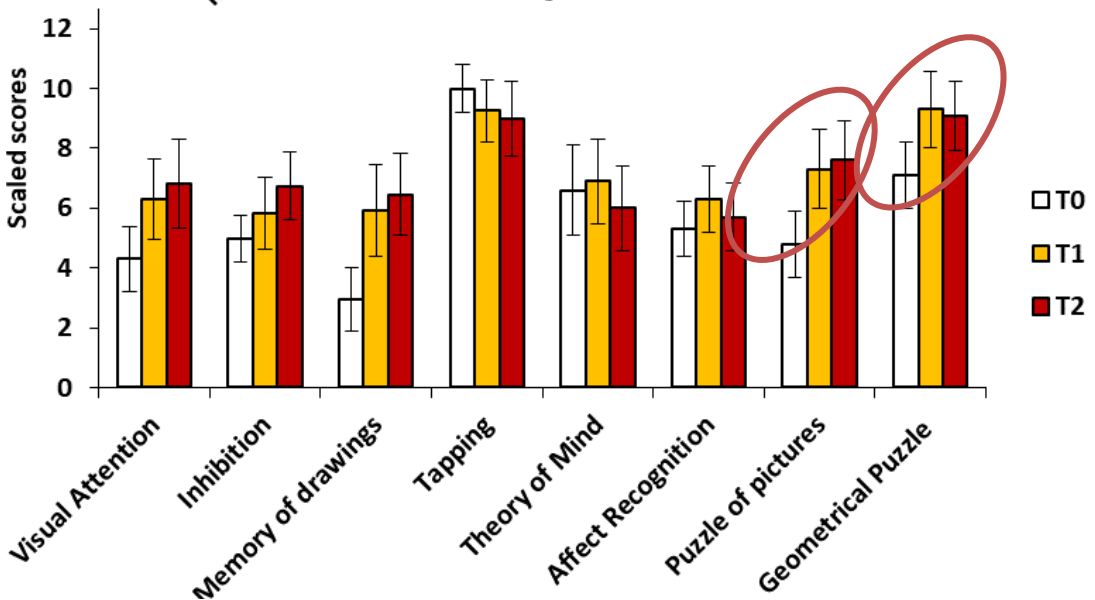
VR-SPIRIT Preliminary results

Transfer

VR-SPIRIT



Control



Conclusions

- Understanding others requires integrating their actions in the embedding context.

- The cerebellum is involved in building and using contextual priors in social and non social domains.

- Children and adolescents with cerbellar alterations show an impairment in integrating contextual priors with perceptual evidence when compared to both healthy peers and patients with non-cerebellar alterations.

- Training implicit learning and use of context-behavior associations boosts social perception abilities in cerebellar patients

IRCCS EUGENIO MEDEA Bosisio Parini (LC)

IRCCS EUGENIO MEDEA Pasian di Prato (UD)

UNIVERSITÀ DEGLI STUDI DI UDINE
hic sunt futura

Niccolo' Butti

Viola Oldrati

Alessandra Finisguerra

Lucia Amoruso

Body Lab UdinE

bodylabudine.uniud.it

Elisabetta Ferrari

Romina Romaniello

Renato Borgatti

Giulia D'Argenio

Valentina Bianco

Emilia Biffi

Claudia Corti

***Funded by**:*
MIUR; Italian Ministry of Health;
Regione Friuli Venezia Giulia