A robotic object hitting task to quantify sensorimotor impairments in participants with stroke

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Statistics

- 750,000 brain injuries in North America each year.
- Long hospitalization and rehabilitation programs.
- Huge cost on the healthcare system.
- Need efficient tools for assessment of brain function.

Neurological assessment

Does he have a concussion?

Will this drug work?

Is strength the biggest problem?

- Brain assessment drives health care decisions.

Traditional Stroke Assessment

Limitations:

- Inherently subjective
- Lack of precision
- Coarse scaling system, not sensitive to small change of brain function
- Floor and ceiling effect

Robotic Neurological Assessment

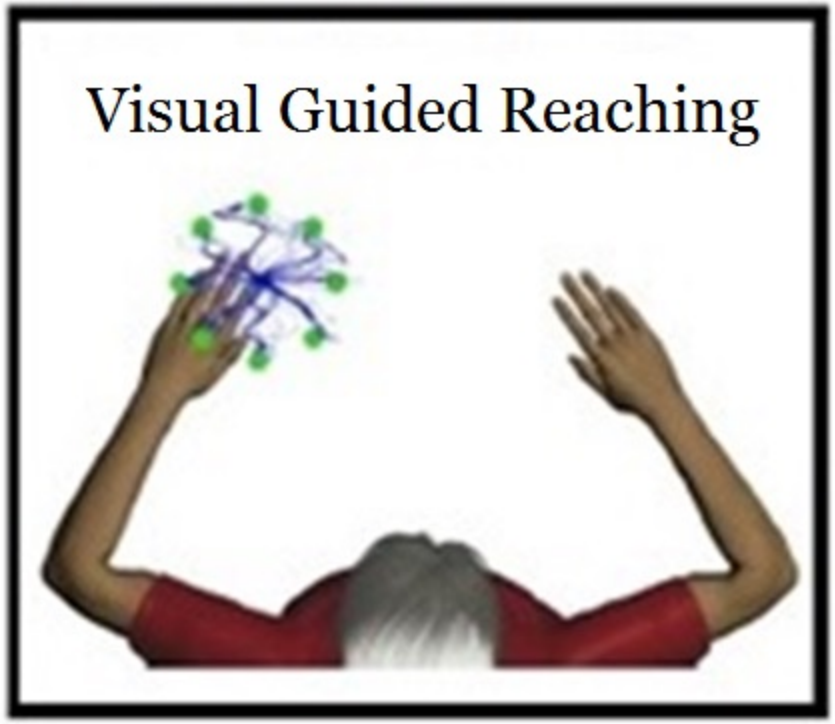
Potential values:

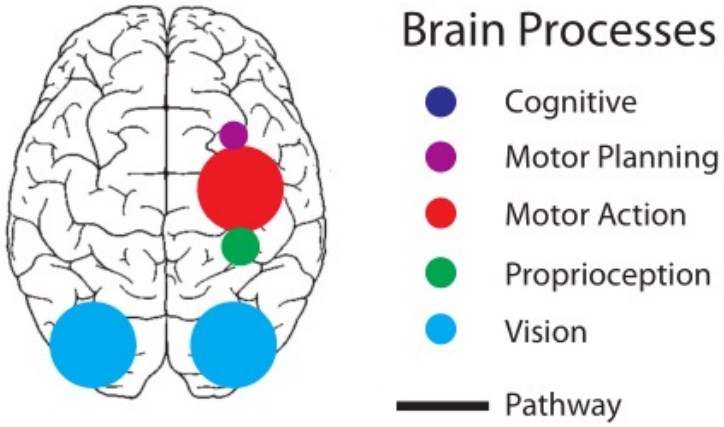
- Inherently objective
- Repeatable with high resolution
- Combined with virtual reality to simulate complex scenarios
- Automated tasks to assess different areas of brain

KINARM in action

Tasks on KINARM

Motor function assessment





Visually Guided Reaching Task

- Objective of Assessment:

Postural Control

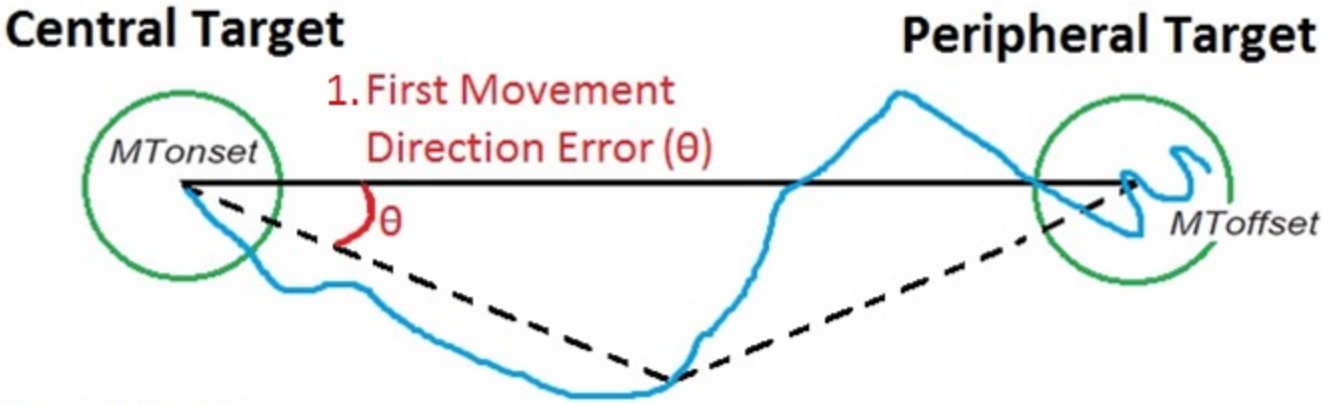
Visuomotor Response

Motor Coordination

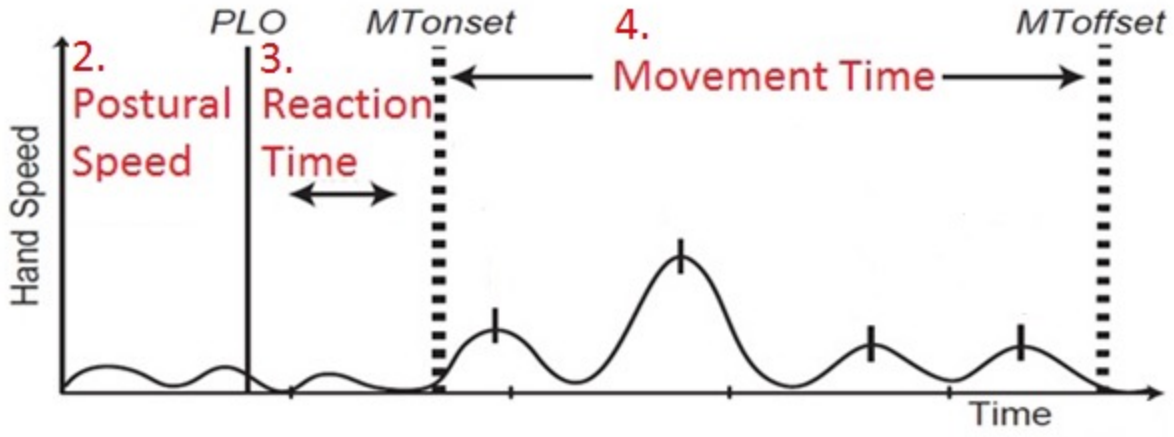
- 8 Spatial Targets & 8 Repeat Trials = 64 Trials, (6-8 Min/arm)

Visual Guided Reaching: 12 Parameters

Hand Movement Profile:

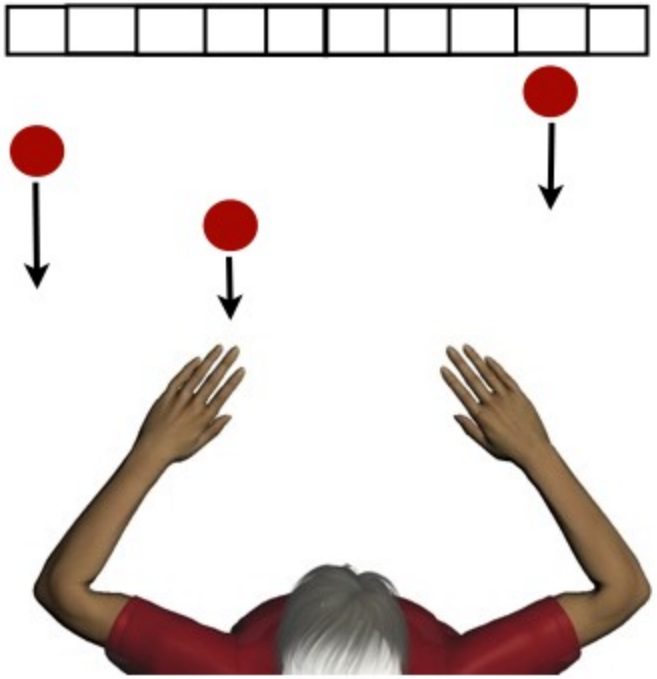


Hand Speed Profile:

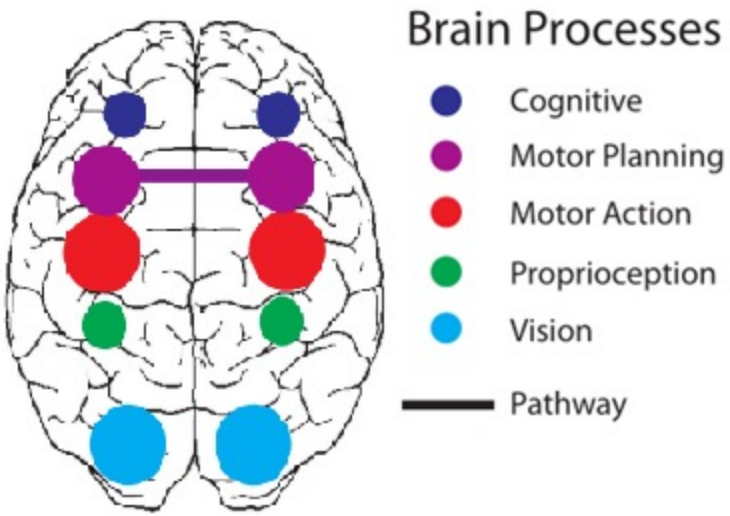


Coderre, et al. NNR 2010

Object Hit Task



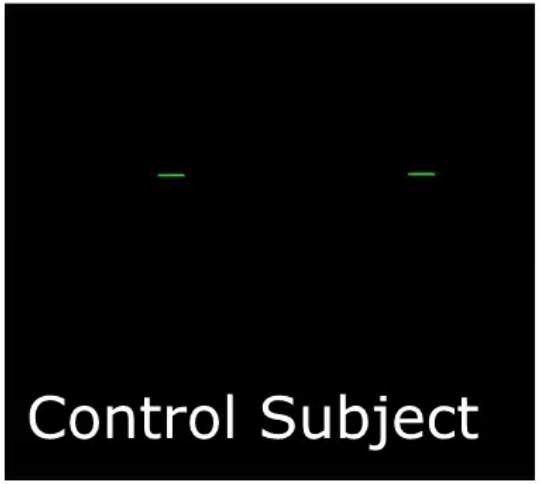
- Arm Motor Function
- Bimanual Motor Planning
- Spatial Attention
- Assess Frontal and Parietal Function

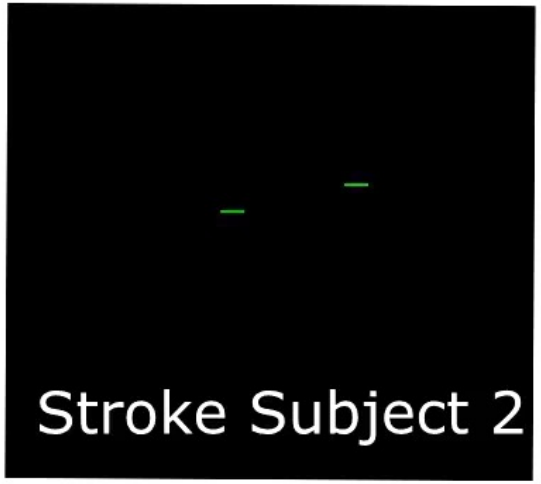


Object Hit task

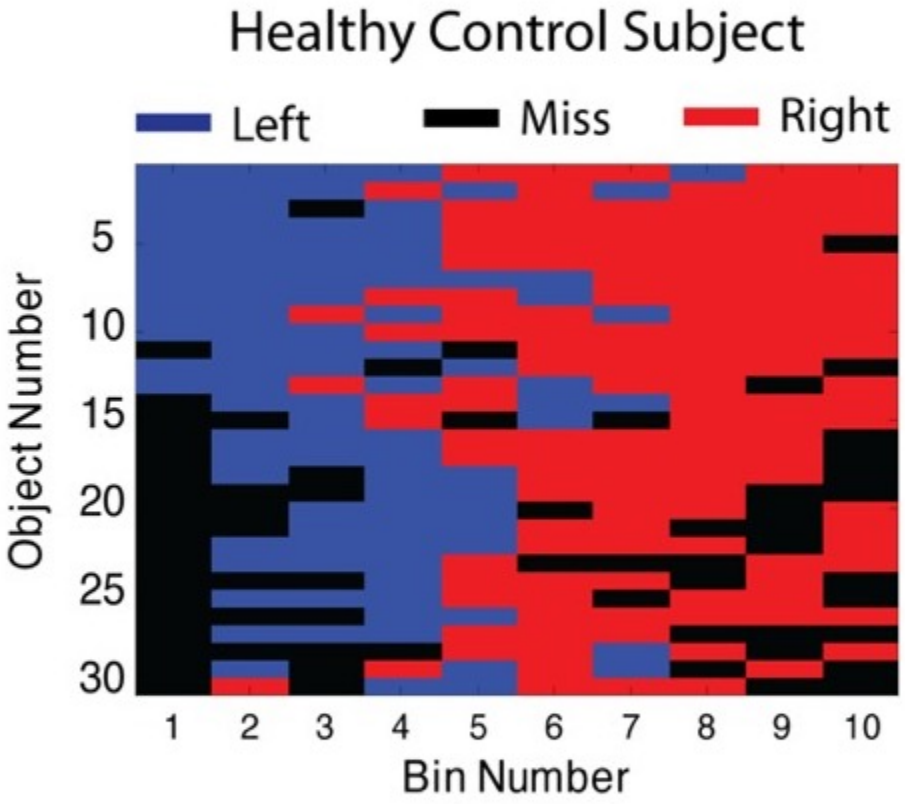
Object Hit Task

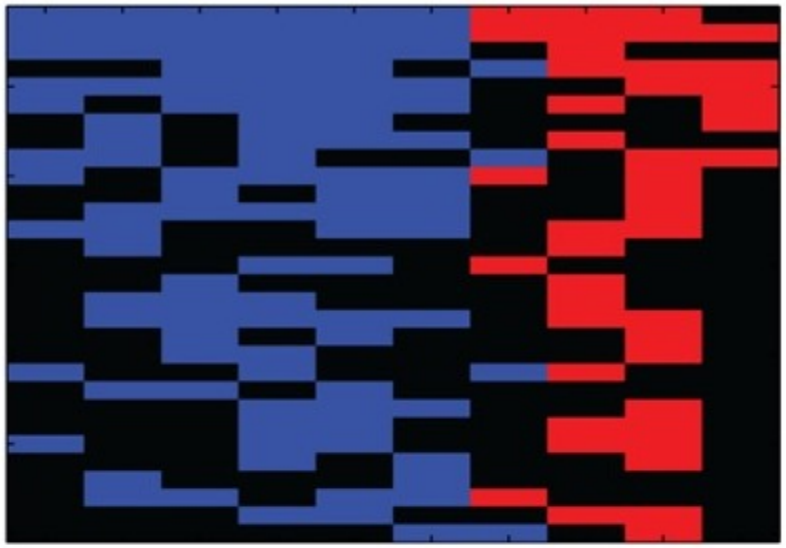
Visual-Guided Motor Skill
Bimanual Planning
Active Spatial Attention

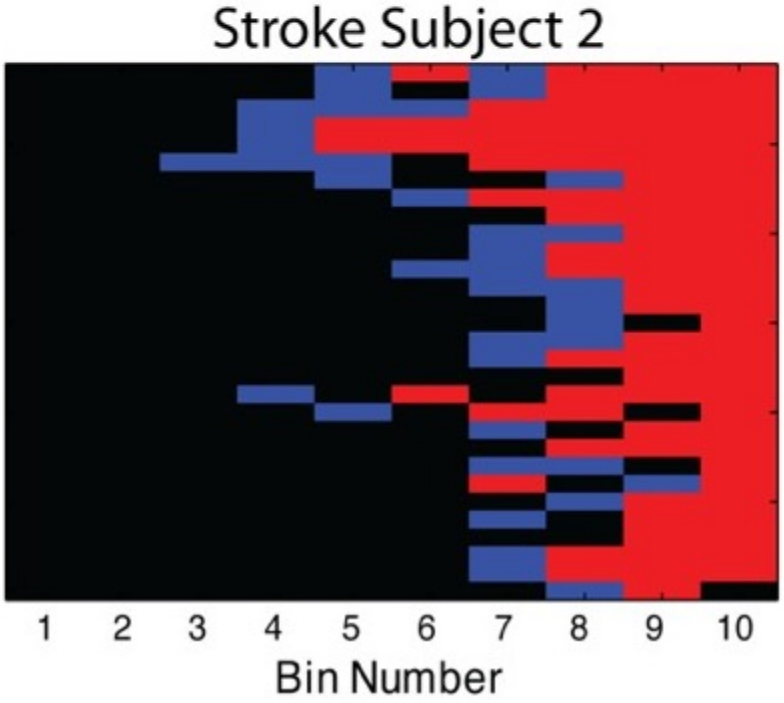




Object Hit Task



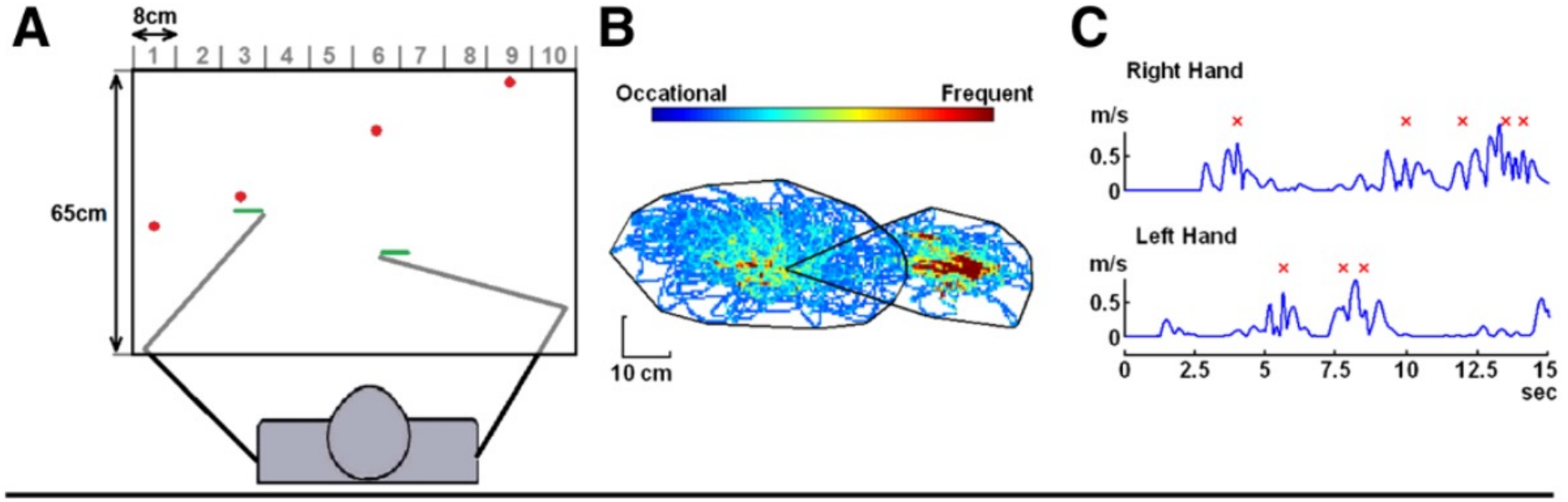




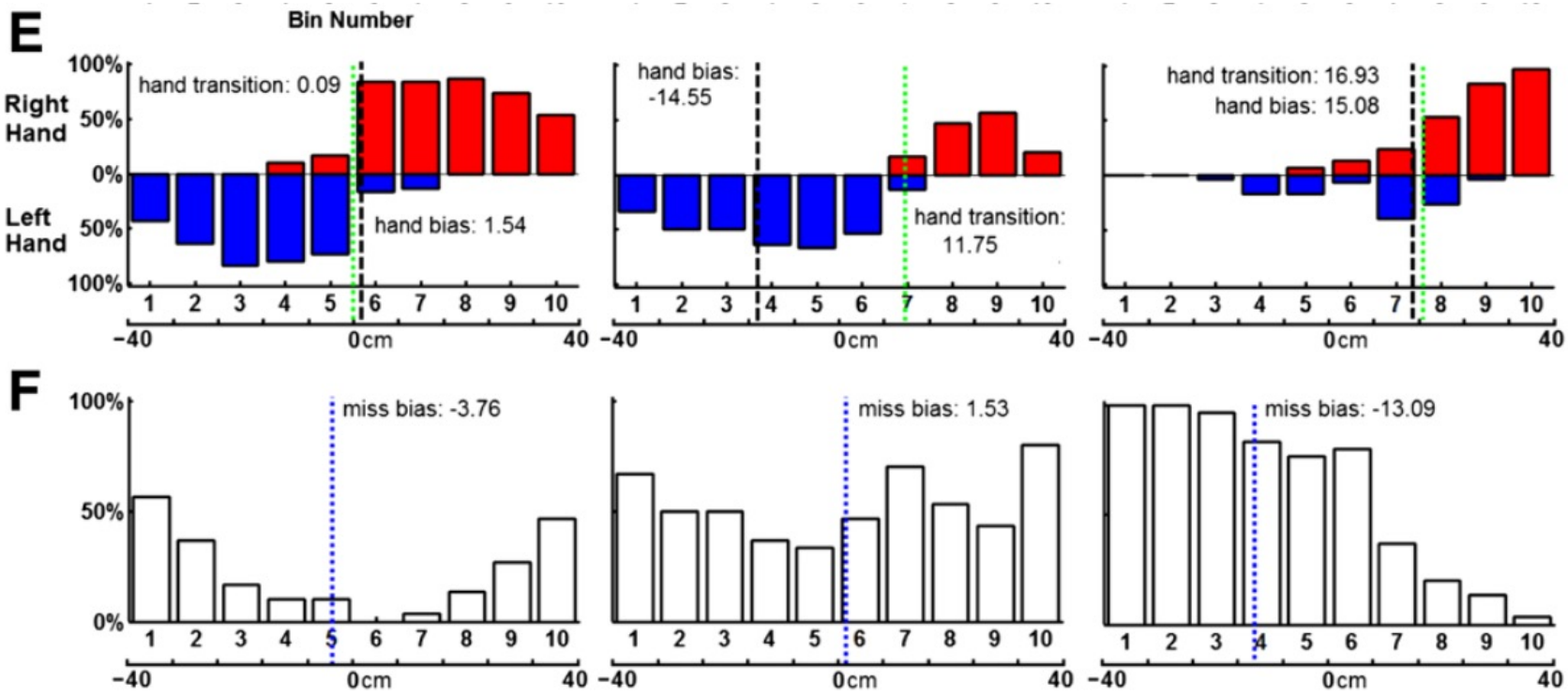
Task parameters

- A. Global Performance
  - Hit percentage
- B. Spatial and Temporal Performance
  - Miss bias
  - Hand transition
  - Median error (ball%)
- C. Motor Performance
  - Movement area
  - Hand bias hits

Parameter visualization



Parameter visualization

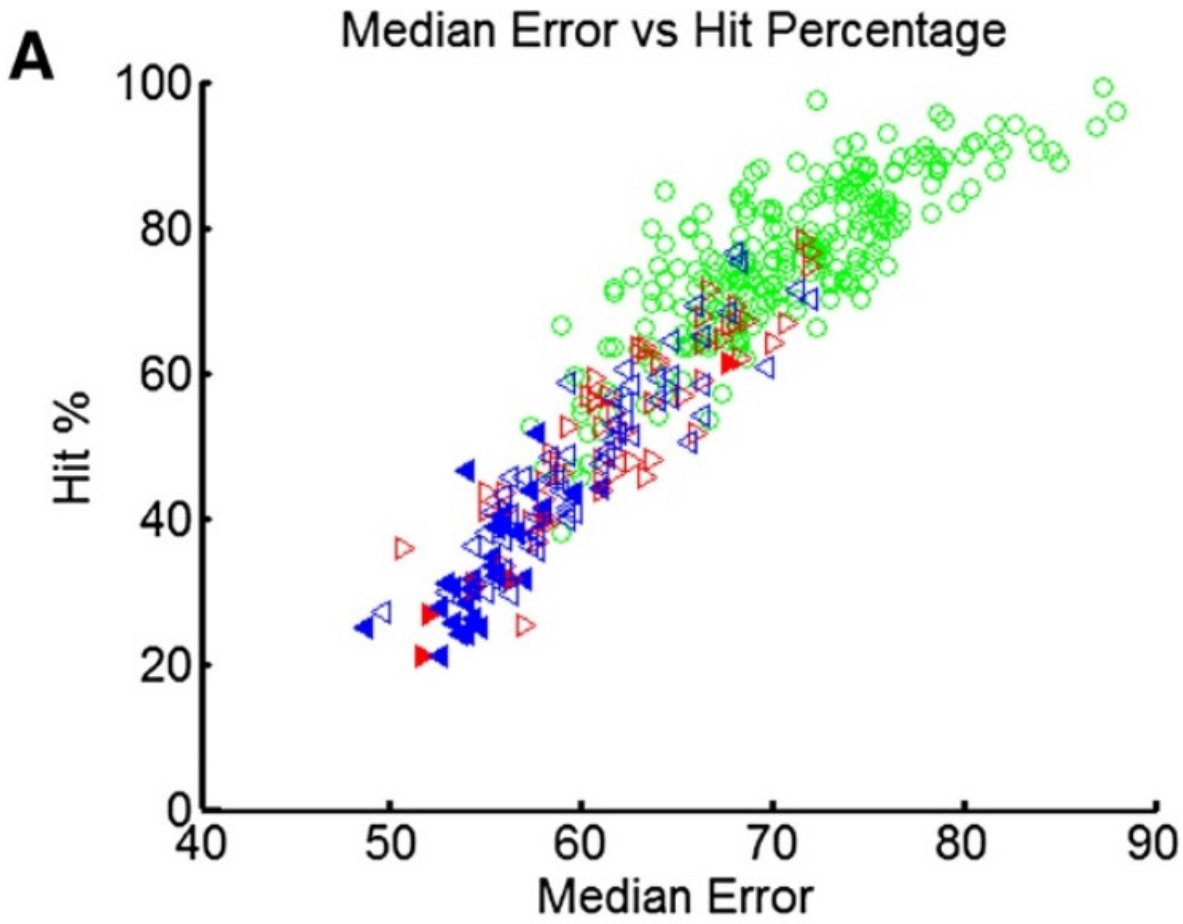


Stroke subjects' performance

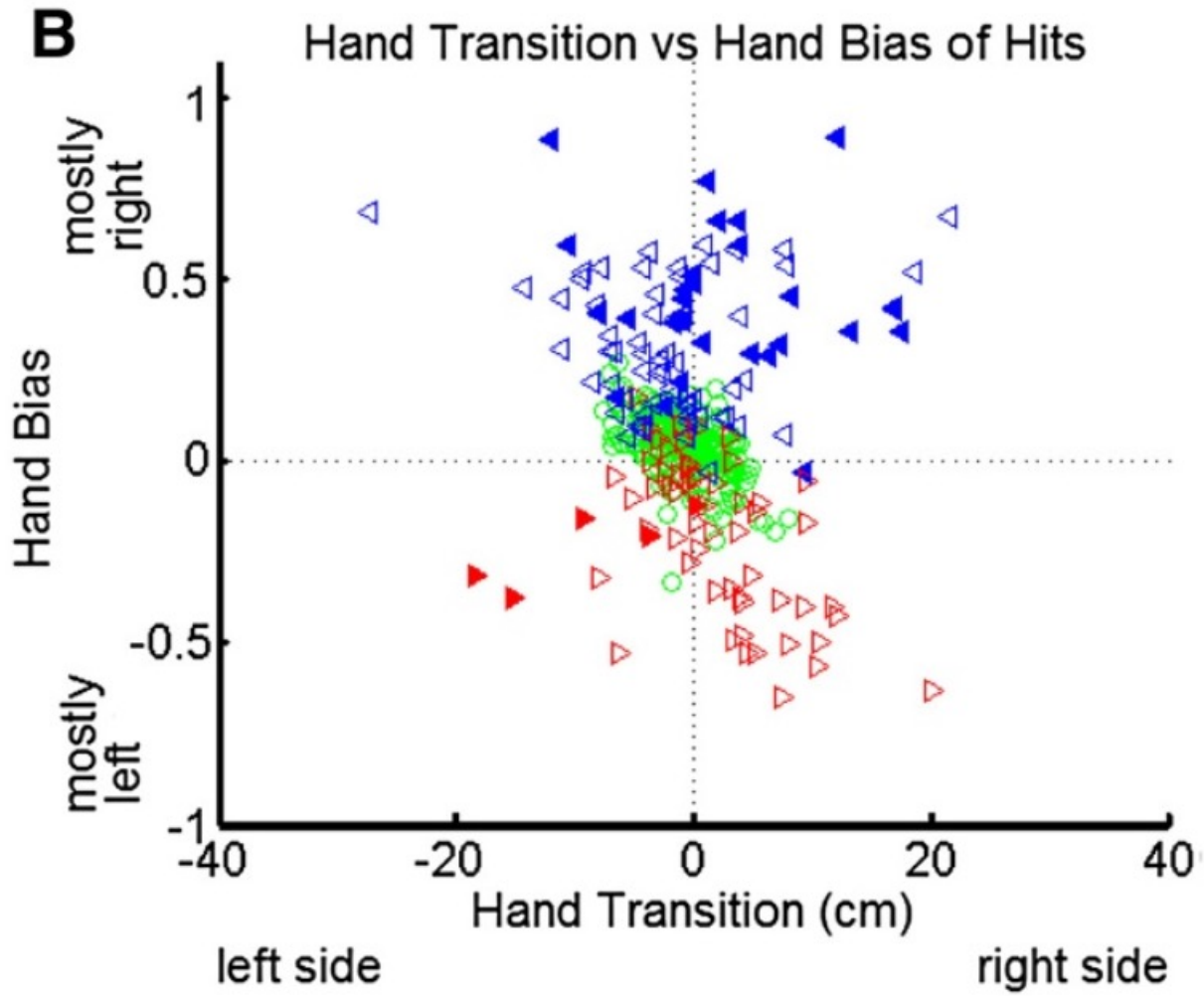
Table 1 Performance of participants with stroke

Parameters	Cut off range (%)	LA stroke (%)	RA stroke (%)	Spatial neglect LA(%)	Spatial neglect RA(%)	Inter rater (r)	Correlations			
							MoCA	FIMm	FIMt	BIT
Global performance										
Hit percentage	<5	87	67	100	80	0.97	**0.37**	**0.58**	**0.62**	**0.55**
Spatial and Temporal Performance										
Miss bias	<2.5, >97.5	11	6	24	0	0.73	−0.01	0.21	**0.21**	**0.21**
Hand transition	<2.5, >97.5	42	38	59	60	0.51	−0.12	−0.07	−0.08	−0.06
Median error	<5	73	44	97	60	0.84	**0.35**	**0.58**	**0.61**	**0.50**
Motor Performance										
Hand bias (hits)	<2.5, >97.5	73	59	90	100	0.94	0.10	**−0.21**	**−0.22**	−0.20
Hand selection overlap	<5	33	19	48	20	0.53	0.07	**0.37**	**0.33**	0.20
Total hand bias area	<2.5, >97.5	55	43	79	60	0.92	0.15	**−0.29**	**−0.28**	**−0.30**
Hand bias speed	<2.5, >97.5	67	54	93	80	0.98	0.14	**−0.30**	**−0.30**	**−0.31**
Total hand area DH	<5	16	38	28	60	0.69	0.08	**0.58**	**0.57**	**0.32**
Total hand area NDH	<5	52	17	69	60	0.86				
Hand speed DH	<5	41	44	76	60	0.90	0.14	**0.59**	**0.60**	**0.40**
Hand speed NDH	<5	73	16	93	60	0.91				

Task parameters (stroke vs. control)



Task parameters (stroke vs. control)



Task parameters (stroke vs. control)