Mock MRI training impact on MRI scanning in children with neurodevelopmental disorders

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Challenge

- Imaging neurodiverse children is challenging due the requirements of compliance and limited motion
- MRI sessions are expensive – average $500/hour in scanner costs
- A range of training options are used to prepare children to the MRI, including mock MRI scanner sessions
- Here, we leverage on-going multimodal neuroimaging study of children with ASD and/or ADHD to address the following goals

Goals:

1. We assessed the impact of a comprehensive mock training protocol into the MRI scan success rate of school age children with autism spectrum disorder (ASD) and/or with attention deficit hyperactivity disorder (ADHD)
2. We explored which training and/or child factors are associated with success in an MRI scanner

Mock MRI training

- A six-step process in ~30-40 min session
- Each step is repeated until the child passes
- The subject wears a motion tracking headband, if the child moves, the system provides auditory feedback
- If the child is unable to complete the protocol, they are invited back to repeat it

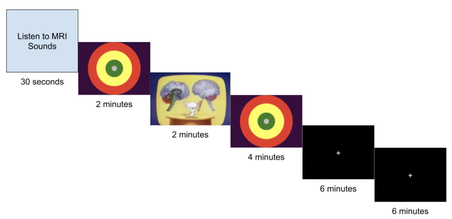

Figure 1. Images shown to the child during each step of the MRI training protocol

MRI Training Steps:

1. Child listens to 'social stories' about what an MRI is and what it does
2. Listen to MRI sounds for 30 seconds
3. Play the target game inside the scanner for 2 min
4. Watch a movie for 2 minutes while lying still
5. Play the target game for 4 minutes
6. Practice lying still for 6 minutes twice

Study sample

Children underwent to a comprehensive diagnostic assessment for autism and or ADHD

- 258 subjects (male=204)
- Age: 8.6 +/- 1.7 years
- ASD: 113, ADHD: 139
- IQ: 101.7 +/- 16.7

1. Mock scan training impact

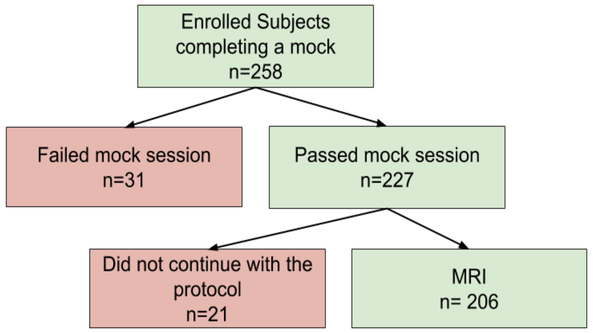

Figure 2. Flowchart showing which subjects entered and continued with the study protocol. 88% of those who attempted the mock scanner protocol completed it successfully.

Subjects passing the mock scan tended to have the following trends compared to those who failed:

Category	Pass mock	Fail mock	P-value
Age	8.7 ± 1.7	7.8 ± 1.5	0.008
IQ	102.6 ± 16.8	95.3 ± 13.6	0.02
ADOS Total	4.7 ± 2.8	6.7 ± 2.8	0.0002
SWAN	1.0 ± 0.8	0.8 ± 0.7	0.2
Sex	M:176, F:51	M:28, F:3	0.4
DX	ADHD:130, ASD:92	ADHD:21, ADHD:9	0.002

Table 1. Selected differences between the the subjects who pass and fail the mock scanner protocol

The bar plot shows the number of subjects that successfully complete each MRI scan

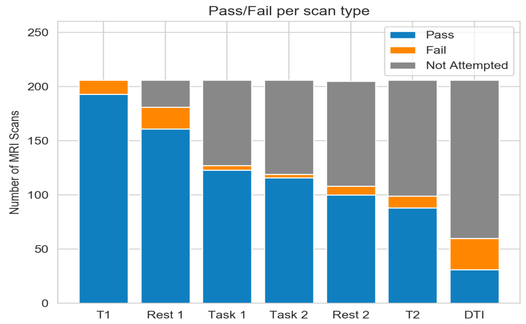

Figure 4. Number of subjects passing each scan in the sequence; the scans occur in the order shown

2. Features predicting MRI success

- To see which aspects of a child are associated with success in an MRI scanner, we examined the relationship between clinical variables and:
  1. Amount of motion in R-fMRI scan
  2. Number of scans a child completes successfully

Methodology

- Trained a random forest regression model
- Input features:
  - Age, Verbal IQ, Nonverbal IQ, ADOS RRB, ADOS SA, SWAN Inattention, SWAN Total Hype, CBCL Internalizing, CBCL Externalizing, SRS-2P, SEQ Seeking, SEQ Hypo, SEQ Hyper, RBS-R: Stereo, Compulsive, Ritual, Same, Restrict, Number of mock scanner sessions, and amount of motion recorded during the last mock scanner training session.

Predicting motion

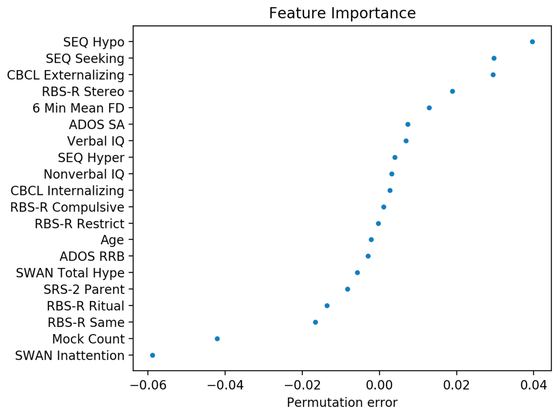

Figure 5. Feature importance as determined via the regression model. Mean average error rate: 0.048

Predicting number of scans completed

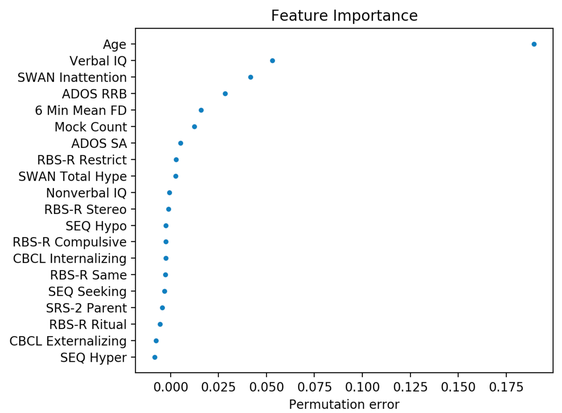

Figure 6. Feature importance as determined by the RF model. Mean average error rate: 1.42

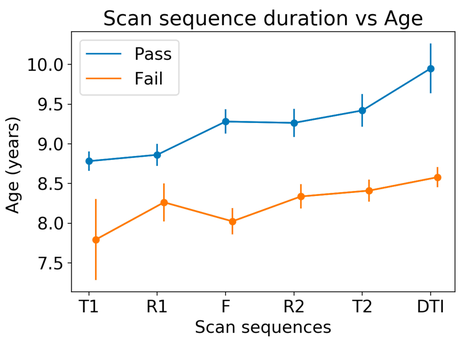

Figure 7. Differences in age of those who pass/fail the scan sequence.

Summary

- 94% of children passing our mock training protocol successfully completed a first ~6 min scan (T1 MPRAGE) with high quality and 76% completed the T1 and a second 6-min R-fMRI (minimum multimodal imaging set)
- The percentage of children completing 2+ multimodal sequence gradually decrease as the # of run progresses
- While combination of child traits predicts the degree of motion at the the first R-fMRI, age is the most important factor for predicting the number of successfully completed scans in a single 1-hour MRI session

Acknowledgements

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