

PHYSICAL THERAPY

Jennifer Millar, MSPT
Johns Hopkins Ataxia Center



DREAM IT.
HOPE IT.

National Ataxia Foundation
Annual Ataxia Conference
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Hosted by the Southeast Region

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PRESENTER DISCLOSURES

- Jennifer Millar
No relationships to disclose



Physical Therapy

Strength training.

**Easiest to accomplish
and we think these can help.
Though, not
specific to primary
problems of ataxia.**

Endurance (aerobic) training.

**Learning new movement patterns
(motor learning). Improve coordination,
balance, stability.**

**What we would like to be able to do.
Depends on neural plasticity and
motor learning ability.**

OUTLINE

- Describe key symptoms of cerebellar damage
- Best rehabilitation strategies for people with cerebellar disorders

Lesions of the cerebellum

ATAXIA = disordered movement

Limb ataxia – dysmetria, abnormal path of movement, action tremor

Gait ataxia – imbalance, staggering or veering gait

Oculomotor deficits

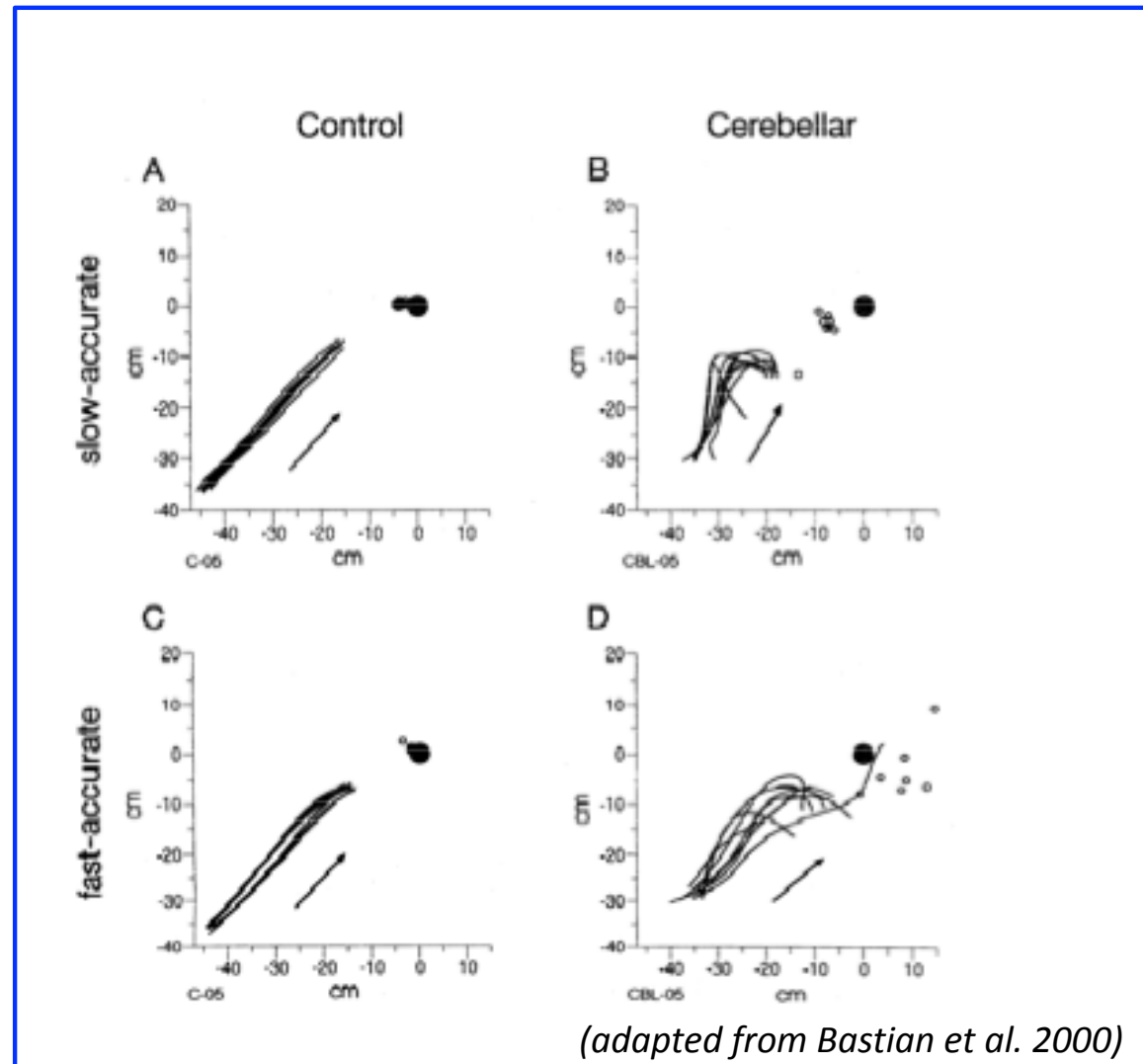
Impaired motor learning

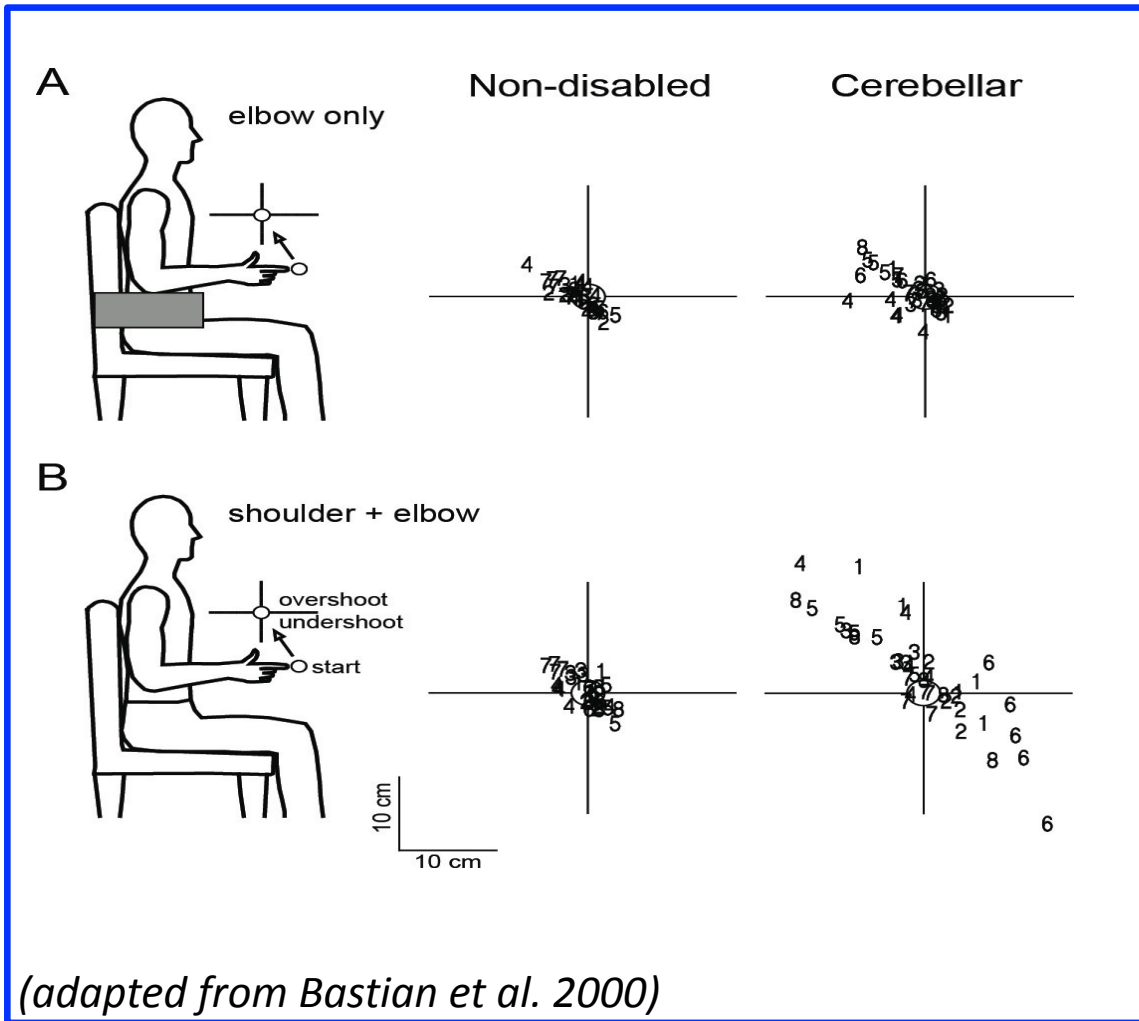
REACHING

finger to chin test

Dysmetria:

- inability to properly scale movement distances
- hypermetria / hypometria





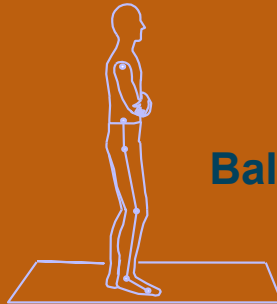
Dyssynergia:

- inability to coordinate multijoint movements
- poor prediction of interaction torques
- single jointed movements less impaired than multi-jointed

WALKING

walking, level
surfaces

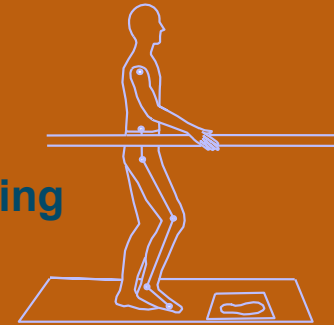
How Do Balance and Voluntary Leg Coordination Deficits Contribute to Cerebellar Gait Ataxia?



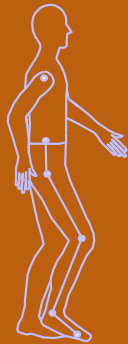
Balance Task
dynamic weight-shifting

**20 control, 20 cerebellar subjects
(atrophy, stroke, tumor)**

Leg Placement Task
visually guided stepping



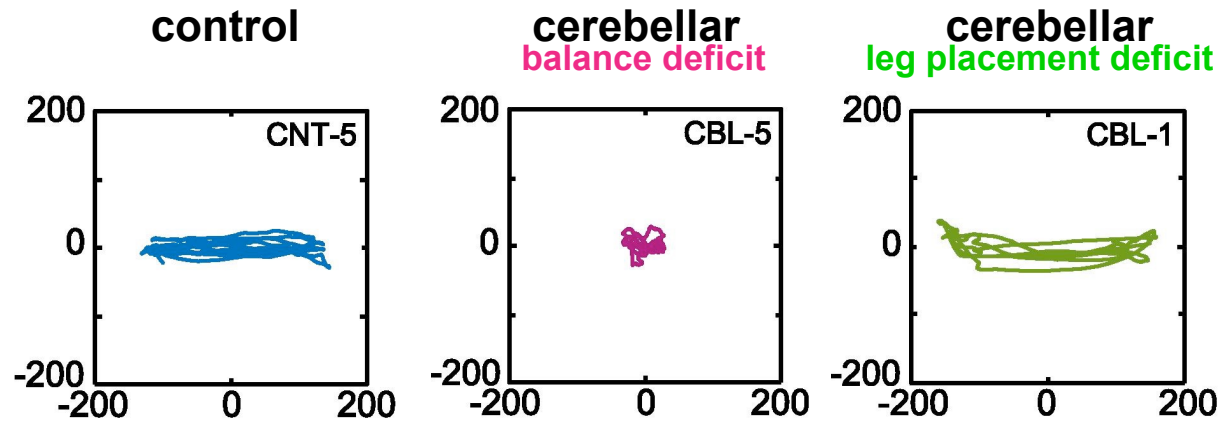
Walking
fast as possible



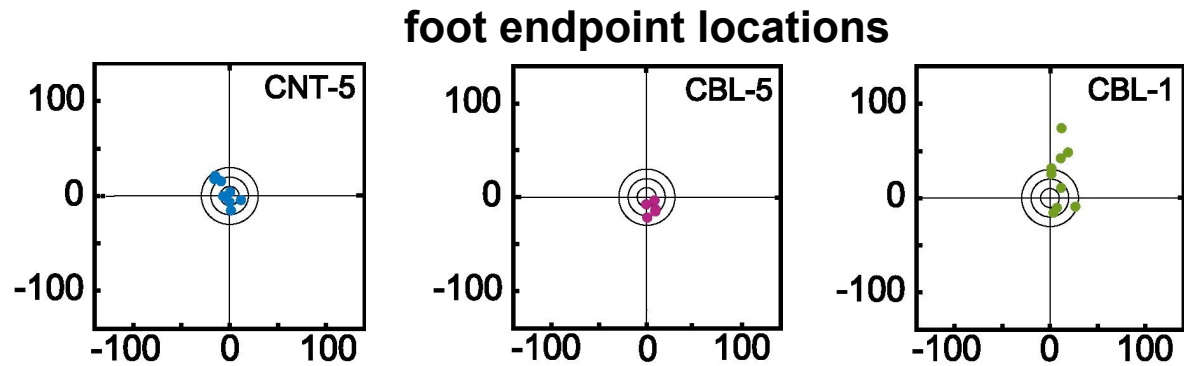
Balance and leg placement deficits will cause different gait abnormalities seen in people with cerebellar damage.

Morton and Bastian 2003

**Balance
Task**

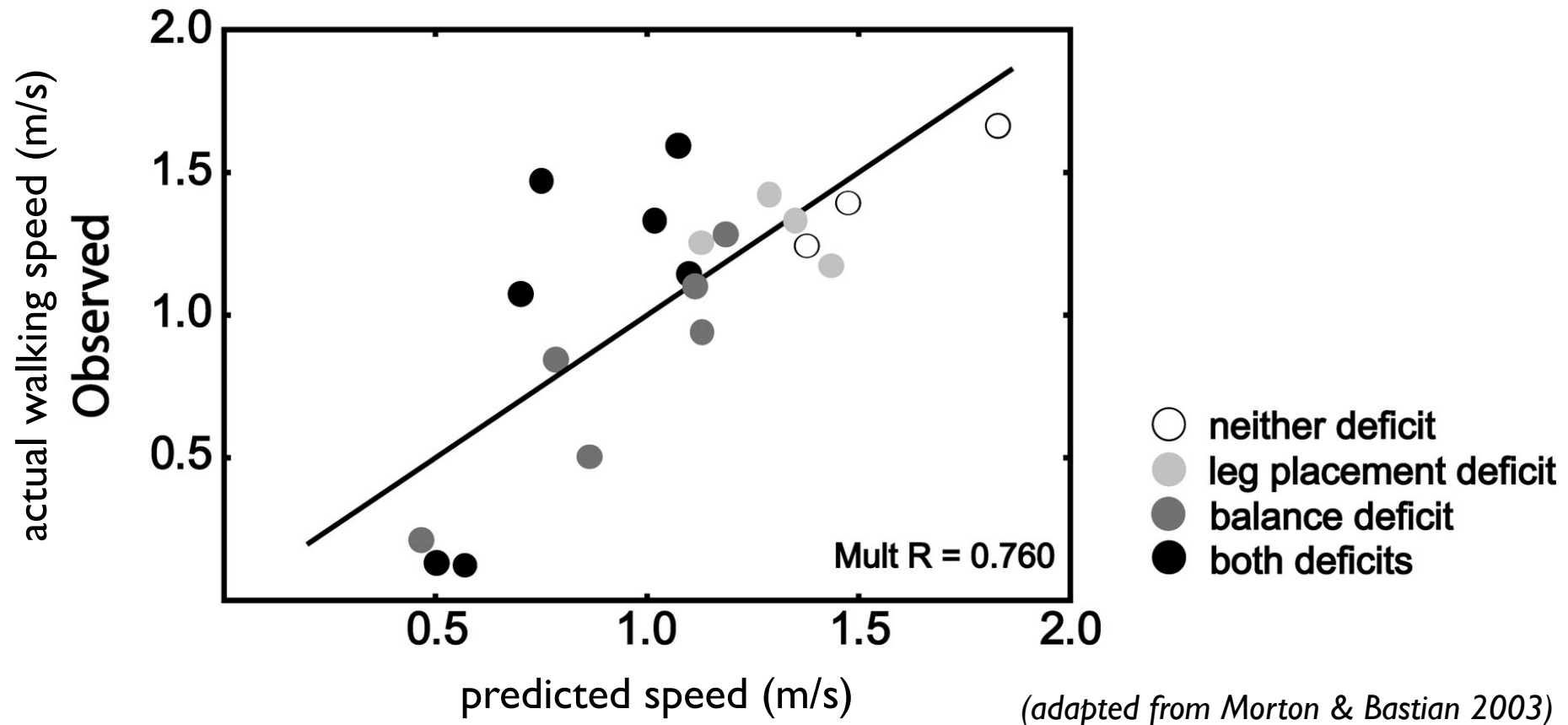


**Leg
Placement
Task**



Morton and Bastian 2003

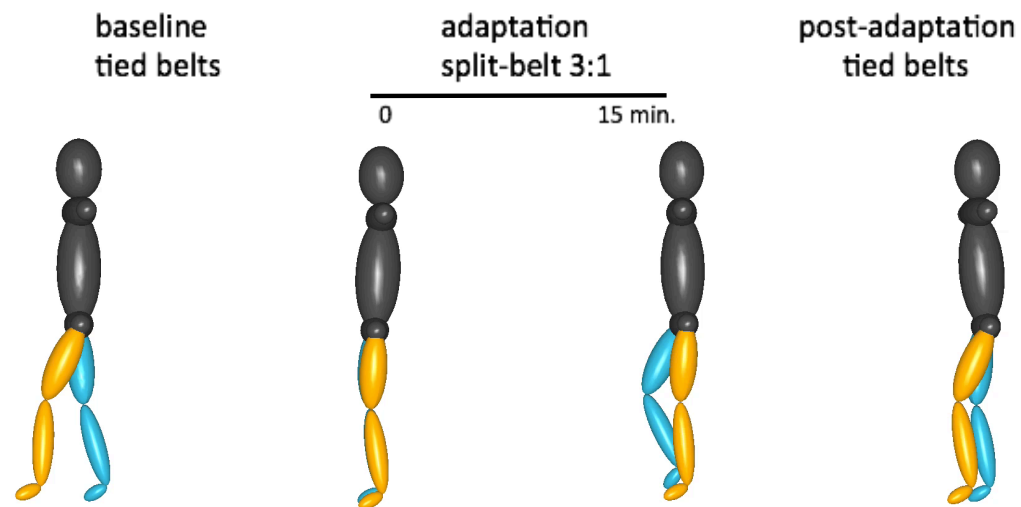
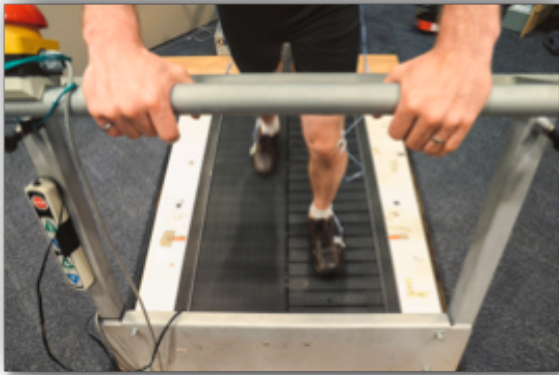
Balance dysfunction predicts cerebellar gait ataxia



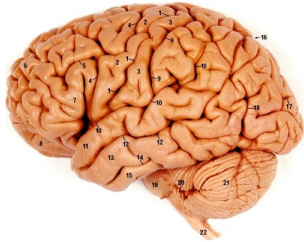
(adapted from Morton & Bastian 2003)

Overall gait function predicted by the severity of imbalance and not leg incoordination

Motor Learning: split belt treadmill



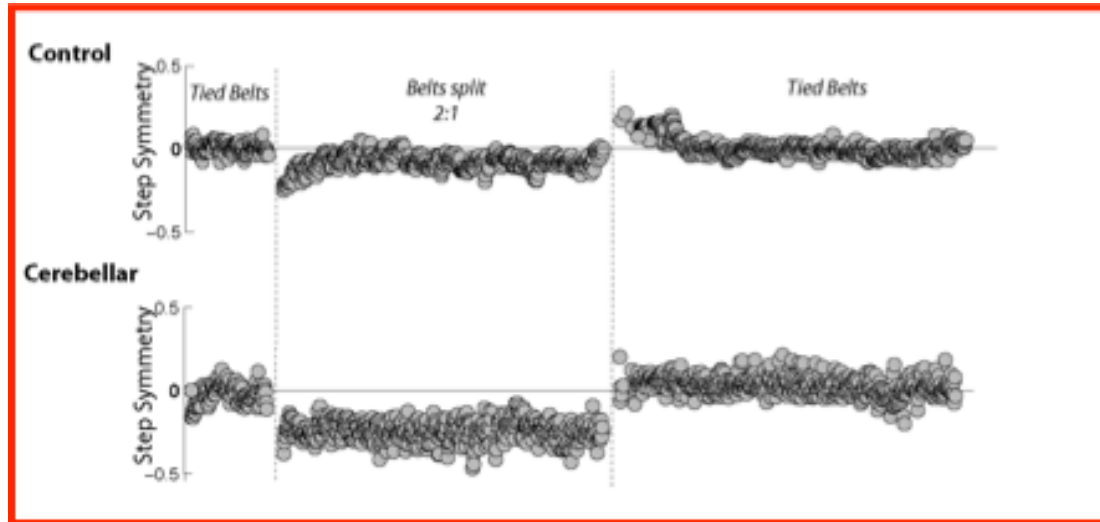
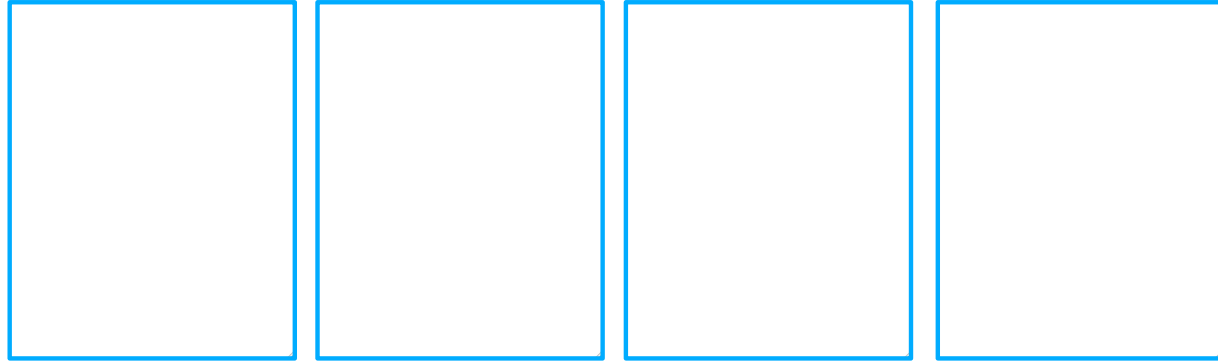
The cerebellum is necessary for adaptation



9 cblr atrophy:

SCA6, SCA8,
Idiopathic

ICARS total
30-56



Morton and Bastian, Journal of Neuroscience 2006

BALANCE TRAINING IMPROVES WALKING IN CEREBELLAR ATAXIA.

Basis:

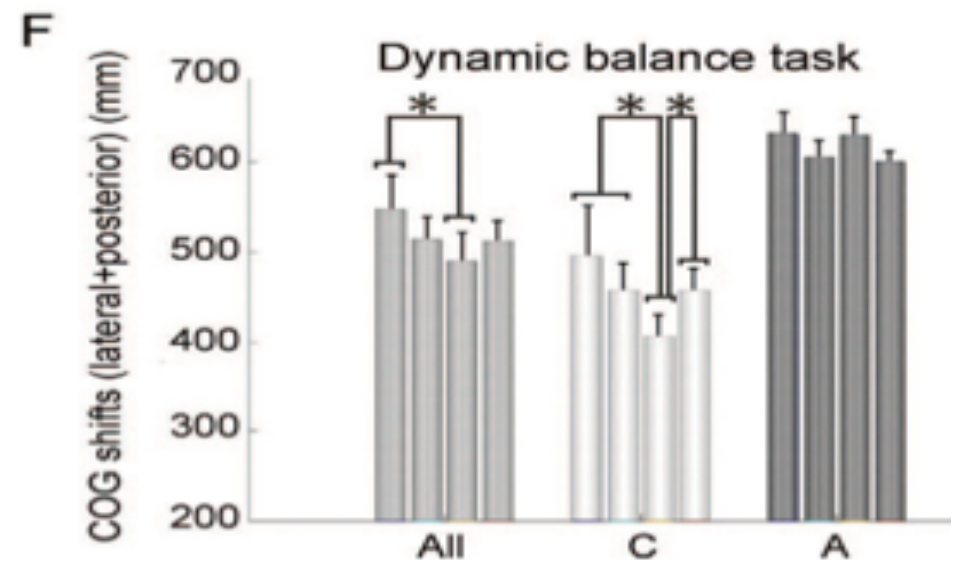
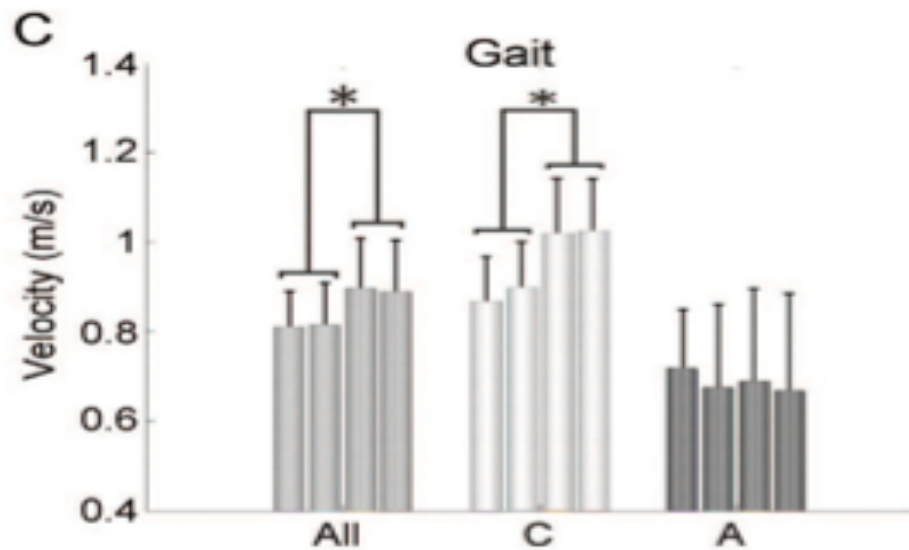
Balance deficits impact gait more than leg placement deficits. (Morton & Bastian 2003)

Evidence:

Intensive outpatient program (Ilg et al., 2009)

Home exercise program (Keller & Bastian, 2014)

Intensive coordinative training improves motor performance in degenerative cerebellar disease



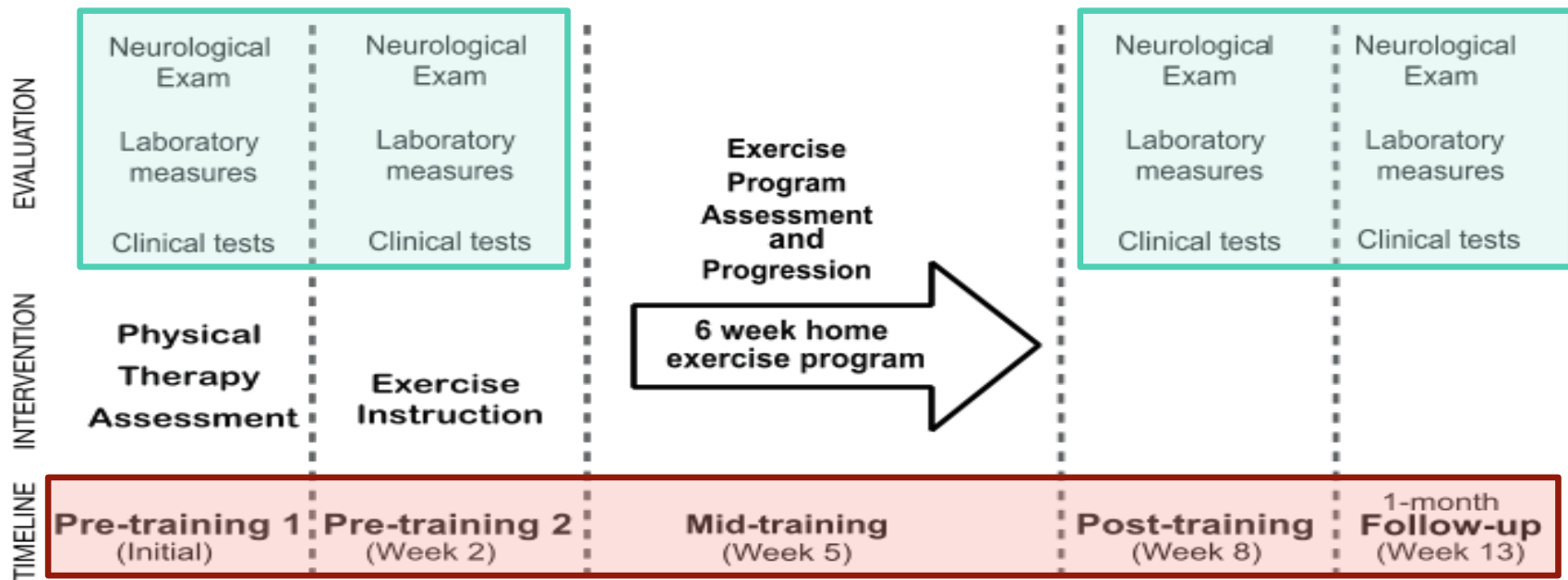
Ilg, 2009

6 WEEK HOME EXERCISE PROGRAM FOR PEOPLE WITH CEREBELLAR DAMAGE

Subject	Age (y)	ICARS (total)	Exercise Duration (days)	Exercise Challenge (%)
1	35	46	23	10
2	74	55	27	18
3	56	49	26	33
4	53	57	30	13
5	56	35	24	40
6	30	8	18	50
7	57	10	19	68
8	56	29	16	53
9	53	56	14	70
10	37	33	28	73
11	61	58	16	60
12	49	36	20	65
13	60	37	23	53
14	57	40	35	49
Mean (SD)	52 (11)	39 (15)	23 (6)	47 (20)

Keller & Bastian 2014

PARADIGM



Balance exercises

Varied support surface



Swedwater



Sitting exercises



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Static
Weight shifting
Feet unsupported



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Trunk rotation



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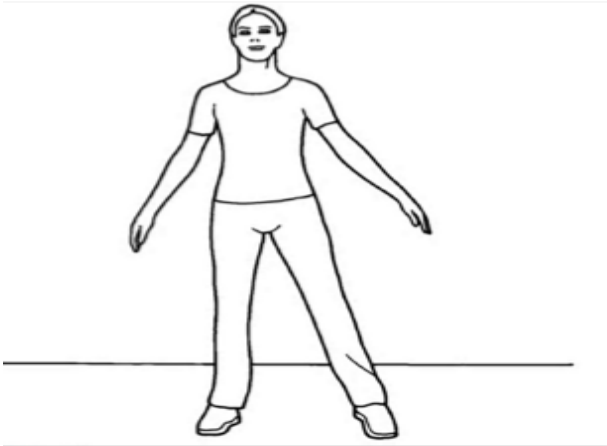
Head turns



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Reaching

Standing



Weight shifts-
all directions,
stable surface,
eyes closed,
foam.



Changing base
of support
stable surface,
eyes closed,
foam.

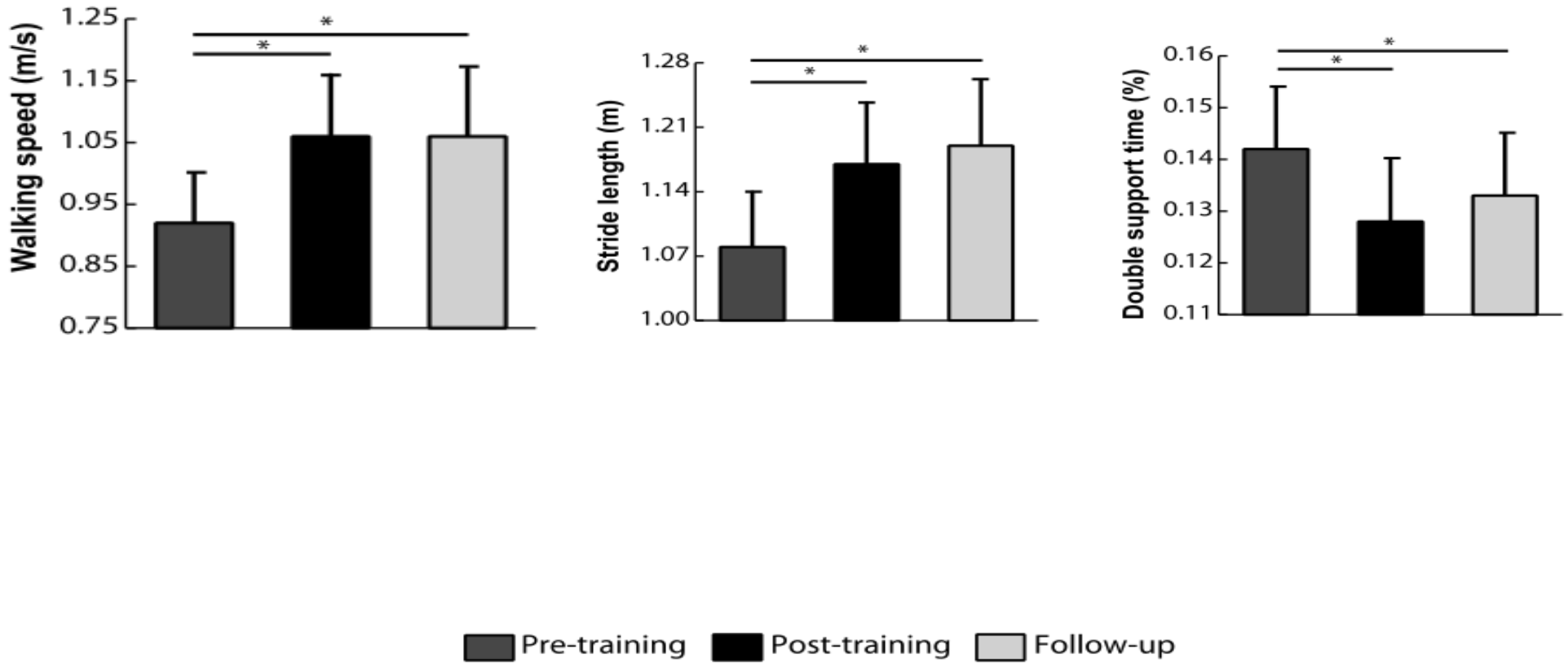


Stepping on steps
stable surface,
foam.

Rated difficulty of exercise –
0% no confidence to 100% complete confidence
in maintaining balance.

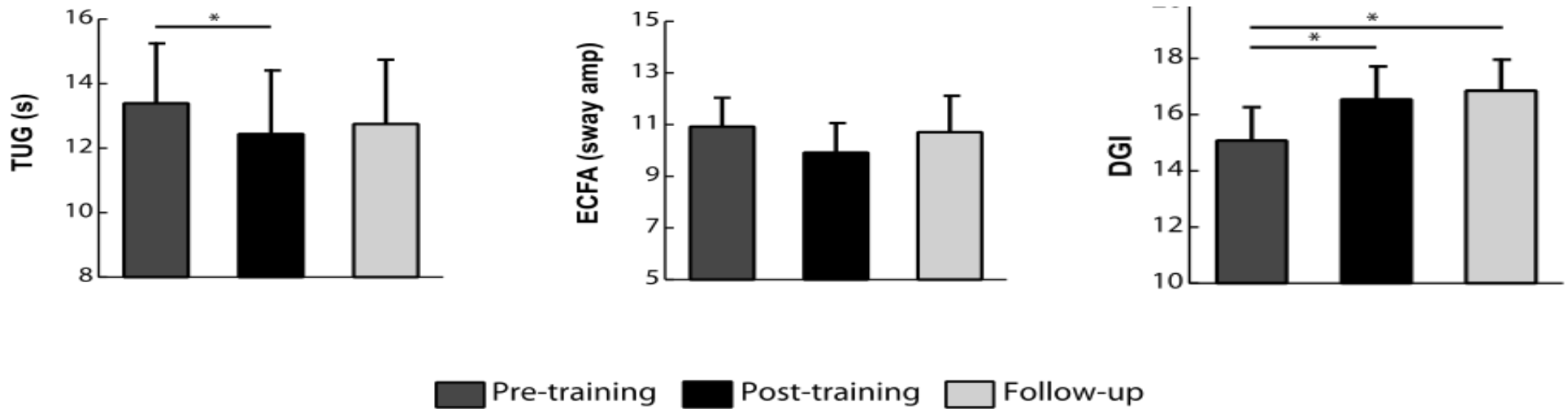
RESULTS:

Tests that were not directly part of the training improved.

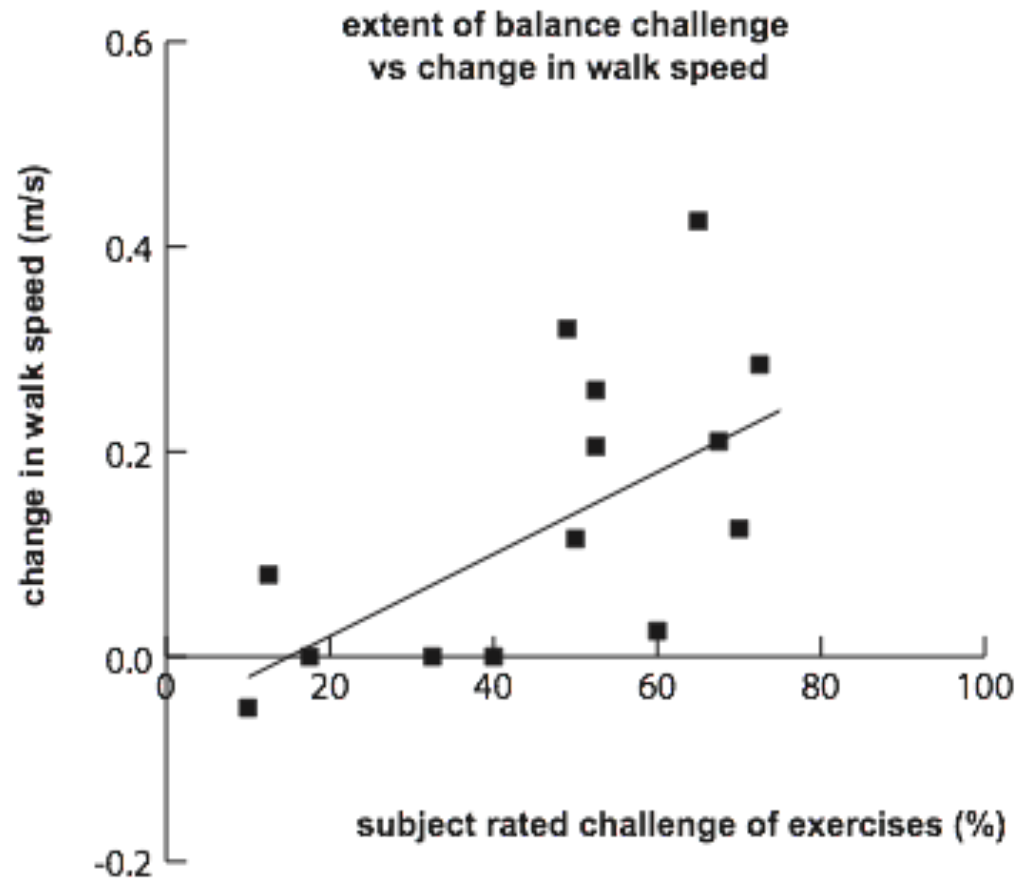


RESULTS:

Tests that were not directly part of the training improved.



Participants who rated the exercise as more challenging improved the most.



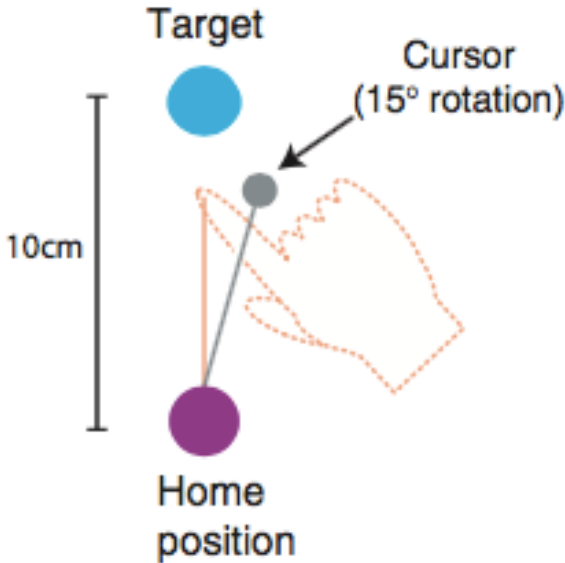
BALANCE TRAINING CAN IMPROVE WALKING PERFORMANCE AND BALANCE TESTS IN CEREBELLAR ATAXIA

- Generalized to tests that were not trained
- Retained 1+ months after
- Possible with both outpatient therapy and a home exercise program
 - Benefit correlates with challenge.
Harder seems better (to a point).

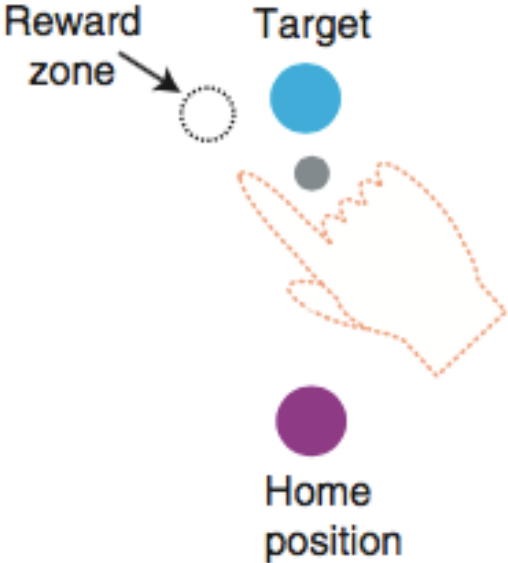
How and what are they learning?

DO INDIVIDUALS WITH CEREBELLAR DAMAGE SHOW INTACT REINFORCEMENT LEARNING?

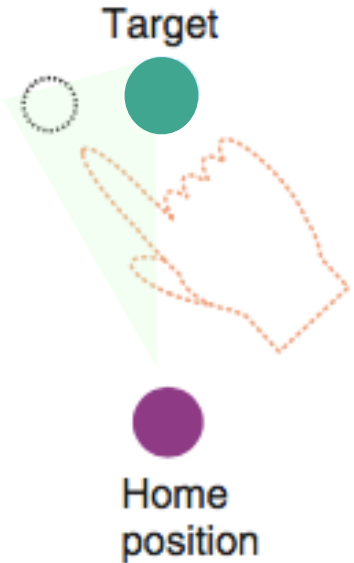
A



Error-based



Reinforcement

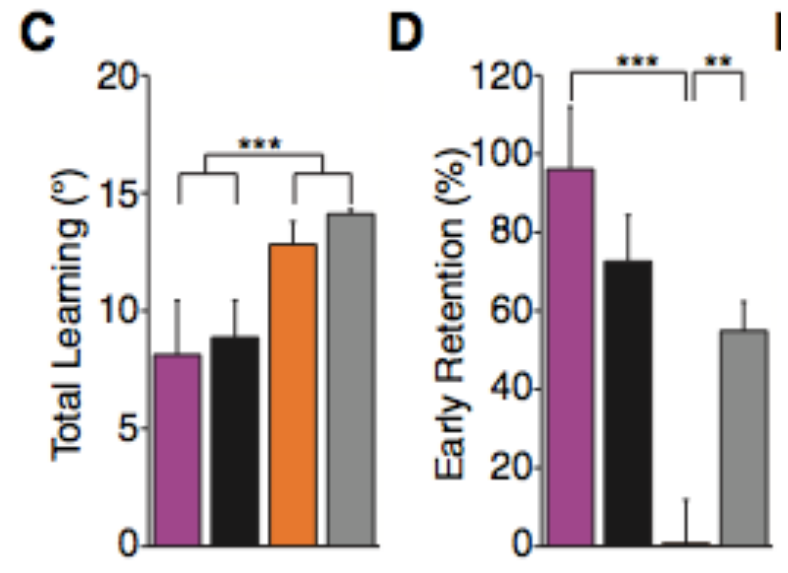
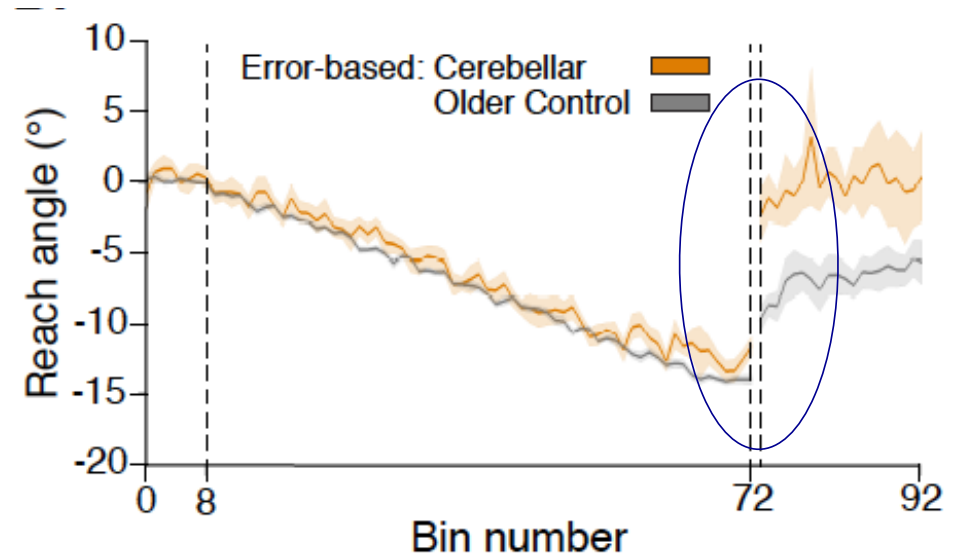
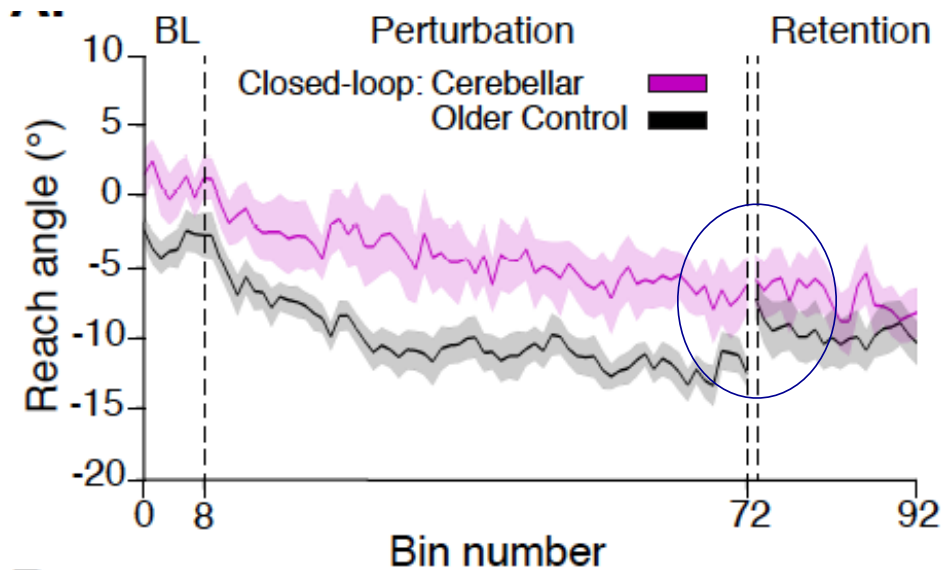


Effective reinforcement learning following cerebellar damage requires a balance between exploration and motor noise – Therrien, Wolpert, and Bastian, 2016

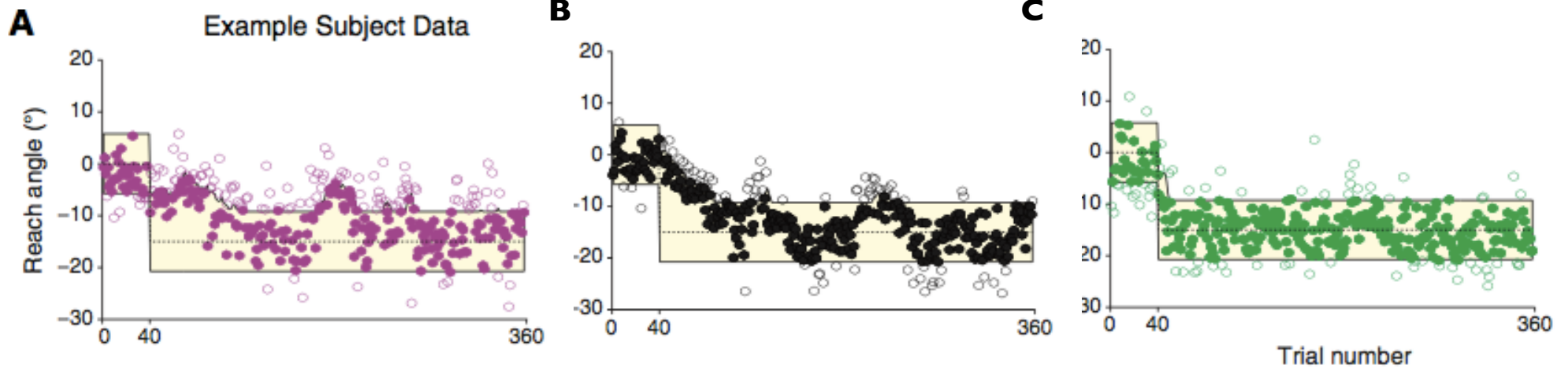
Table 1 Subject demographics

Subjects	Age (years)	Diagnosis	ICARS	
			Total (/100)	Kinetic (/52)
CB01*	54	OPCA	36	16
CB02	51	Sporadic	64	36
CB03	63	ADCA III	12	1
CB04	61	SCA 6	55	21
CB05	42	SCA 8	59	23
CB06	61	SCA 6/8	66	25
CB07	66	ADCA III	54	18
CB08	80	ADCA III	45	23
CB09	74	Sporadic	34	8
CB10	57	SCA 7	54	49
CB11	64	SCA 6	13	4
CB12	65	SCA 6	39	19
CB group	61.5 ± 10.0		44.3 ± 18.1	20.3 ± 13.2
OC group	59.6 ± 9.0			

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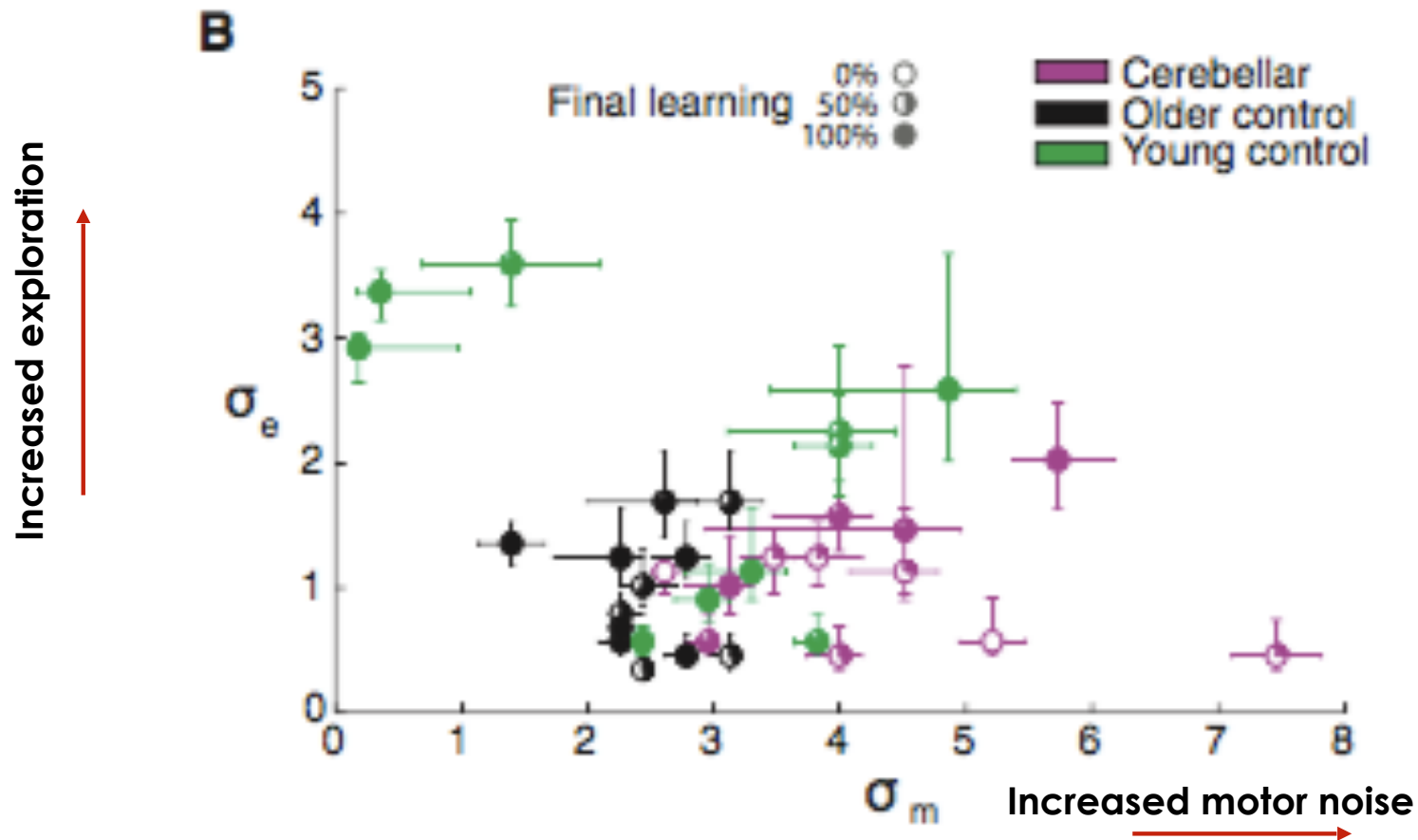


Patients with ataxia show retention of learning under the reinforcement feedback condition.



Cerebellar subjects show more variability of movement and explore less than controls

EFFECTIVE REINFORCEMENT LEARNING FOLLOWING CEREBELLAR DAMAGE REQUIRES A BALANCE BETWEEN EXPLORATION AND MOTOR NOISE



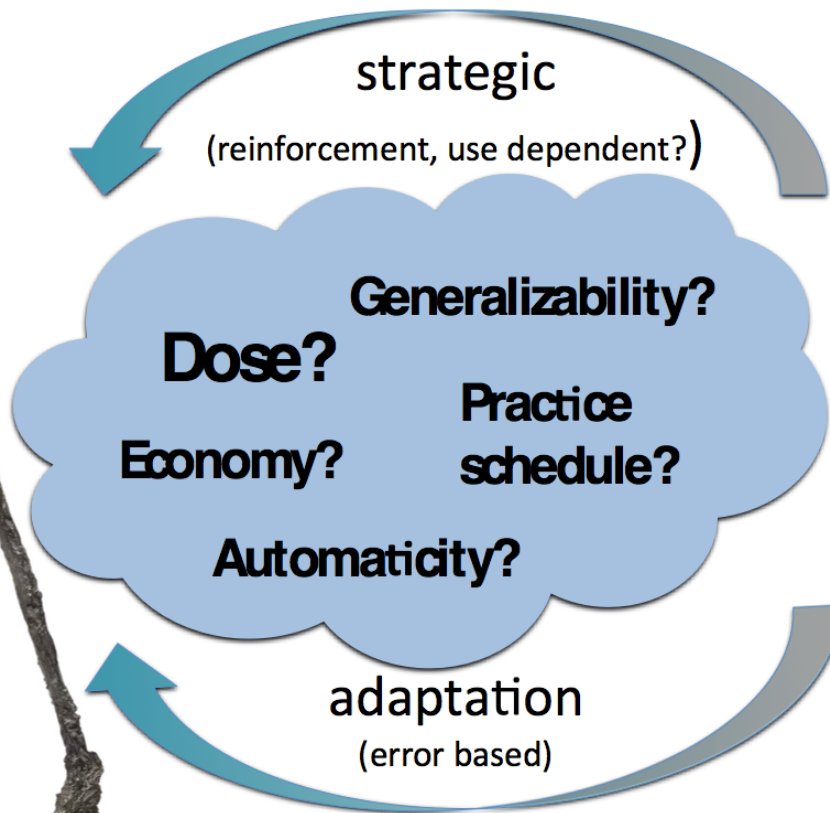


VIDEO BASED COORDINATIVE TRAINING

- Ilg Study, 2012 Germany
- 10 subjects
- Ages 8-20
- Xbox Kinect Training:
 - 2 weeks in lab 1 hour per day, 4 days
 - 6 weeks at home
- Outcomes:
 - Improved quantitative gait measures, SARA, Dynamic Gait Index Scores
 - Participants were motivated - reporting the training was fun!



Alberto Giacometti, "L'Homme Qui Marche I"



Amy Bastian, "Badly drawn walking guy"

Center for Movement Studies

Amy Bastian

Amanda Therrien

Jennifer Keller

All of our participants with ataxia

NAF conference organizers and attendees



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Motion Analysis Lab. To participate in studies in Baltimore, MD contact us at 443-923-2716.