

Patterns of Functional Connectivity during Preparation Periods Can Predict the Tendency to Give Up in Following Decision-Making

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RESEARCH BACKGROUND

◆ Task difficulty expectation engages in different behavioral strategies and neural patterns across individuals. (Jung et al.,2014)

dACC & ventral striatum synchrony during resting-state
dACC & right anterior insula synchrony during task

predict

Ambiguity Aversion

Research Question

Can we predict whether participants would give up solving a problem or not using patterns of cortical functional connectivity during the period of task expectation?

EXPERIMENTAL DESIGN

SCAN PROTOCOLS: 3T, EPI sequence, TR=2s, TE=30ms, 33 axial slices, 30° oblique to AC-PC line

EASY

Difficulty Level CUE
(1500ms)

◆ either 'EASY' or 'HARD'
◆ randomly presented

PREPARATION
(8000ms)

◆ Task expectation period

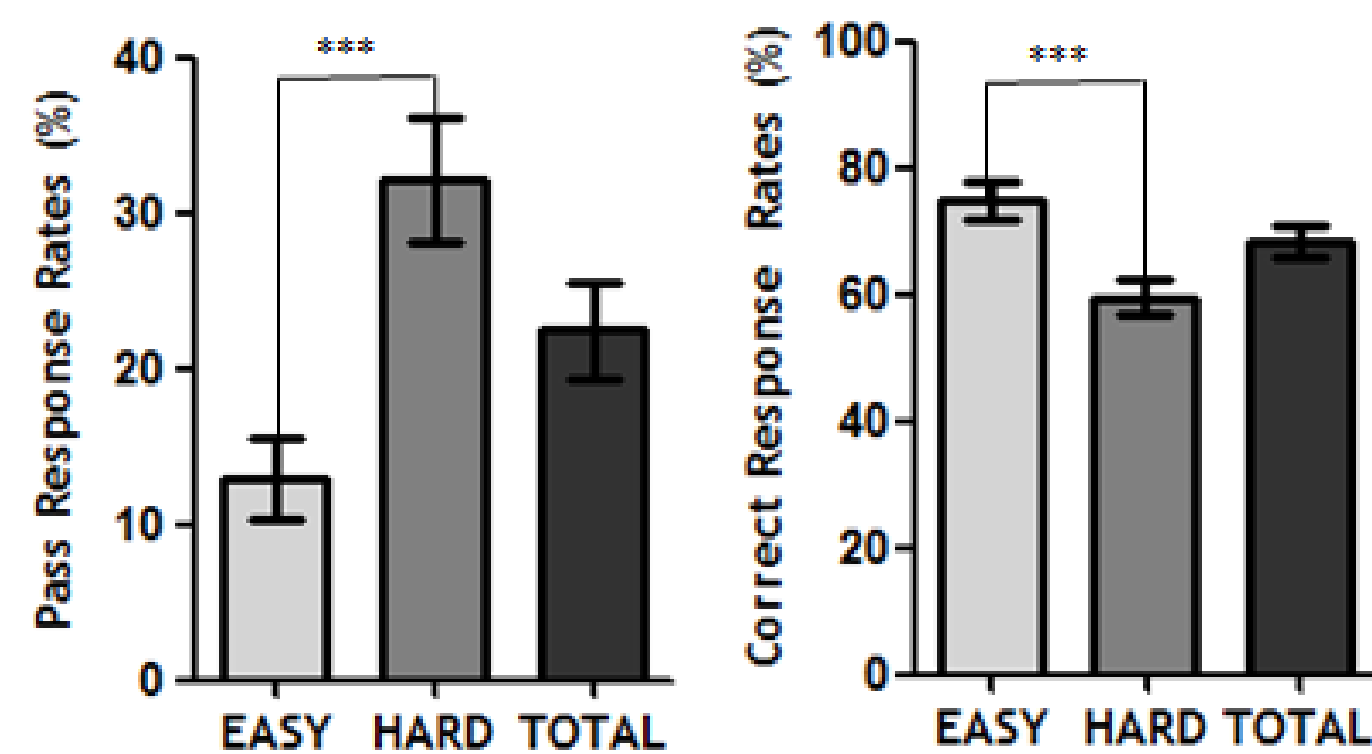
PROBLEM
(2000ms)

◆ Number of circles
→ 'ODD' ? 'EVEN' ?
◆ 'PASS'
= Measurement of ambiguity
aversion or risk aversion
(tendency to give up)

FEEDBACK
(1000ms)

◆ Correct: +\$0.1
Incorrect: -\$0.1
Pass: \$0
Time-over: -\$0.05

BEHAVIORAL RESULTS



◆ Pass Responses: M= 23%
(Easy trials: M= 13% < Hard trials: M= 32%, p<0.001)

◆ Correct Responses: M= 68%
(Easy trials: M= 75% > Hard trials: M= 59%, p<0.001)

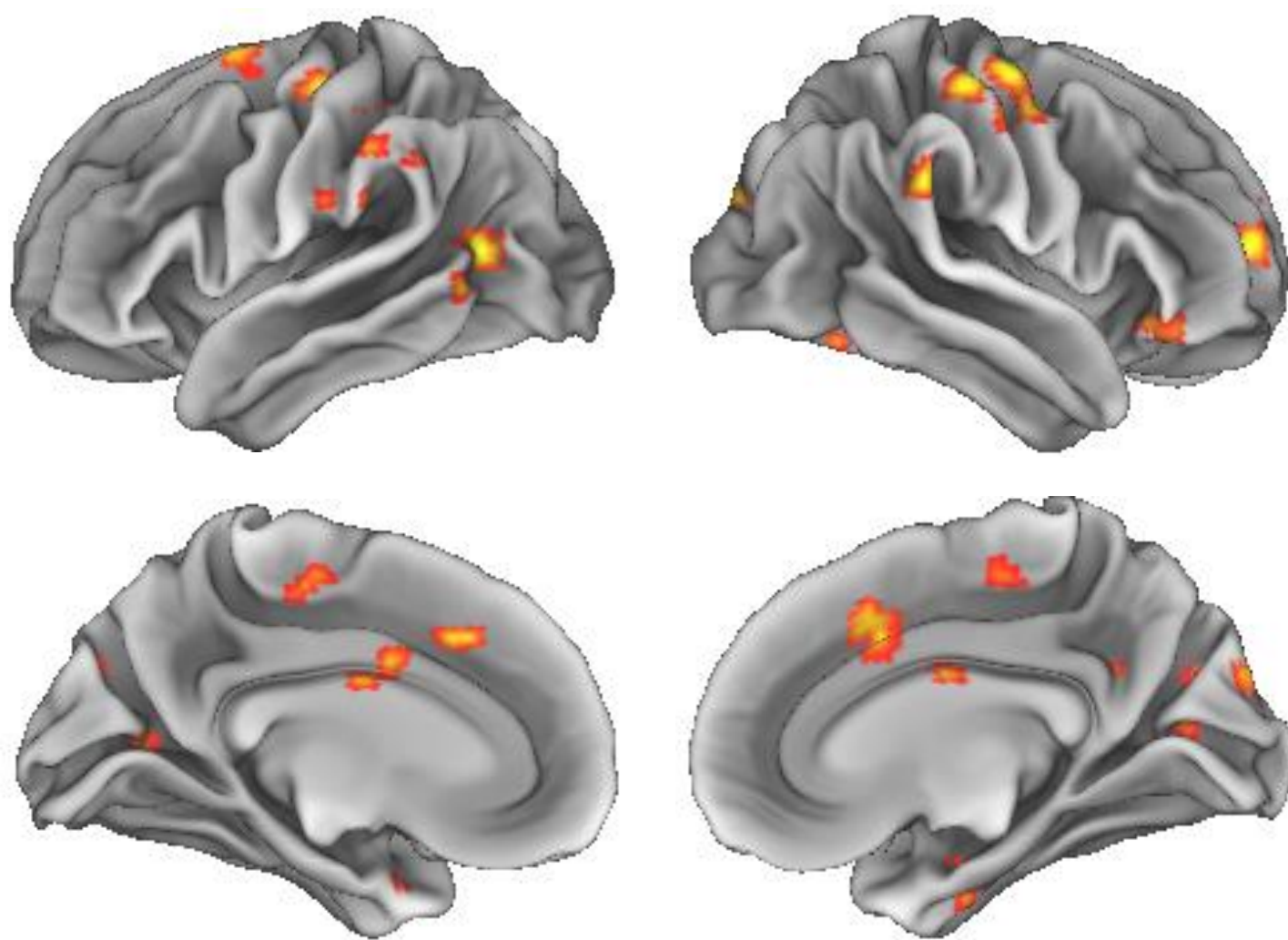
◆ High Pass Group (HP, N=15)
(Pass : M=34.26%, SD=16.06%)
(Correct : M= 70%, SD= 13%)

◆ Low Pass group (LP, N=16)
(Pass : M=16.75%, SD=18.14%)
(Correct: M= 73%, SD= 16%)

◆ 2(group)x2(cue) ANOVA
→ HP passed more on HARD trials
(F(1,29)=27.534, p <0.001)

ACTIVATION MAP

◆ Regions that showed greater activation on
HARD cue > EASY cue (p<0.001/ no extent)

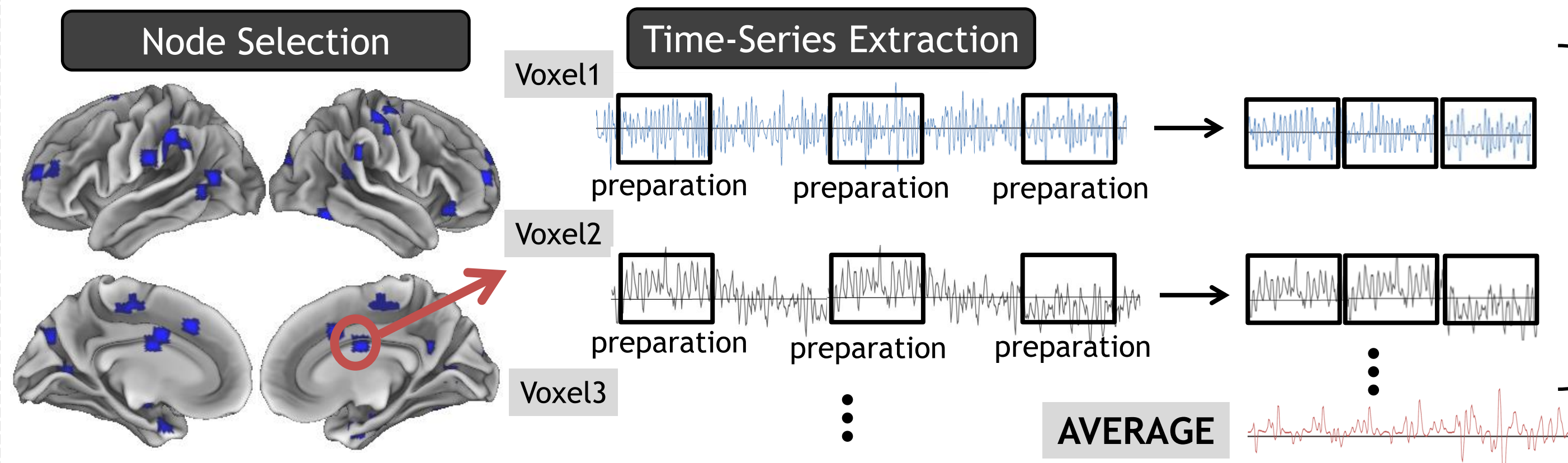


fMRI ANALYSES -1

Regions	Hemisphere	BA	MNI Coordinates		t-score	
			x	z		
<i>Hard cue vs. Easy cue (Whole Brain)</i>						
Precentral Gyrus	R	4	45	-12	66	4.92
Postcentral Gyrus	R	3	51	-21	60	4.53
Superior Frontal Gyrus	R	6	30	-9	63	3.49
Postcentral Gyrus	L	3	-36	-27	54	4.81
Superior Frontal Gyrus	L	6	-21	6	72	4.76
Midcingulate Cortex	R	32	9	15	36	4.68
Medial Frontal Gyrus	L	24	-3	24	39	4.05
Hippocampus and Amygdala	L	20	-27	-9	-12	4.57
Superior Occipital Gyrus	R	19	18	-84	24	4.48
Caudate Nucleus	R	11	15	21	-9	4.39
Superior Frontal Gyrus	R	10	24	57	12	4.37
Middle Temporal Gyrus	L	37	-45	-66	12	4.34
Supramarginal Gyrus	R	-	66	-33	33	4.16
Parahippocampal Cortex	R	20	33	-15	-27	4.16
Fusiform Gyrus	R	36	30	0	-33	3.54
Midcingulate Cortex	R	-	0	-24	51	4.11
Supplementary Motor Area	R	6	0	-15	57	3.84
Calcarine Sulcus	L	19	-21	-66	6	3.99
Inferior Parietal Gyrus	L	40	-63	-48	39	3.91
Middle Frontal Gyrus	L	45	-42	48	18	3.89
Middle Temporal Gyrus	L	37	-60	-60	3	3.80
Precentral Gyrus	L	6	-33	-6	60	3.76
Superior Frontal Gyrus	R	10	15	63	27	3.76
Inferior Parietal Gyrus	L	40	-60	-36	42	3.73
Inferior Orbitofrontal Cortex	R	47	48	30	-9	3.66
Precuneus	R	23	12	-51	24	3.64
Cuneus	L	18	-12	-78	33	3.61
Midcingulate Cortex	L	24	-3	3	33	3.61
Postcentral Gyrus	L	-	0	-3	27	3.60
Supramarginal Gyrus	L	40	-66	-36	30	3.58
Parahippocampal Cortex	L	28	-27	6	-30	3.56
Calcarine Sulcus	R	17	15	-66	6	3.52
Superior Temporal Gyrus	R	42	51	-42	18	3.18
Inferior Parietal Gyrus	L	40	-45	-42	54	3.49
Inferior Occipital Cortex	R	37	42	-60	-15	3.39

fMRI ANALYSES -2. METHOD

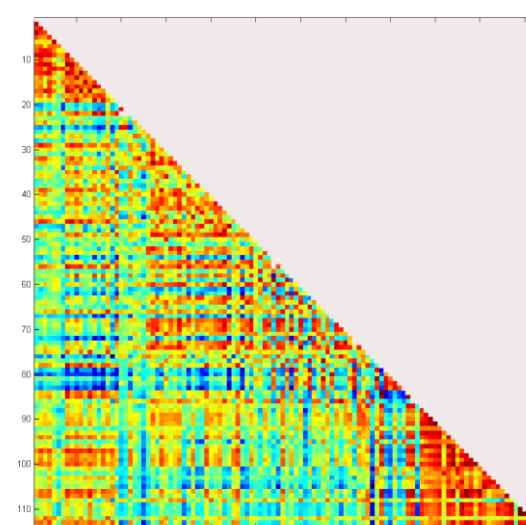
▷ Can we classify HP and LP using patterns of functional connectivity during preparation periods?



◆ 41 cube-shaped ROIs

◆ Time-series of each voxel during the 'preparation' periods were concatenated and averaged

fcMVPA



X_for_train <30x820 double>							
	1	2	3	4	5	6	7
1	-2.0723	0.9747	0.1528	-2.3470	-1.4022	-0.4375	-1.7369
2	-0.3326	-0.2674	0.4887	0.6860	-0.2911	0.7450	0.1649
3	-1.0403	0.2607	0.2836	-0.6146	-0.6977	0.0281	-0.1077
4	-0.8374	1.4968	0.5829	-1.1328	-1.1028	0.1574	0.9234
5	-1.6804	-0.0026	0.6073	1.1830	-0.4394	-0.0780	0.2361
6	-0.2350	1.0580	0.2071	-0.1701	1.1671	1.1392	0.9635
7	0.6982	1.8108	0.9832	-0.2916	0.3890	0.6663	0.4296
8	-1.2065	0.1299	1.2202	-2.0242	-0.5209	-0.3464	-1.8054
9	0.4943	0.2207	0.0670	1.2748	1.2627	1.6399	0.8150
10	-0.8245	1.4256	0.9858	-1.3096	0.7708	-0.4719	-1.3878
11	0.4163	0.2222	-0.8719	0.7477	-1.0799	1.2383	0.6626
12	-0.7602	-1.6815	0.9846	0.3544	0.2867	-0.0900	-0.5869

◆ Feature (link) Selection
: Pair-wise cross-correlation coefficients between 41 ROIs were calculated and ranked based on absolute t-score from the independent two-sample t-test.

◆ The whole procedures were repeated in three different ways: TOTAL, EASY, and HARD
✓ Groups were divided into HP and LP based on the number of pass responses of the 1. total trials 2. trials that EASY cue was presented (EASY trials) 3. trials that HARD cue was presented (HARD trials).

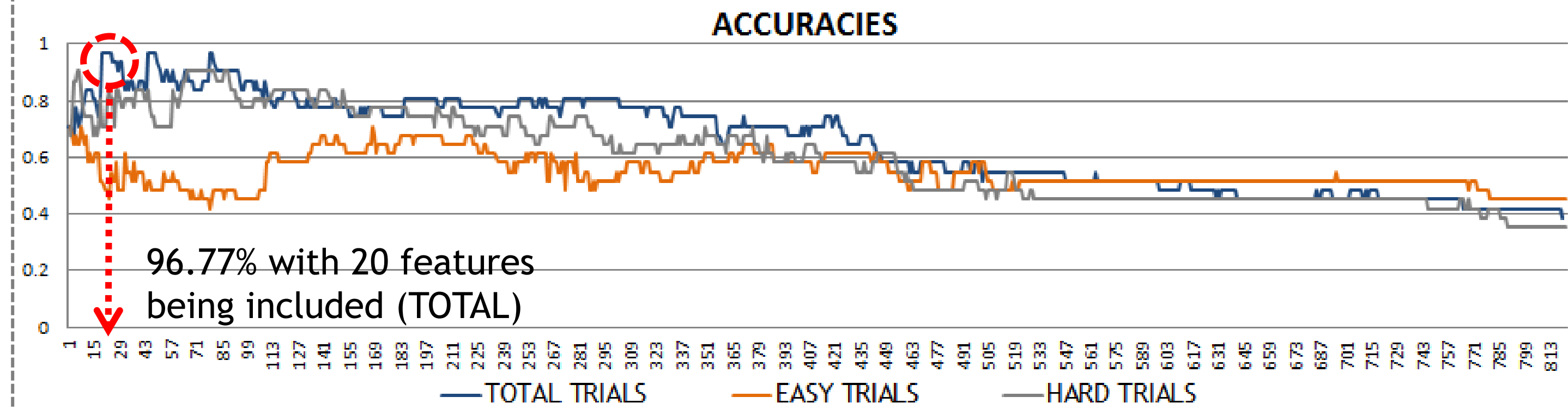
✓ Time-series during preparation periods of 1. total trials 2. EASY trials 3. HARD trials were extracted and averaged.

✓ 1+1=TOTAL, 2+2= EASY, 3+3 =HARD

◆ Group Classification using support vector machine algorithm (SVM)
✓ Each feature was added cumulatively by iteration.
✓ Leave-one-out cross validation was applied.
✓ Permutation tests were performed (n=100).

fMRI ANALYSES -2. RESULTS

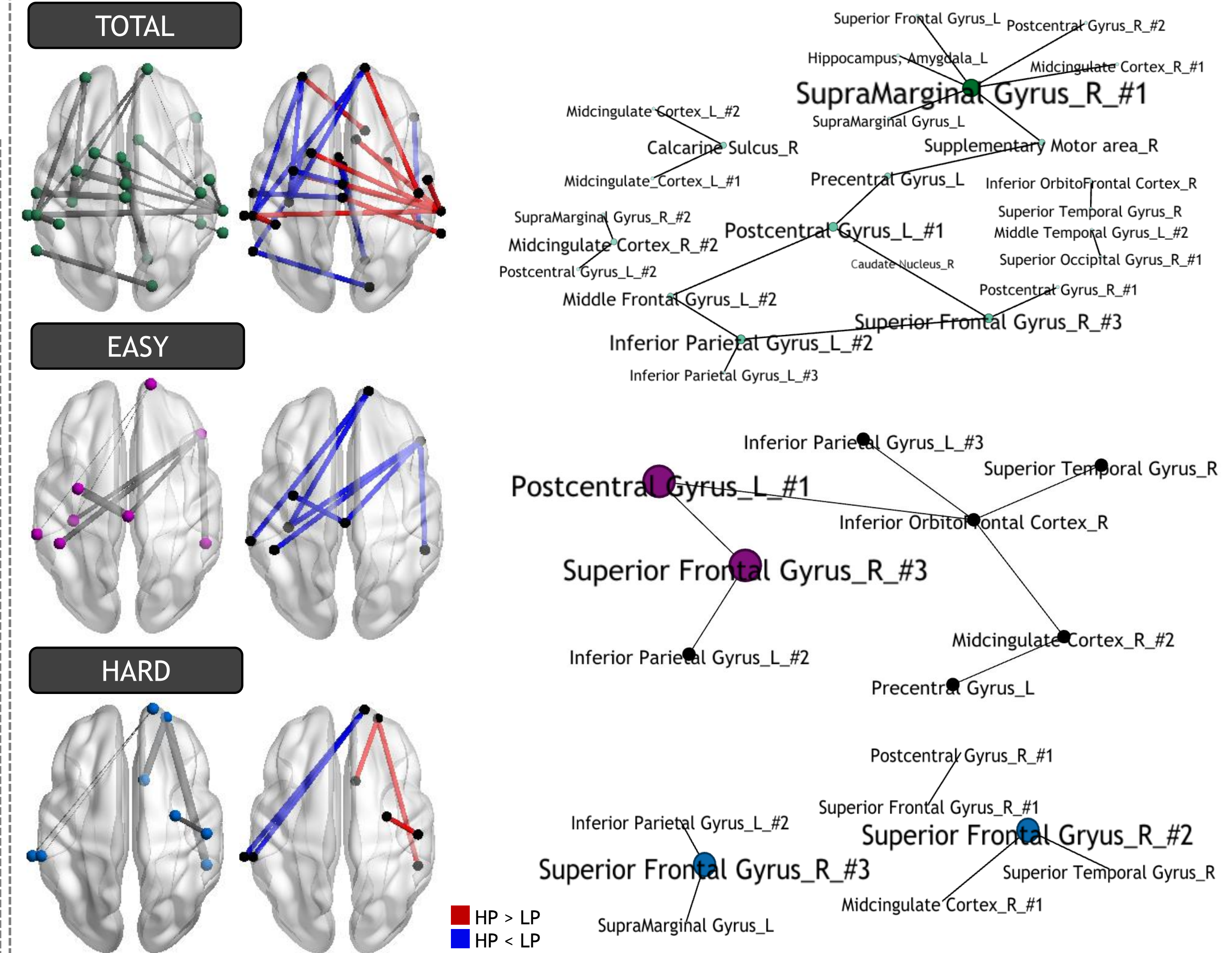
▷ Discriminating HP vs. LP groups



◆ Classification 'accuracies' indicate how successfully the combination of included features discriminated two groups.

◆ Peak Accuracy
1. TOTAL : 96.77% (using top 20 features)
2. EASY : 70.97% (using top 7 features)
3. HARD : 90.32% (using top 5 features)

▷ Features (Links) eliciting peak performance



CONCLUSIONS/SUMMARY

◆ HP and LP showed significant behavioral and neural differences when the task was expected to be HARD.
◆ Patterns of cortical functional connectivity successfully predicted whether one would have a tendency to give up solving problems or not (predicting ambiguity aversion).
◆ The midcingulate cortex and right superior frontal gyrus were mainly involved in distinguishing two groups.

References Jung, Y. C., Schulte, T., Müller-Oehring, E. M., Hawkes, W., Namkoong, K., Pfefferbaum, A., & Sullivan, E. V. (2014). Synchrony of anterior cingulate cortex and insular-striatal activation predicts ambiguity aversion in individuals with low impulsivity. *Cerebral Cortex*, 24(5), 1397-1408.

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