Unsupervised use of web-based tool at home yields valid estimates of Ataxia severity

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Motivation

1. **Objective and quantitative measurements of motor function** to more precisely track the patient state over time, in support of clinical trials and clinical care
2. **Unsupervised, home-based assessments** may reduce burden on patients and healthcare teams and enable more frequent assessments
3. **More frequent assessments at home** may reduce the variance of patient state estimates, enabling improved statistical power to detect disease change over time

Three questions

1. **Objective and quantitative measurements of motor function**
   Is this possible?

2. **Unsupervised, home-based assessments**
   Can people perform these assessments from home?

3. **More frequent assessments at home**
   What challenges show up with frequent use?

Tool

The Hevelius system includes caregiver inputs, dot clicking tasks, and follow-up questions

How tired is your child right now compared to most other times?

Much less tired | Usual | A lot more tired

How cooperative is your child right now compared to most other times?

Much less cooperative | Usual | Much more cooperative

How many times has your child stumbled or tripped in the past week?

0 times | 1-5 times | 6-10 times | over 10 times | N/A

What have been some current events for your child since they last used this tool?

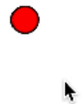
Any information that you provide will help researchers better understand the data.
E.g. a trip, a big family gathering, tummy troubles, social or school events

Caregiver reports

Participant self-reports

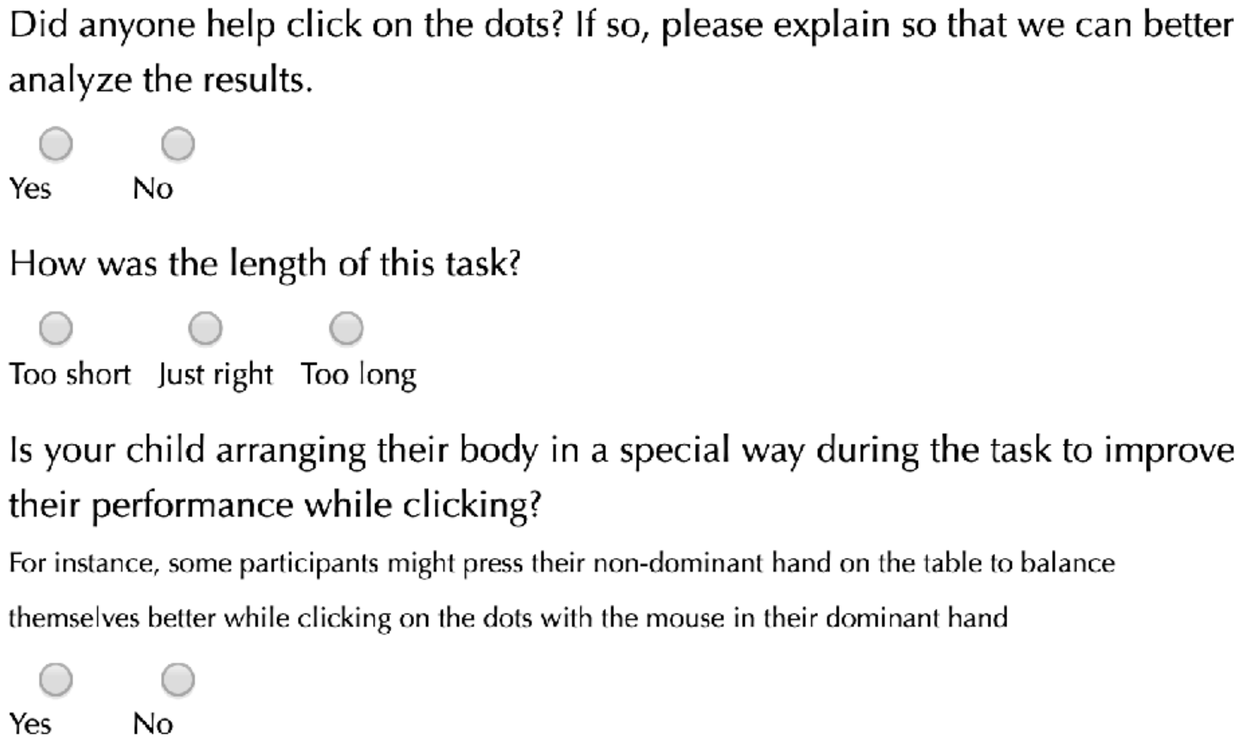
Tool

Task 5 out of 8



Dot clicking task

Tool
The Hevelius system includes caregiver inputs, dot clicking tasks, and follow-up questions

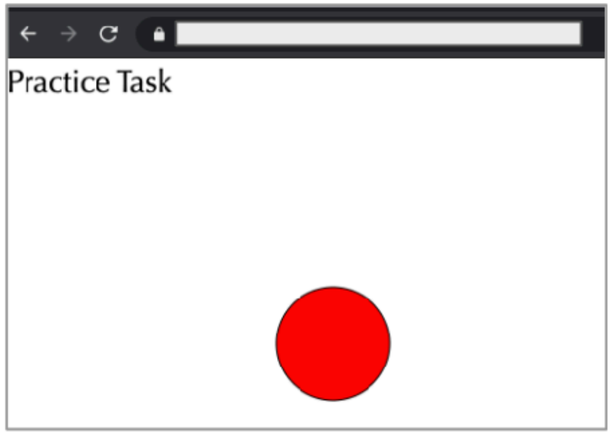


Caregiver follow-up questions

Tool

Hevelius estimates clinical scores with regression models over the interpretable movement features

Participant clicks on dots for a few mins



Neurologist-approved features drawn from mouse trajectories

movement_time: 4084 msec
execution_time: 2100 msec
num_pauses: 6
Duration of longest pause: 1137msec
...

Z-scores after comparing to normative data

movement_time: 2.4
execution_time: 3.57
num_pauses: 5.03
…
…
...

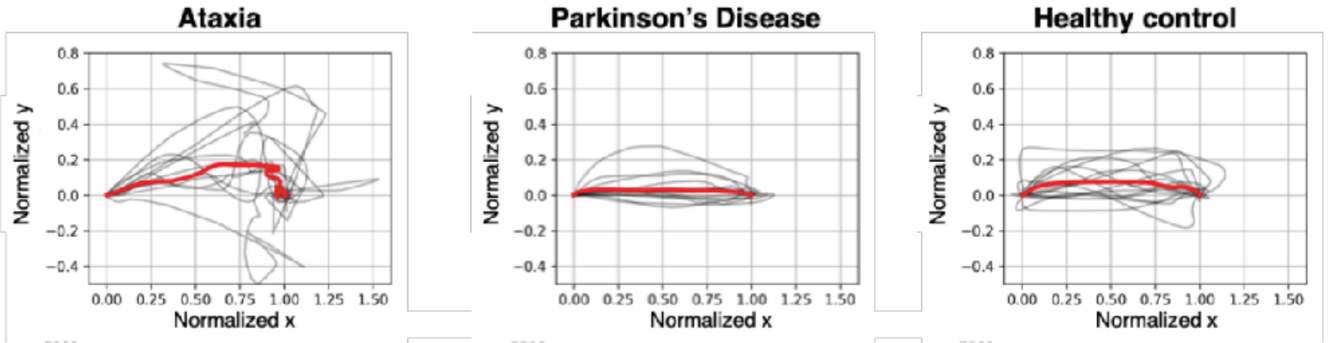
Severity score

Previous Results

In-person deployment demonstrated strong correlation between clinical score and estimated score

Clinical score estimated (score range in parentheses)	Number per diagnosis	Mean absolute error (MAE)	MAE as a percentage of maximum score	Correlation between clinical score and estimated score from regression models (*r*)
BARS dominant arm (0–4)	Ataxia, 91; controls, 29	0.35 ± 0.056	8.9% ± 1.4%	0.78, $P < 0.0001$
BARS total (0–30)	ataxia, 83; controls, 29	2.82 ± 0.582	9.4% ± 1.6%	0.83, $P < 0.0001$

Visualization of mouse trajectories –>

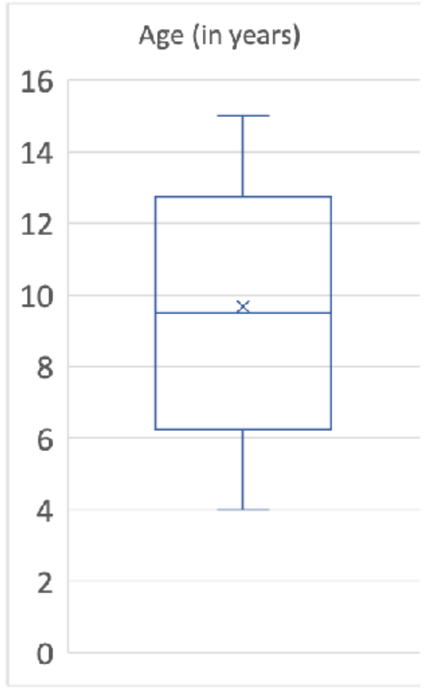


Gajos, Krzysztof Z., Katharina Reinecke, Mary Donovan, Christopher D. Stephen, Albert Y. Hung, Jeremy D. Schmahmann, and Anoopum S. Gupta. **Computer mouse use captures ataxia and parkinsonism, enabling accurate measurement and detection.** Movement Disorders. 2020.

Methods

12-week deployment at home

N=12
(10 A-T, 2 controls)

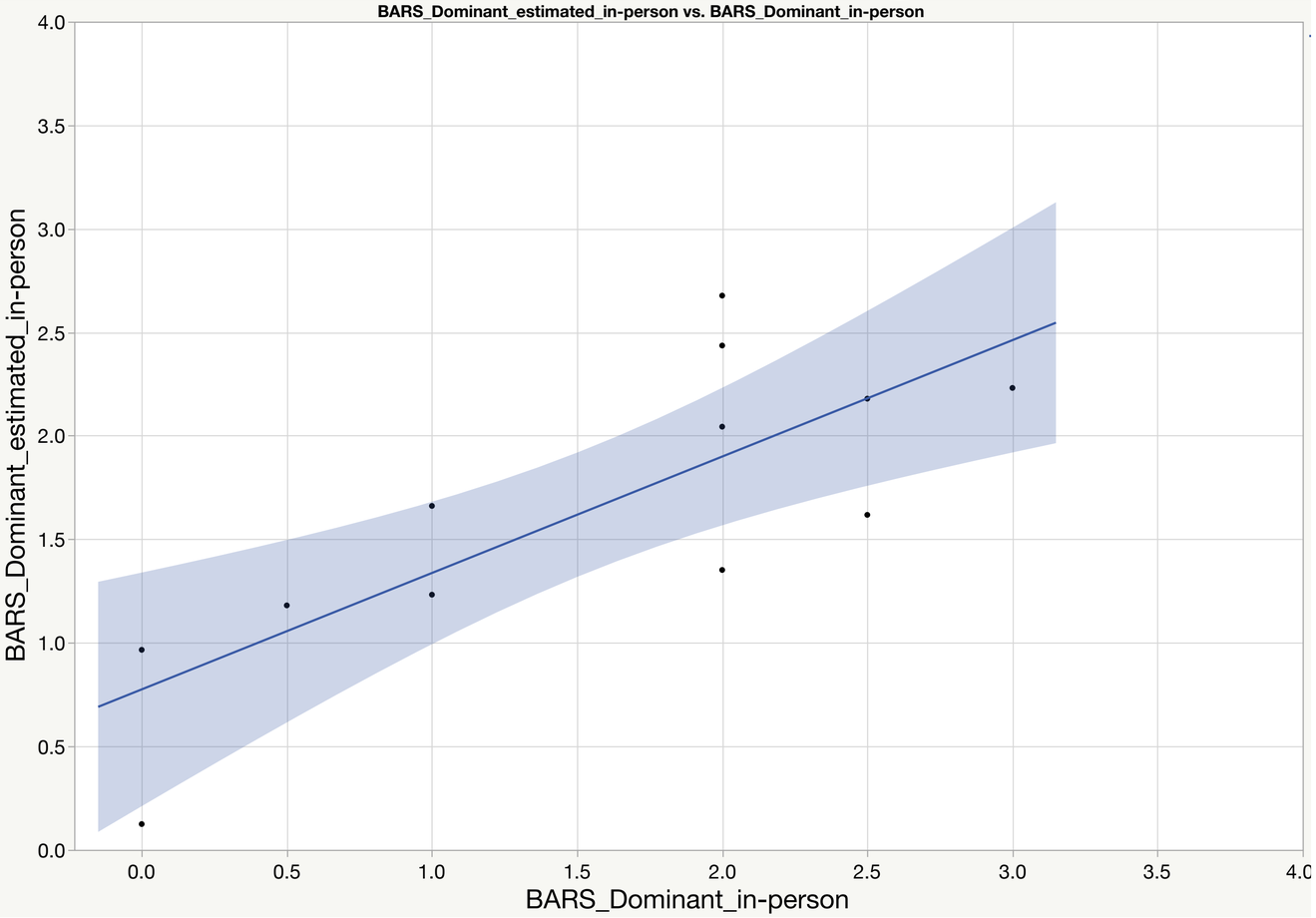


In-person	*At home*
Neurological assessment	-
Tool use	**Tool use**
Interview	-

Total at home sessions: 114
At home Sessions per participant: 9.5 (median)

Results

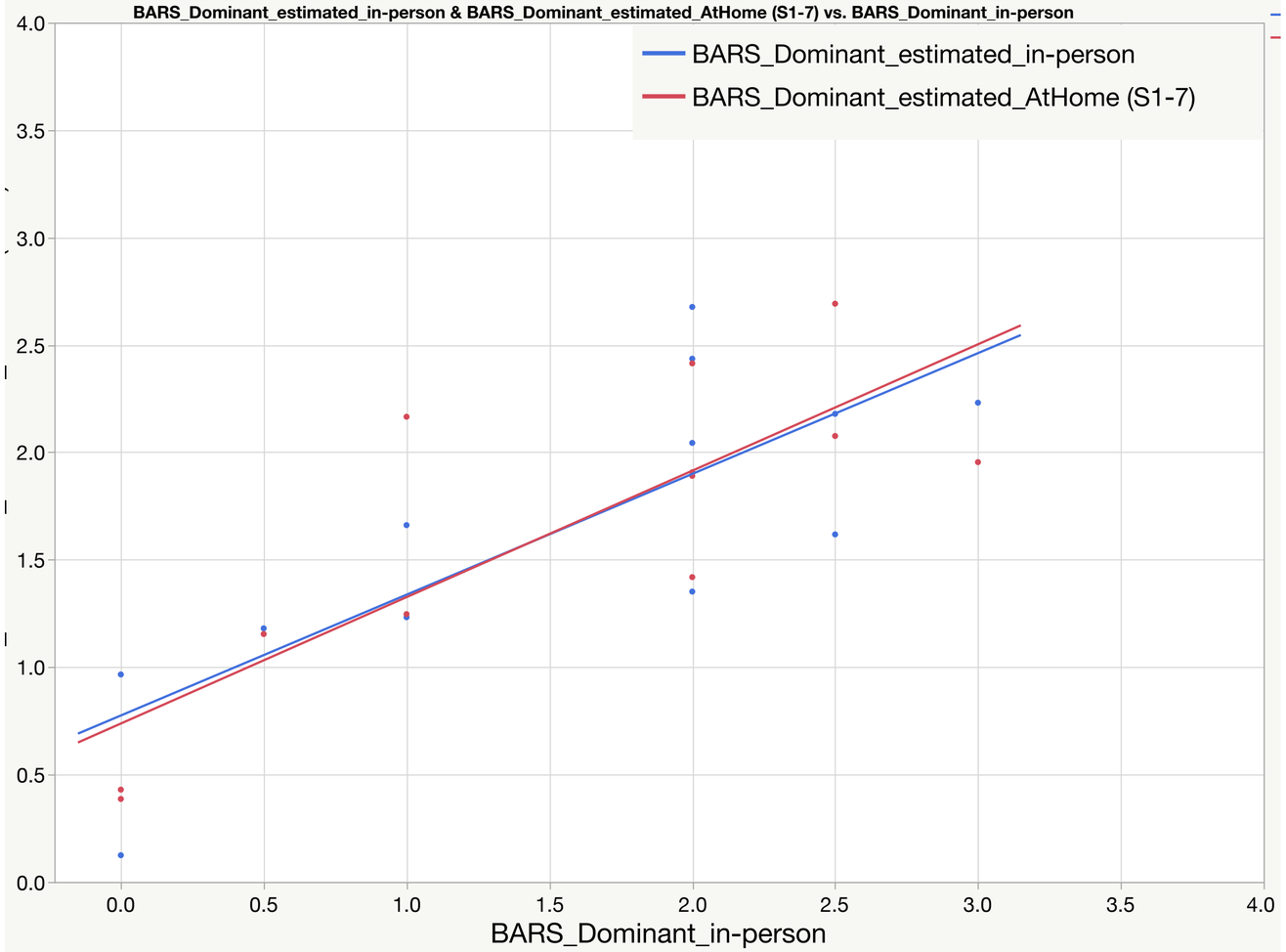
Severity score estimated from tool usage correlates well with clinician assessments (in-person)



corr (estimated_in-person, in-person) = **0.78**; p<0.005

In-person tool usage correlates well with in-person assessment

Results
Severity score estimated from tool usage correlates well with clinician assessments (at home)



corr (estimated_in-person, in-person) = **0.78**; p<0.005

In-person tool usage correlates well with in-person assessment

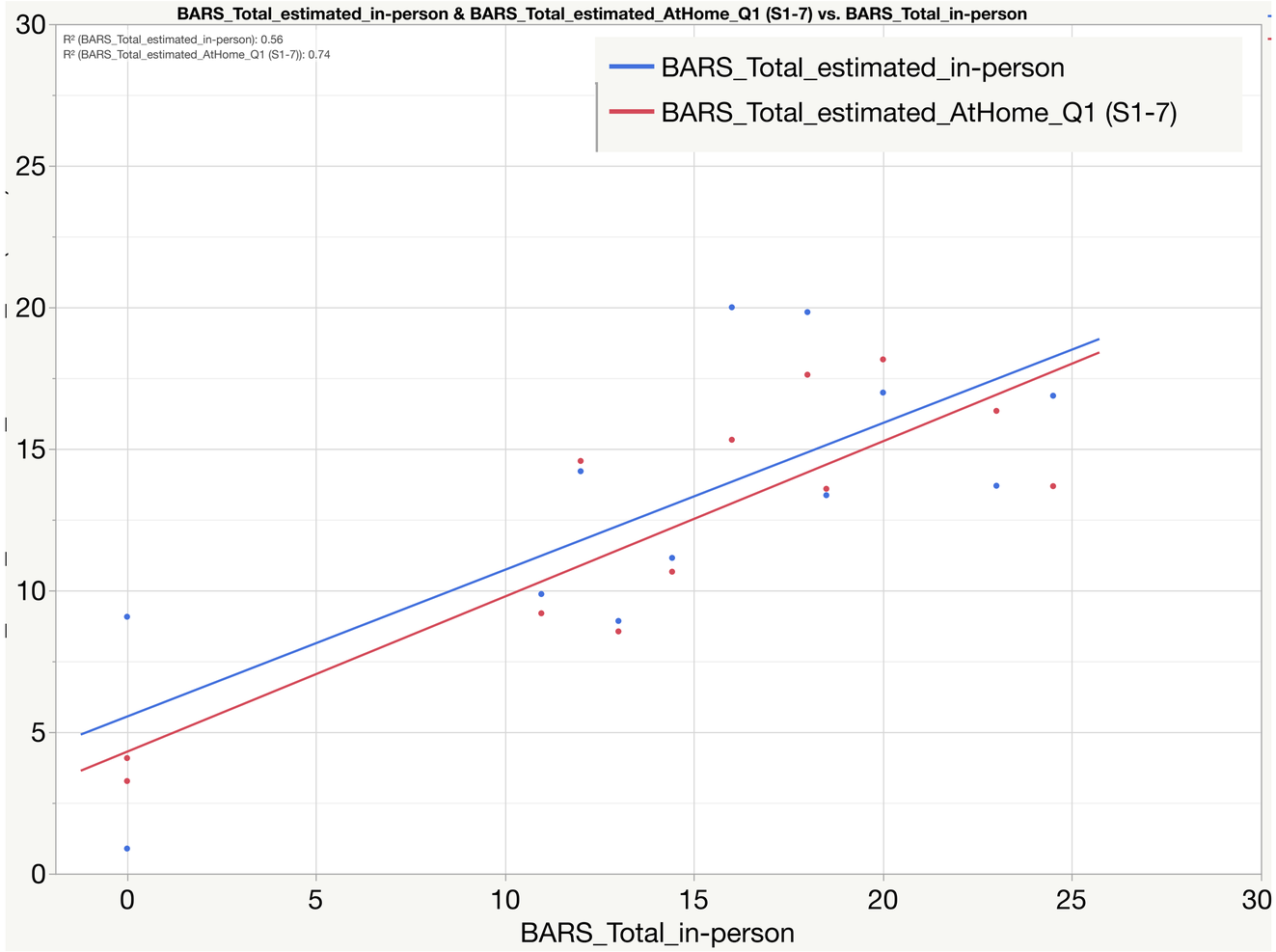
corr (estimated_atHome, in-person)= **0.81**; p<0.001

Information from multiple at-home uses more closely aligns with clinician assessment than single in-person use

Results

Similar trends hold for BARS total.

First-quartile (best) performance correlates best with in-person assessments.



corr (estimated_in-person, in-person) = **0.75**; p<0.005

In-person tool usage correlates well with in-person assessment

corr (estimated_atHome, in-person)= **0.86**; p<0.001

Information from multiple at-home uses more closely aligns with clinician assessment than single in-person use

Results

Assessments are reliable across at-home sessions

Results
Feasibility of the tool for participants/families at home

Sessions 1-7 (out of 12) were the most appropriate. Why?
11/12 participants were using the tool and their performance had “stabilized”

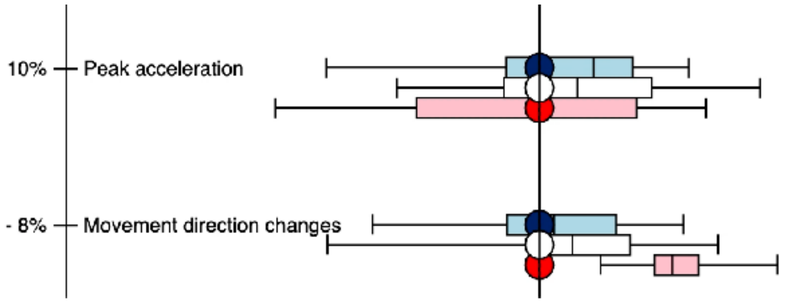
Session 1 (at home) performance was worse than in-person.

People’s self reports yielded limited utility over tool use.
(BARS dominant) Variance explained: factors
0.74: Participant Identifier
0.75: Participant Identifier + Session number
0.77: Participant Identifier + Session number + Caregiver+testtaker reports

Conclusion

1. **Objective and quantitative measurements of motor function is feasible** with a web-based tool. In-person and at-home assessments correlate well with the clinical severity.
2. **More frequent assessments from home are feasible and useful.** Information from multiple at-home uses more closely aligns with clinician assessment than single in-person use.

Future work



Dashboard for neurologists and researchers

Exchange postcards

INTERACTIVE PETS!

CONQUER TOWERS AND EXPLORE

More engagement / fun ideas for kids + sharing information back with parents

Dysmetria

Dystonia

Executive memory

Diagnostically-useful motor + cognitive performance tools