Machine Learning-based Mouse Tracking Enhances Adult ADHD Diagnosis

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Introduction

ADHD is usually diagnosed using clinical interviews and questionnaires. However, these measures are a) subjective, b) cannot study pathophysiology. Stop-signal task is a popular measure of impulsivity.
Poor performance on SST ⇒ pathological gambling, substance abuse, and ADHD

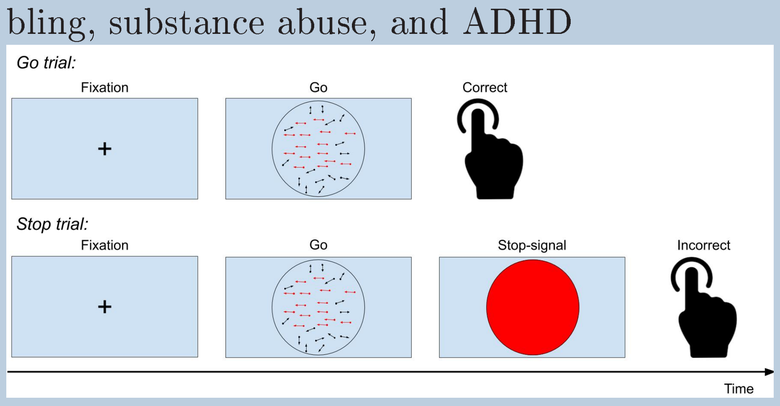

Figure 1: Stop-signal task

Problem: measures in traditional SST have weak correlations with questionnaires scores

Participants & Design

Total: 100 participants

1. **s-SST**: 50 (27 males and 23 females) → Conners Adult ADHD questionnaire (CAARS)
2. **Motor-SST**: 50 (15 males and 35 females) → Conners Adult ADHD questionnaire (CAARS)

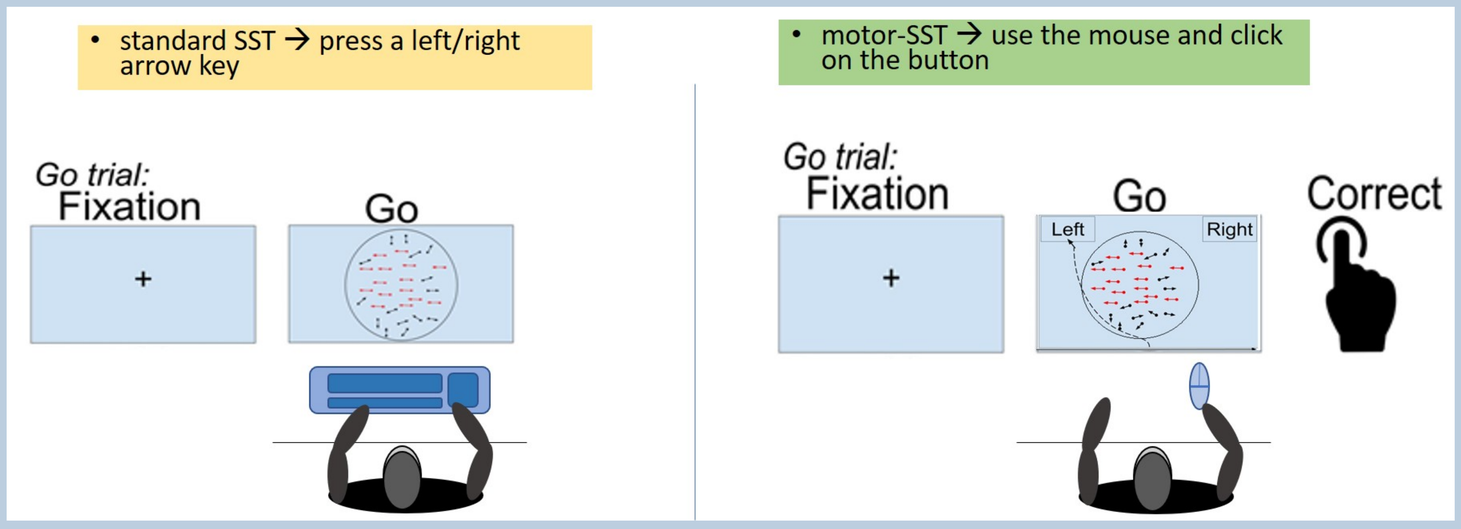

Figure 4: Standard and Motor Stop-signal tasks

Analysis techniques

Predictors

1. standard SST (8 variables)
2. motor-SST (14 variables)

Machine learning models:
Ridge, Random Forest, SVM

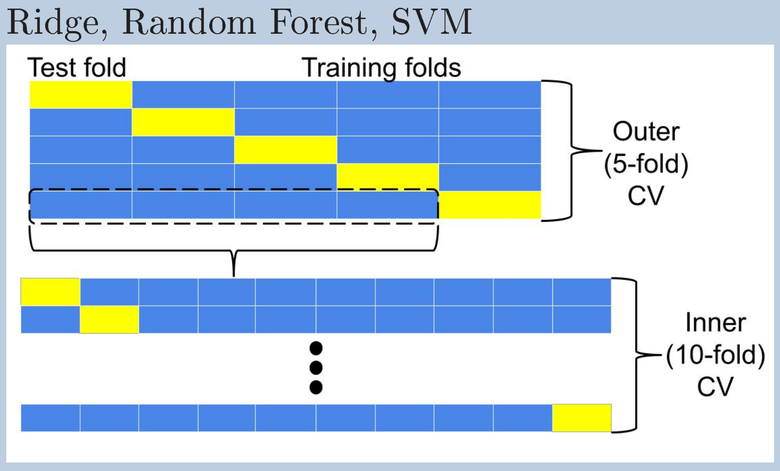

Figure 2: Nested cross-validation

Feature importance

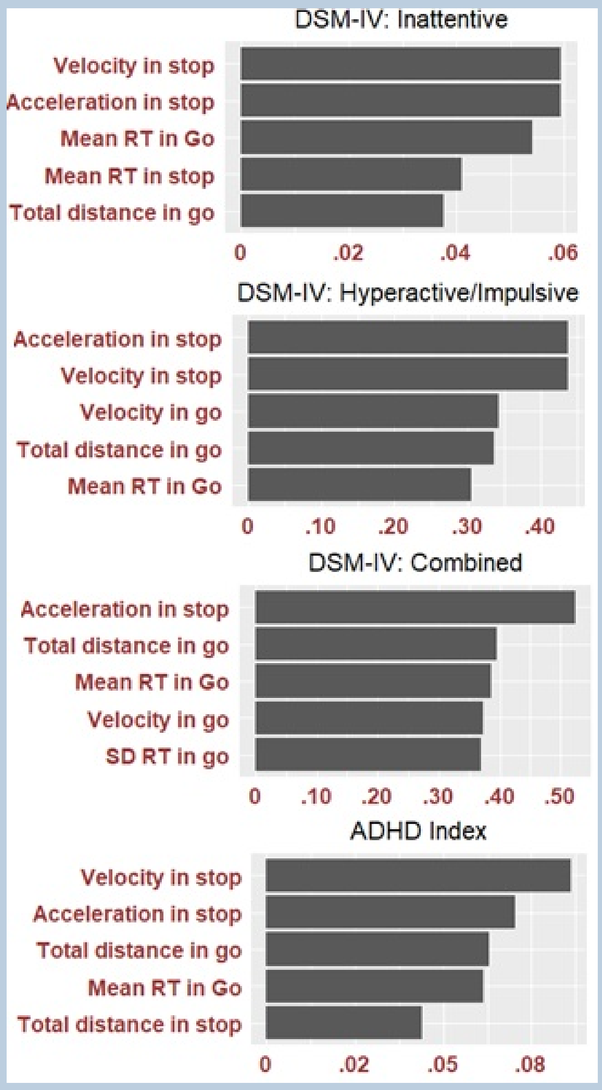

Figure 3: Relative feature importance

Correlations between predicted & observed/permuted data

- Spearman's rank correlation (predicted vs. observed symptom scores, 10CV nested within 5 CV, repeated 20 times)
- Permutation tests (1000 times, predicted vs. permuted symptom scores)

Table 1: Correlations between predicted and *observed* scores

	DSM-IV: Inattentive	**DSM-IV: Hyperactive/ Impulsive**	**DSM-IV: Combined**	**ADHD Index**
s-SST				
Ridge	-0.27 (0.07)	-0.11 (0.12)	-0.24 (0.07)	-0.22 (0.06)
Random forest	0.02 (0.06)	0.25 (0.05)	0.19 (0.06)	-0.06 (0.1)
SVM	-0.28(0.11)	0.09 (0.13)	-0.12 (0.11)	-0.21 (0.09)
Mouse-SST				
Ridge	**0.25 (0.06)***	0.20 (0.07)	**0.30 (0.04)***	**0.34 (0.05)****
Random forest	0.29 (0.07)	0.13 (0.1)	0.22 (0.08)	0.16 (0.06)
SVM	-0.09 (0.13)	-0.25 (0.13)	0.16 (0.1)	-0.1 (0.1)

$^{*}p < .05$, $^{**}p < .01$.

Table 2: Correlations between predicted and *permuted* scores

	DSM-IV: Inattentive	**DSM-IV: Hyperactive/ Impulsive**	**DSM-IV: Combined**	**ADHD Index**
s-SST				
Ridge	-0.16 (0.12)	-0.23 (0.16)	-0.16 (0.14)	-0.23 (0.13)
Random forest	-0.01 (0.19)	-0.14 (0.12)	-0.009 (0.19)	0.04 (0.13)
SVM	-0.16 (0.11)	-0.18 (0.18)	-0.19 (0.11)	-0.17(0.1)
Mouse-SST				
Ridge	-0.02 (0.27)	-0.11 (0.18)	-0.09(0.17)	-0.08(0.23)
Random forest	-0.09 (0.19)	-0.12 (0.15)	-0.08 (0.15)	-0.04 (0.17)
SVM	-0.14(0.13)	-0.1 (0.17)	-0.21 (0.17)	-0.29 (0.14)

Conclusions

1. Ridge regression produces the strongest and most stable associations between behavioral measures and questionnaire scores.
2. Introducing mouse movement measures improves predictive accuracy.
3. Machine Learning can be applied to mental disorder diagnosis.