

# Human fMRI project

2022. 11. 08

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## 1. Subject summary

- a. 16 subjects 사용 가능(10 good / 6 bad perform.)
- b. 나머지 17 subjects는 fMRI data가 없거나 부족

## 2. Behavior data

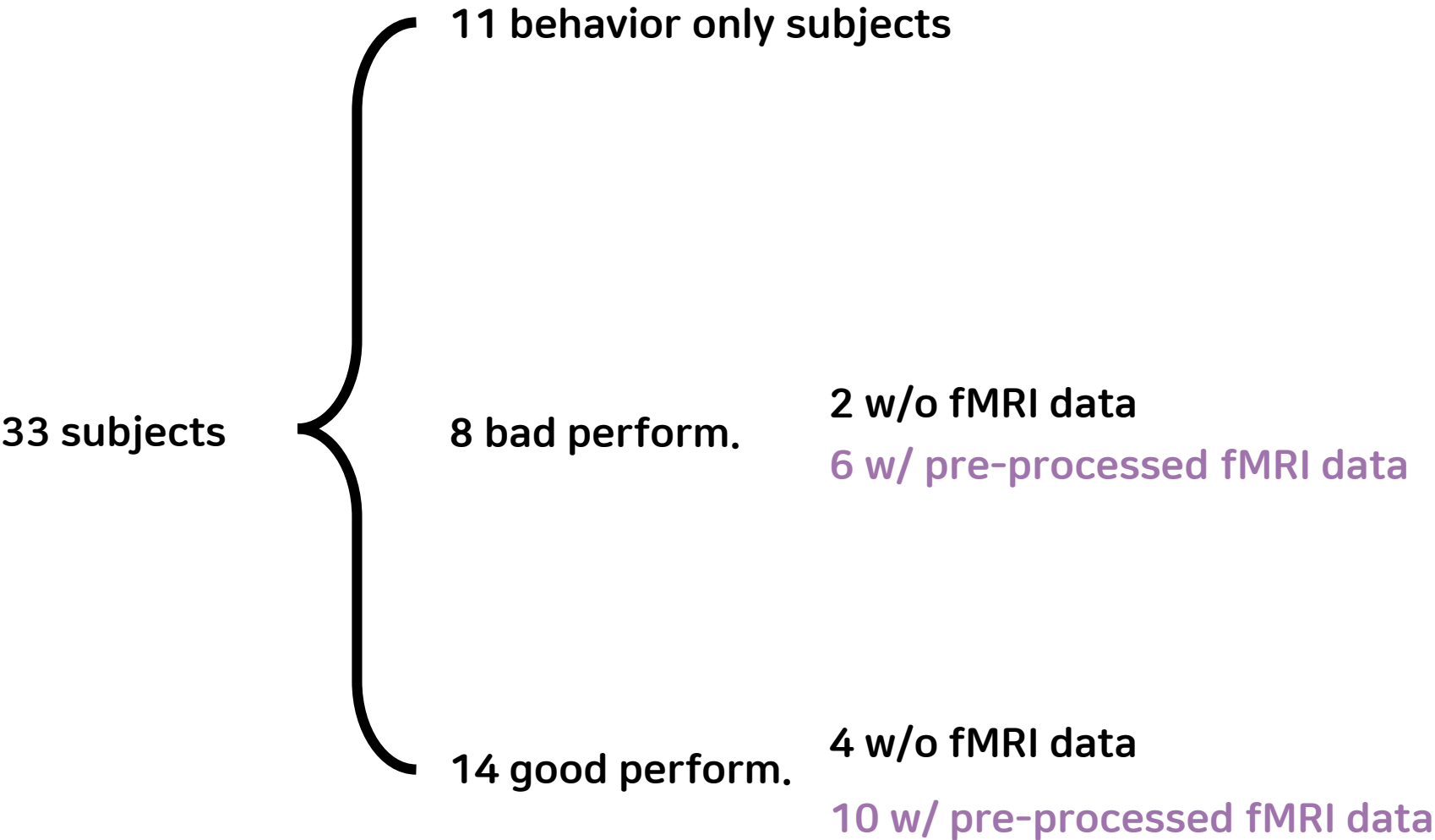
- a. Timestamp별 position head direction data 없어서,  
UDK log로부터 trial parsing 다시 해야 함
- b. MR signal timestamp는 있음

## 3. MR data

- a. SPM 사용하여 MR image processing 필요
- b. Hippocampus segmentation 및 preprocessing 완료됨

# Subject summary

총 16명 fMRI data를 사용할 수 있음



# Data structure

LeeStorage2(WW147.47.203.148) (Y:) > EPhysRawData > fmri\_oppa\_analysis > CL121121\_1

이름	수정한 날짜	유형	크기
fmri	2022-10-26 오전 3:05	파일 폴더	
SNU_SAVED_20121122_151056_718000	2022-10-26 오전 3:20	파일 폴더	
studyphase_excluded	2022-10-26 오전 3:21	파일 폴더	
.DS_Store	2015-09-18 오전 7:39	DS_STORE 파일	9KB
analyzeudklogA	2013-10-23 오후 6:27	MATLAB Code	12KB
analyzeudklogB1121_2	2013-04-25 오후 10:33	MATLAB Code	40KB
analyzeudklogB1121_2_ver2	2013-11-28 오전 2:15	MATLAB Code	50KB
CL121121_1A	2012-11-21 오후 3:25	텍스트 문서	547KB
CL121121_1A	2012-11-21 오후 7:05	MATLAB Data	249KB
CL121121_1Atest	2012-11-21 오후 7:05	PNG 파일	23KB
CL121121_1Avisit	2012-11-21 오후 7:05	PNG 파일	9KB
CL121121_1B	2012-11-22 오후 4:45	텍스트 문서	609KB
CL121121_1B	2013-04-25 오후 10:33	MATLAB Data	538KB
CL121121_1B_test	2013-11-28 오전 2:16	PNG 파일	32KB
CL121121_1B_ver2	2013-11-28 오전 2:16	MATLAB Data	550KB
CL121121_1B_visit	2013-11-28 오전 2:16	PNG 파일	9KB
mrtools_orp	2015-06-04 오전 8:24	HDR 파일	1KB
mrtools_orp	2015-06-04 오전 8:24	디스크 이미지 파일	2,058KB
ScanLog_CL121029_1	2012-11-21 오전 10:24	Microsoft Excel ...	276KB
valid_orp	2015-06-04 오전 8:24	HDR 파일	1KB
valid_orp	2015-06-04 오전 8:24	디스크 이미지 파일	2,058KB

fmri pre-processed data

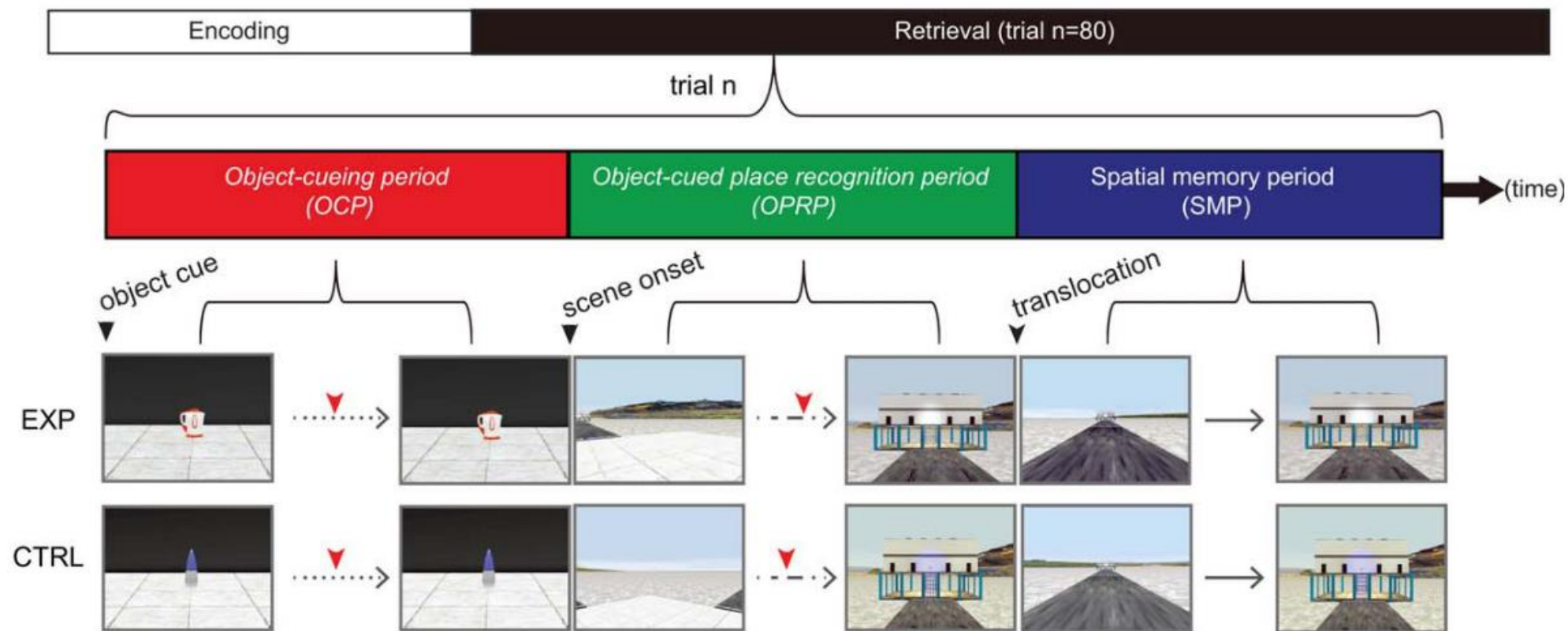
fmri raw data

UDK log parsing program code

UDK log file  
(A=study session, B=test session)

# Trial 구조 확인

: CTRL trial + EXP trial



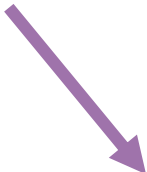
# CTRL trials timestamp 확인

timestamp x timestamp.adj_timeframe x timestamp.control_rt x	
1x1 struct 13개 필드 포함	
필드 ▲	값
pause	1x15 cell
studyend	1x1 cell
timeframe	1x1306 cell
adj_timeframe	1x1258 cell
enter_12	1x2 cell
enter_03	1x2 cell
enter_09	1x4 cell
enter_06	1x2 cell
control_rt	40x2 cell
OCPR_rt	40x2 cell
acc_control	1x40 cell
acc_OCPR	1x24 cell
wrong_OCPR	1x16 cell



timestamp.acc_control x					
timestamp.acc_control					
	1	2	3	4	5
1	0622.06	0701.43	0778.31	0858.03	0974.02
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

CTRL trials, **Correct**  
Trial end timestamp



timestamp x timestamp.control_rt x					
timestamp.control_rt					
	1	2	3	4	5
1	586.3800	622.0600			
2	667.5900	701.4300			
3	745.9700	778.3100			
4	824.3800	858.0300			
5	937.9100	974.0200			
6	1.0163e+03	1.0485e+03			
7	1.0947e+03	1.1254e+03			
8	1.1675e+03	1.1988e+03			
9	1.2816e+03	1.3139e+03			
10	1.3572e+03	1.3898e+03			
11	1.4356e+03	1.4668e+03			
12	1.5140e+03	1.5451e+03			

CTRL trials, **All**  
Trial start – Trial end

# EXP trials timestamp 확인

timestamp	timestamp.adj_timeframe	timestamp.control_rt
1x1 struct 13개 필드 포함		
필드	값	
pause	1x15 cell	
studyend	1x1 cell	
timeframe	1x1306 cell	
adj_timeframe	1x1258 cell	
enter_12	1x2 cell	
enter_03	1x2 cell	
enter_09	1x4 cell	
enter_06	1x2 cell	
control_rt	40x2 cell	
OCPR_rt	40x2 cell	
acc_control	1x40 cell	
acc_OCPR	1x24 cell	
wrong_OCPR	1x16 cell	

timestamp.acc_OCPR					
timestamp.acc_OCPR					
	1	2	3	4	5
1	0661.73	0738.22	0816.90	0896.27	1010.50
2					
3					
4					
5					

EXP trials, **Correct**  
Trial end timestamp

timestamp.wrong_OCPR					
timestamp.wrong_OCPR					
	1	2	3	4	5
1	1429.53	1506.12	1843.18	2105.99	2590.45
2					
3					
4					
5					

EXP trials, **Wrong**  
Trial end timestamp

timestamp	timestamp.OCPR_rt				
timestamp.OCPR_rt					
	1	2	3	4	5
1	628.3700	661.7300			
2	706.7700	738.2200			
3	785.1600	816.9000			
4	863.5700	896.2700			
5	979.8900	1.0105e+03			
6	1.0555e+03	1.0883e+03			
7	1.1311e+03	1.1620e+03			
8	1.2039e+03	1.2362e+03			
9	1.3208e+03	1.3518e+03			
10	1.3964e+03	1.4295e+03			
11	1472	1.5061e+03			
12	1.5504e+03	1.5809e+03			
13	1.6605e+03	1.6919e+03			

EXP trials, **All**  
Trial start – Trial end

# Encoding phase timestamp 확인

timestamp		timestamp.adj_timeframe	timestamp.control_rt
1x1 struct 13개 필드 포함			
필드	값		
pause	1x15 cell		
studyend	1x1 cell		
timeframe	1x1306 cell		
adj timeframe	1x1258 cell		
enter_12	1x2 cell		
enter_03	1x2 cell		
enter_09	1x4 cell		
enter_06	1x2 cell		
control_rt	40x2 cell		
OCPR_rt	40x2 cell		
acc_control	1x40 cell		
acc_OCPR	1x24 cell		
wrong_OCPR	1x16 cell		



timestamp.enter\_03

timestamp.enter\_03

	1	2	3	4
1	0188.53	0290.38		
2				
3				
4				
5				
6				
<				

timestamp.enter\_06

timestamp.enter\_06

	1	2	3	4
1	0332.53	0432.41		
2				
3				
4				
5				
6				
<				

timestamp.enter\_09

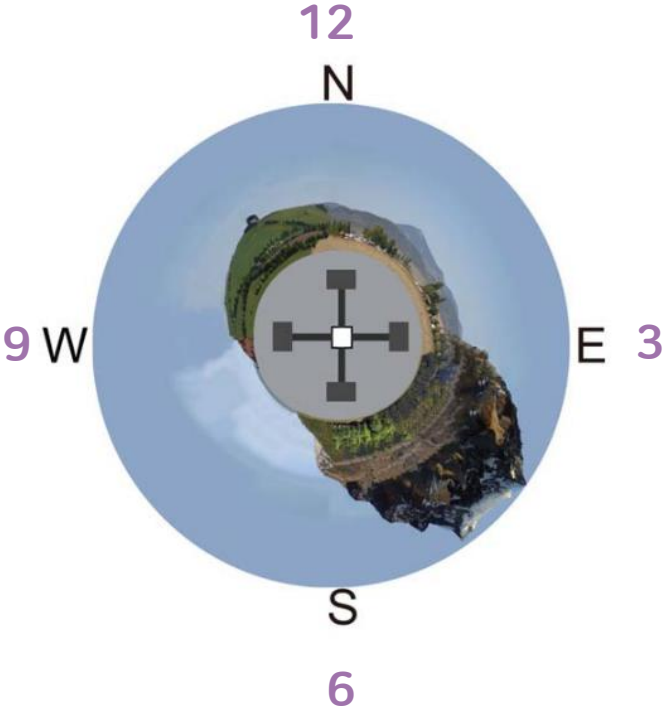
timestamp.enter\_09

	1	2	3	4
1	0313.29	0329.85	0446.91	0546.43
2				
3				
4				
5				
6				
<				

timestamp.enter\_12

timestamp.enter\_12

	1	2	3	4
1	0073.99	0175.28		
2				
3				



# MR timestamp 확인

timestamp		timestamp.adj_timeframe	timestamp.control_rt
1x1 struct 13개 필드 포함			
필드 ▲	값		
pause	1x15 cell		
studyend	1x1 cell		
timeframe	1x1306 cell		
adj_timeframe	1x1258 cell		
enter_12	1x2 cell		
enter_03	1x2 cell		
enter_09	1x4 cell		
enter_06	1x2 cell		
control_rt	40x2 cell		
OCPR_rt	40x2 cell		
acc_control	1x40 cell		
acc_OCPR	1x24 cell		
wrong_OCPR	1x16 cell		



fMRI에서 2.8초마다 나오는 신호 + manual input(키보드 5)

timestamp.timeframe											
timestamp.timeframe											
	1	2	3	4	5	6	7	8	9	10	11
1	0057.71	0060.51	0063.31	0066.11	0068.90	0071.71	0074.52	0077.30	0080.11	0082.91	0085.70
2											
3											
timestamp											
timestamp.adj_timeframe											
timestamp.adj_timeframe											
	1	2	3	4	5	6	7	8	9	10	11
1	0068.90	0071.71	0074.52	0077.30	0080.11	0082.91	0085.70	0088.50	0091.31	0094.11	0096.91
2											

Manual input 제거하고 실제 MR image가 있는 timestamp만 모음



# Position info : raw data parsing 필요

frame_num	
frame_num.epoch3_movement_trace	
1x1 struct 10개 필드 포함	
필드	값
ocpr	1306x1 double
control	1306x1 double
ocpr_num	40x39 double
control_num	40x39 double
rev_control	1258x1 double
rev_ocpr	1258x1 double
epoch3_movement_trace	783x4 double
adj_ocpr_num	40x39 double
epoch2_trace	40x1 double
adj_control_num	40x39 double



frame_num		frame_num.epoch3_movement_trace			
frame_num.epoch3_movement_trace					
	1	2	3	4	5
166	569.3310	-582.3460	9	1	
167	620.9730	-561.0280	9	1	
168	729.4840	-507.3200	9	1	
169	865.0810	-386.8620	9	1	
170	1.0457e+03	-211.6080	9	1	
171	1.2743e+03	10.4140	9	1	
172	1.5477e+03	275.9450	9	1	
173	1.8856e+03	568.4760	9	1	
174	2.3111e+03	822.9350	9	1	
175	2.8514e+03	966.6250	9	1	
176	3.4727e+03	1.0457e+03	9	1	
177	3.5472e+03	1.0543e+03	9	1	
178	-1147	1080	10	0	
179	-1147	1080	10	0	
180	-1147	1080	10	0	
181	-1147	1080	10	0	
182	-1147	1080	10	0	
183	-1147	1080	10	0	
184	-1147	1080	10	0	
185	-1147	1080	10	0	
186	-1147	1080	10	0	
187	-1.1243e+03	1.0868e+03	10	0	
188	-1.0393e+03	1.1038e+03	10	0	
189	-891.7100	1.1153e+03	10	0	
190	-674.7690	1.1173e+03	10	0	
191	-394.2330	1.0995e+03	10	0	
192	-52.4080	1.0622e+03	10	0	
193	354.9140	1.0477e+03	10	0	
194	833.2680	1.0337e+03	10	0	
195	1.3762e+03	1.0179e+03	10	0	
196	1.9859e+03	1.0001e+03	10	0	
197	2.6266e+03	981.4470	10	0	
198	3.2649e+03	962.8390	10	0	
199	3.5482e+03	948.7950	10	0	
200	565	-584	11	0	
201	565	-584	11	0	
202	565	-584	11	0	

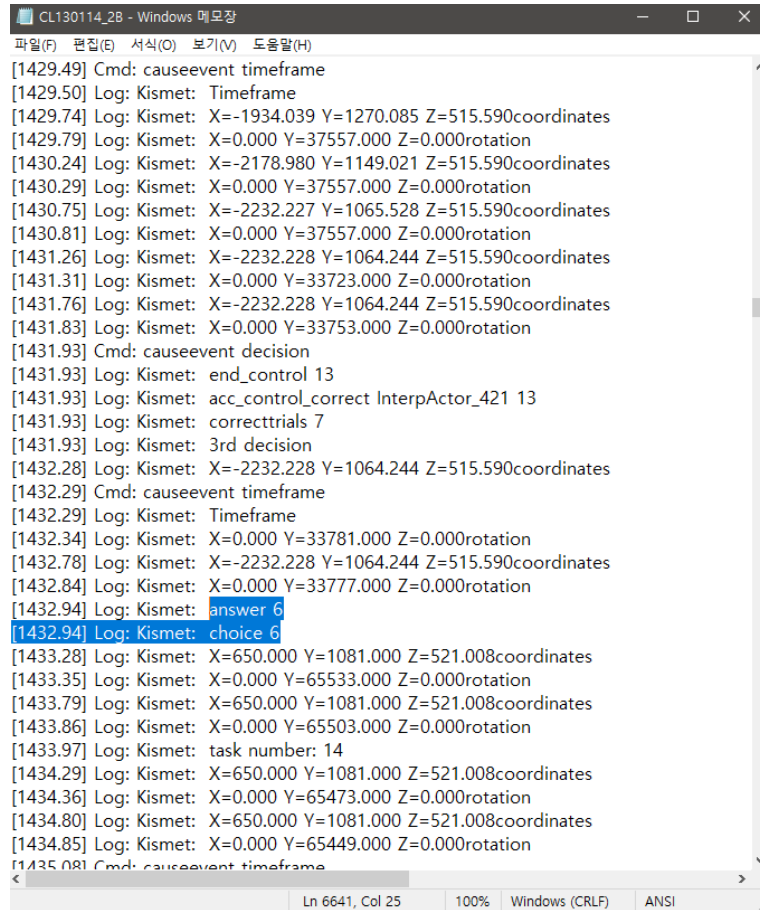
- 각 position 값의 timestamp는?
- 각 timestamp에서 head direction은?
- 각 trial의 correct answer / player choice 정보?

X? Y? EXP Correctness?  
Trial?

# Position info : raw data parsing에 필요한 raw data와 parsing code 모두 있음

- 각 timestamp의 position 및 head direction
- 각 trial의 correct answer / player choice

## Raw UDK log



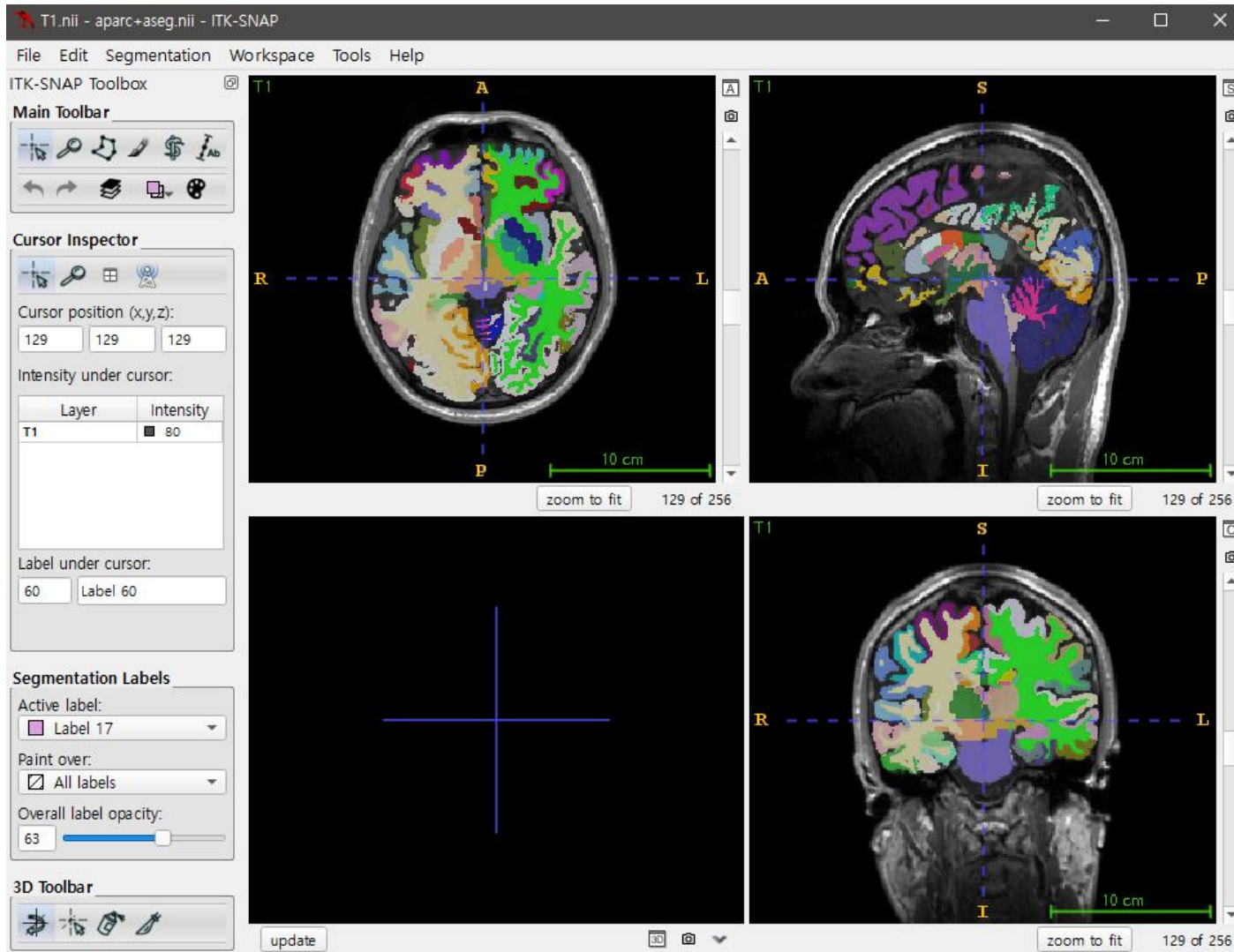
```
CL130114_2B - Windows 메모장
파일(F) 편집(E) 서식(O) 보기(V) 도움말(H)
[1429.49] Cmd: causeevent timeframe
[1429.50] Log: Kismet: Timeframe
[1429.74] Log: Kismet: X=-1934.039 Y=1270.085 Z=515.590coordinates
[1429.79] Log: Kismet: X=0.000 Y=37557.000 Z=0.000rotation
[1430.24] Log: Kismet: X=-2178.980 Y=1149.021 Z=515.590coordinates
[1430.29] Log: Kismet: X=0.000 Y=37557.000 Z=0.000rotation
[1430.75] Log: Kismet: X=-2232.227 Y=1065.528 Z=515.590coordinates
[1430.81] Log: Kismet: X=0.000 Y=37557.000 Z=0.000rotation
[1431.26] Log: Kismet: X=-2232.228 Y=1064.244 Z=515.590coordinates
[1431.31] Log: Kismet: X=0.000 Y=33723.000 Z=0.000rotation
[1431.76] Log: Kismet: X=-2232.228 Y=1064.244 Z=515.590coordinates
[1431.83] Log: Kismet: X=0.000 Y=33753.000 Z=0.000rotation
[1431.93] Cmd: causeevent decision
[1431.93] Log: Kismet: end_control 13
[1431.93] Log: Kismet: acc_control_correct InterpActor_421 13
[1431.93] Log: Kismet: correcttrials 7
[1431.93] Log: Kismet: 3rd decision
[1432.28] Log: Kismet: X=-2232.228 Y=1064.244 Z=515.590coordinates
[1432.29] Cmd: causeevent timeframe
[1432.29] Log: Kismet: Timeframe
[1432.34] Log: Kismet: X=0.000 Y=33781.000 Z=0.000rotation
[1432.78] Log: Kismet: X=-2232.228 Y=1064.244 Z=515.590coordinates
[1432.84] Log: Kismet: X=0.000 Y=33777.000 Z=0.000rotation
[1432.94] Log: Kismet: answer 6
[1432.94] Log: Kismet: choice 6
[1433.28] Log: Kismet: X=650.000 Y=1081.000 Z=521.008coordinates
[1433.35] Log: Kismet: X=0.000 Y=65533.000 Z=0.000rotation
[1433.79] Log: Kismet: X=650.000 Y=1081.000 Z=521.008coordinates
[1433.86] Log: Kismet: X=0.000 Y=65503.000 Z=0.000rotation
[1433.97] Log: Kismet: task number: 14
[1434.29] Log: Kismet: X=650.000 Y=1081.000 Z=521.008coordinates
[1434.36] Log: Kismet: X=0.000 Y=65473.000 Z=0.000rotation
[1434.80] Log: Kismet: X=650.000 Y=1081.000 Z=521.008coordinates
[1434.85] Log: Kismet: X=0.000 Y=65449.000 Z=0.000rotation
[1435.08] Cmd: causeevent timeframe
Ln 6641, Col 25 100% Windows (CRLF) ANSI
```

## Log parsing code



```
analyzeudklogB0114_2_ver2.m
1 %analyzeudklog.m
2 close all;clear all;clc
3 %IMPORTFILE(FILETOREAD1)
4 % Imports data from the specified file
5 % FILETOREAD1: file to read
6
7 % Auto-generated by MATLAB on 27-Aug-2012 12:13:16
8 filename='CL130114_2B';
9 fileToRead1=strcat(filename, '.log');
10 DELIMITER = ',';
11 HEADERLINES = 22511;
12 no_trials=80;
13
14 % Import the file
15 rawData = importdata(fileToRead1, DELIMITER, HEADERLINES);
16
17 % For some simple files (such as a CSV or JPEG files), IMPORTDATA might
18 % return a simple array. If so, generate a structure so that the output
19 % matches that from the Import Wizard.
20 [~,name] = fileparts(fileToRead1);
21 log_data=rawData;
22
23 %%Get timestamps
24 no_lines=max(size(log_data));
25 count_pause=0;count_timeframe=0; count_12=0; count_03=0; count_06=0; count_09=0;
26
27 for i=1:no_lines
28 k=strcmp(log_data{i}, 'Pause');
29 if ~isempty(k)
30 count_pause=count_pause+1;
31 line_index_pause(count_pause)=i;
32 string=log_data{i};
33 timestamp.pause(count_pause)=string(2:8);
```

# MR data : SPM 사용한 trial parsing 필요



- Freesurfer 사용한 segmentation 완료
- SPM을 사용한 pre-processing 완료
- Mat file로 MR image가 변환된 것이 없어서,  
pre-processing 완료된 파일을 SPM으로 변환 필요  
(timestamp \* voxel 형태)

# Analysis plan

~11/09

**Behavior data UDK log parsing**하여,

timestamp별 position, head direction, trial info 표시된 array 생성

~11/11

**MR data SPM processing** 진행,

timestamp\*voxel 형태의 MR BOLD activity array 생성

~11/15

**Trial별 hippocampus activity average,**

trial - correctness - reaction time - HPC activity로 구성된 array 생성  
correct / wrong trial에 따른 hippocampus activity 분포 확인