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Sleep scoring using Neuroscore

DOI

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Protocol status: Working

We use this protocol and it's working



Created: February 22, 2024

Last Modified: September 23, 2024

Protocol Integer ID: 95633

Keywords: ASAPCRN, behavior, sleep, neuroscore, neuroscore analysis of sleep data, sleep scoring, sleep data, using neuroscore analysis, using neuroscore

Funders Acknowledgements:

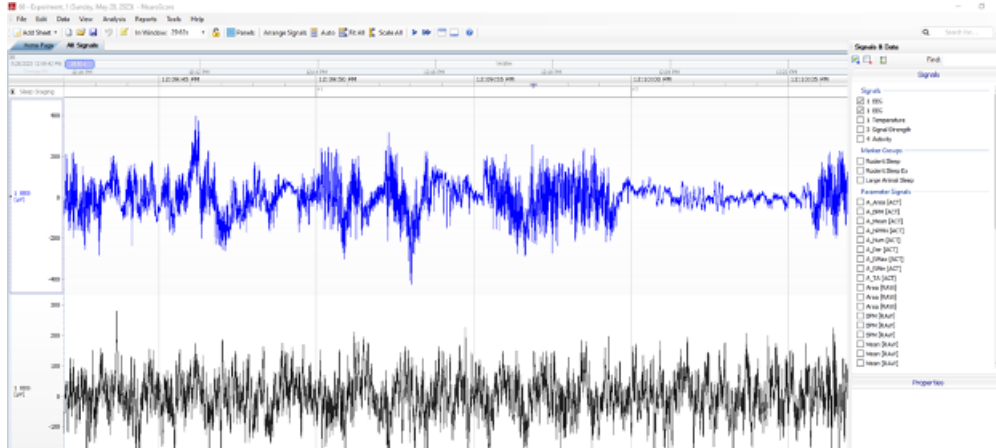
Aligning Science Across Parkinson's

Grant ID: 020608

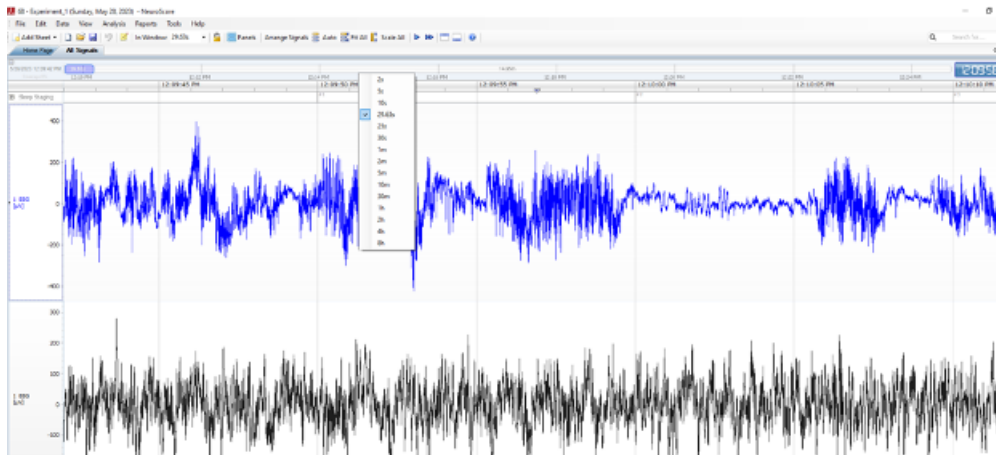
Abstract

Analysis of sleep data using Neuroscore v.30

- 1 Open the file using File – Open Recording – Browse – Open
- 2 Remove unused signals using the right side tools “signal & data” and unselect all markers:

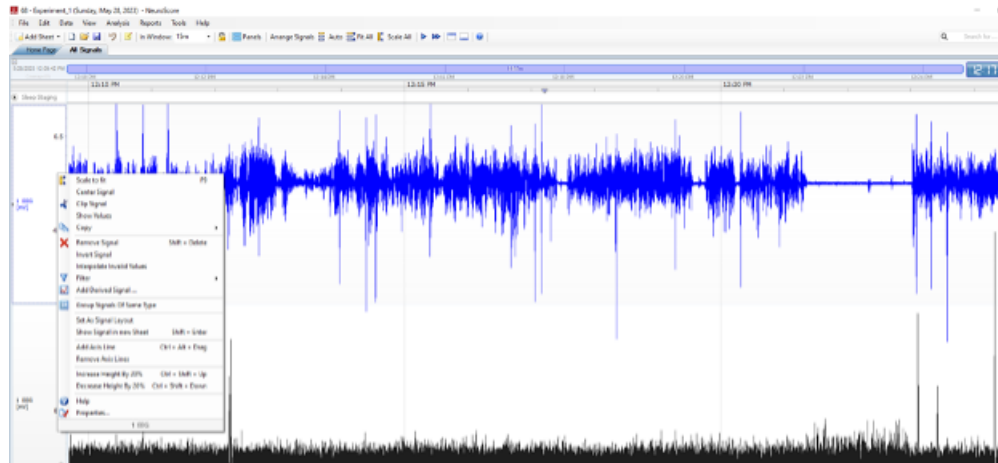


- 3 Identify the EEG and EMG signals by adjusting the time windows:

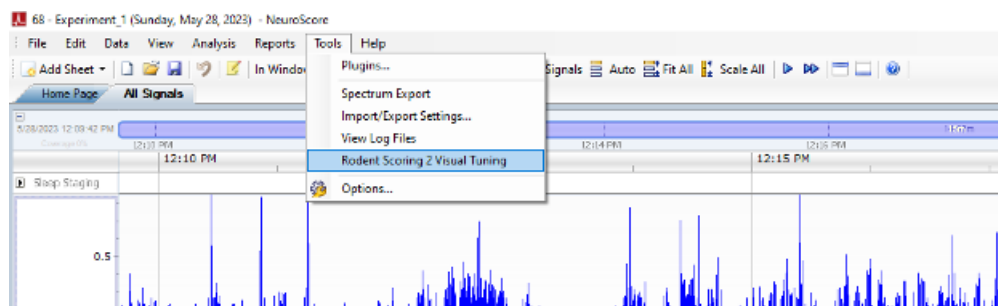


- 4 If the signal is unusable, just move to another recording. Here the top signal is EMG and bottom is EEG. You can see clear changes in EMG corresponding to movement and nice oscillation in EEG, the signal is as expected.

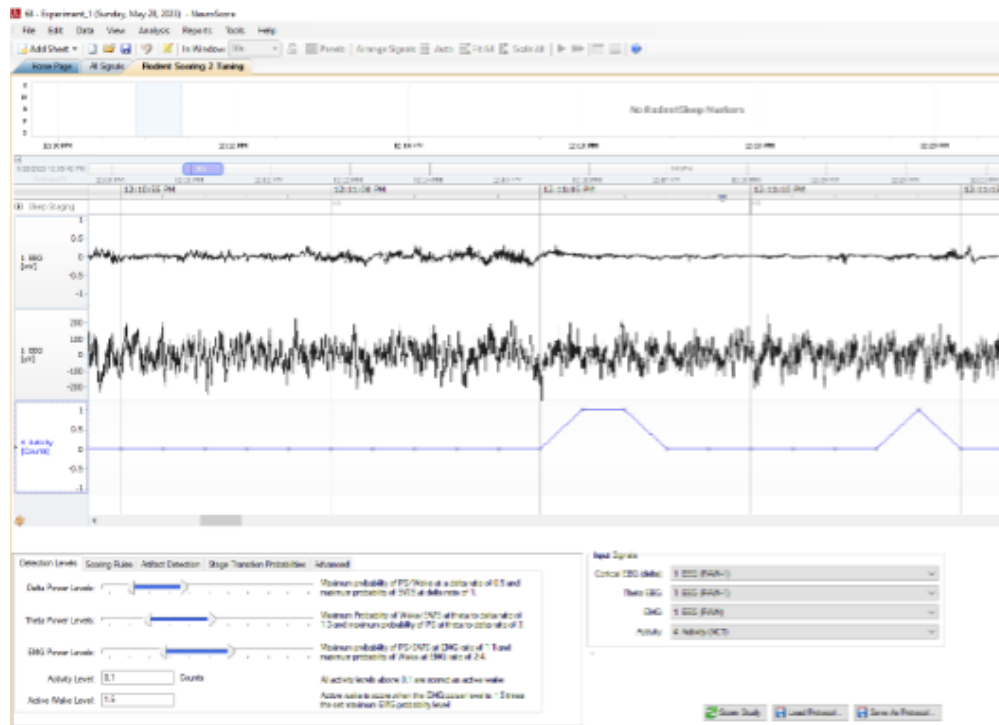
- 5 You can adjust the vertical scale for each signal using the right-click on the axis and scale to fit.



- 6 Once the signal is identified, you can proceed to sleep scoring. The built-in sleep scoring allows perfect scoring of frontal cortex EEG/EMG.



- 7 In inputs signal, select EEG channel for both Cortical EEG and theta EEG, EMG for EMG and activity for activity. Adjust the vertical scale to confirm the selection of correct signals.



8 In scoring rules, select "score active wake as awake."

The screenshot shows the 'Scoring Rules' tab in the Rodent SleepEx software. It contains several checkboxes and input fields. The 'Score active wake as awake' checkbox is checked. Below it, there is a checkbox for 'Discriminate SWS to SWS1 and SWS2. By checking this box, Rodent SleepEx should be used for reporting and viewing options'. There are input fields for 'Wake Percentage (W+AW): 50', 'Active Wake Percentage: 30', 'Paradoxical Sleep Percentage: 50', 'SWS Percentage: 50', 'SWS1 Percentage: 50', and 'SWS2 Percentage: 70'. At the bottom, there is a text field for 'Score Percentage Order: Active Wake -> Wake -> Paradoxical -> SWS'.

9 In artifact detection, select the threshold based on the signal of the recordings. Move the time windows to avoid cutting off signals.

Detection Levels Scoring Rules **Artifact Detection** Stage Transition Probabilities Advanced

☒ Detect EEG Artifacts
 EEG Artifact Threshold: mV

☒ Detect EMG Artifacts
 EMG Artifact Threshold: mV

10 Select the stage transition as below:

Detection Levels Scoring Rules **Artifact Detection** **Stage Transition Probabilities** Advanced

From/To	Wake	Active Wake	SWS	Paradoxical Sleep
Wake	100	100	90	90
Active Wake	100	100	80	70
SWS	80	80	100	90
Paradoxical Sleep	70	70	80	100

11 In advanced, select delta oscillation starting at 0.5Hz.

Detection Levels Scoring Rules **Artifact Detection** **Stage Transition Probabilities** **Advanced**

Power Bands

Delta: to Hz

Theta: to Hz

Contribution Factors

Delta EEG Contribution Factor: %

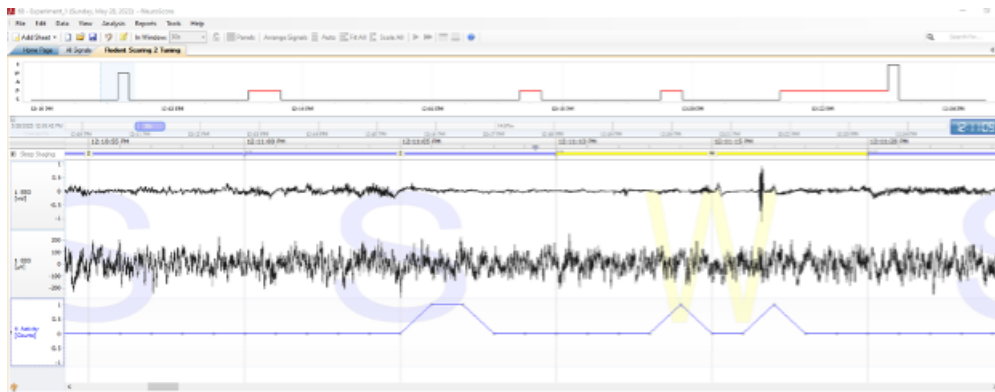
Theta/Delta EEG Contribution Factor: %

EMG Contribution Factor: %

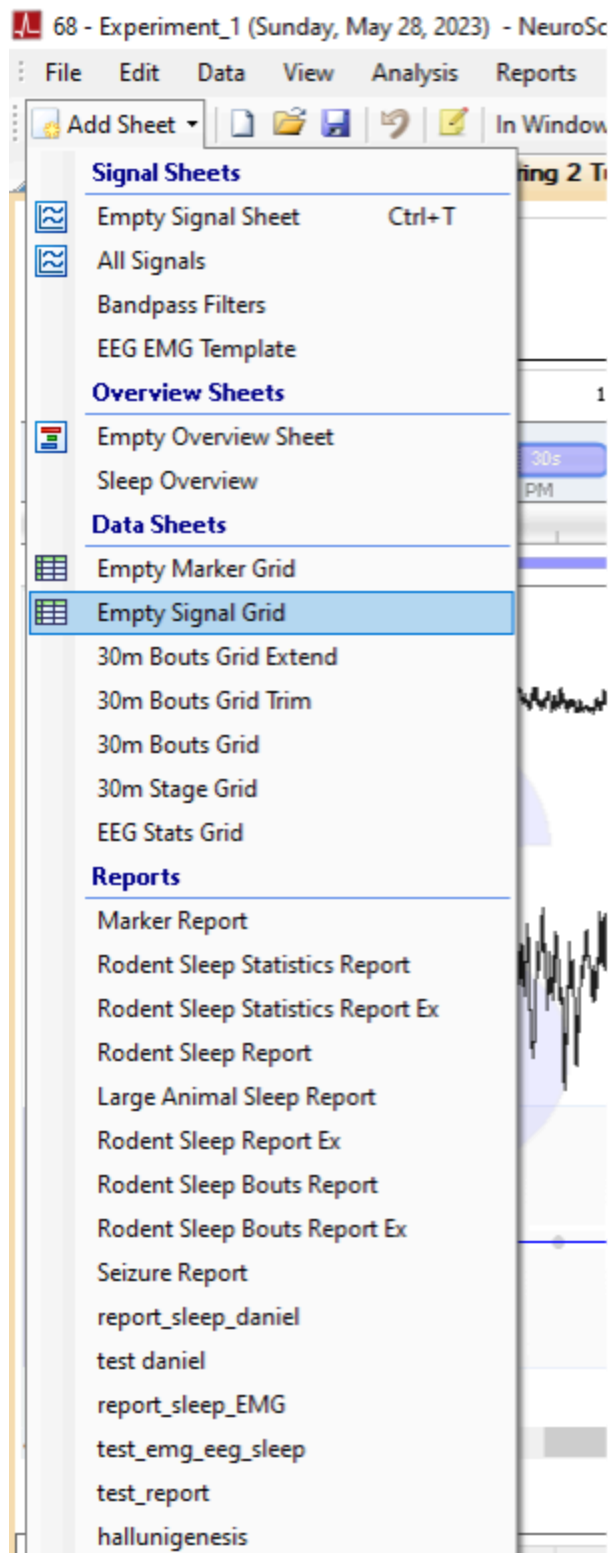
12 Press score study.

No protocol has been executed in this session			Cancel
Detector	Status	Message	
Rodent Scoring 2	Finished	01:28:08 - Input Cortical EEG = 1 EEG (RAW-1, Channel #489) 01:28:08 - Input Theta EEG = 1 EEG (RAW-1, Channel #489) 01:28:08 - Input Neck EMG = 1 EEG (RAW, Channel #488) 01:28:08 - Input Activity = 4 Activity (ACT, Channel #491) 01:28:08 - Created scoring: Rodent Scoring 2 01:28:08 - Success! Initializing detector 'Rodent Scoring 2 (v. 1.0.0)' 01:28:09 - 0.34s	

13 You should have sleep scoring for all your recordings on top of the signals.



14 Extract the data.



15 Select the data that need to be analyzed:



- time stamps normally 20s
- sleep scoring S is NREM, P is REM, W is awake and X is artifact
- select add column – select EMG channel – select statistical Root Mean Square



68 - Experiment_1 (Sunday, May 28, 2023) - NeuroScore

File Edit Data View Analysis Reports Tools Help

Add Sheet In Window: 30s

Home Page All Signals Rodent Scoring 2 Tuning **Signal Grid**

Add Column Remove Properties Reorder Columns Export

Epoch# [20s]	Time Stamp	Rodent Sleep	1 EEG (RMS, 20s) V	
0	12:10:00 PM	S	6.671e-05	
1	12:10:20 PM	S	6.718e-05	
2	12:10:40 PM	S	6.769e-05	
3	12:11:00 PM	S	6.734e-05	
4	12:11:20 PM	S	6.953e-05	
5	12:11:40 PM	S	6.629e-05	
6	12:12:00 PM	S	0.0001223	
7	12:12:20 PM	S	6.463e-05	
8	12:12:40 PM	S	6.391e-05	
9	12:13:00 PM	P	6.376e-05	
10	12:13:20 PM	P	6.406e-05	
11	12:13:40 PM	S	6.145e-05	
12	12:14:00 PM	S	6.052e-05	
13	12:14:20 PM	S	6.674e-05	
14	12:14:40 PM	S	6.99e-05	
15	12:15:00 PM	S	7.195e-05	
16	12:15:20 PM	S	7.006e-05	
17	12:15:40 PM	S	7.325e-05	
18	12:16:00 PM	S	6.749e-05	
19	12:16:20 PM	S	6.777e-05	
20	12:16:40 PM	S	6.946e-05	
21	12:17:00 PM	S	6.961e-05	
22	12:17:20 PM	P	6.77e-05	
23	12:17:40 PM	S	6.035e-05	
24	12:18:00 PM	S	6.221e-05	
25	12:18:20 PM	S	6.292e-05	
26	12:18:40 PM	S	6.807e-05	
27	12:19:00 PM	S	7.233e-05	
28	12:19:20 PM	P	7.083e-05	
29	12:19:40 PM	P	6.787e-05	
30	12:20:00 PM	S	6.729e-05	
31	12:20:20 PM	S	6.475e-05	
32	12:20:40 PM	S	6.801e-05	
33	12:21:00 PM	S	6.871e-05	
34	12:21:20 PM	P	8.361e-05	
35	12:21:40 PM	P	8.134e-05	
36	12:22:00 PM	P	9.025e-05	
37	12:22:20 PM	P	8.028e-05	
38	12:22:40 PM	P	8.914e-05	
39	12:23:00 PM	X	7.454e-05	
40	12:23:20 PM	S	6.641e-05	



- 16 Copy this to excel:
- a) Using the time you can extract the total number of sleep events, number of Awake, REM and NREM and thus express it onto %

		mean RMS EMG	2.96749E-05			2.96749E-05				5.80219E-05				4.22059E-05
		STED RMS EMG	6.85335E-05			6.85335E-05				5.02039E-05				9.88279E-05
		NUMBER EVENTS	4172			4172				4172				4172
		COUNT IF SLEEP	2343			2343				2343				2343
		COUNT IF rem	735			735				735				735
		COUNT IF Wake	1090			1090				1090				1090
		% TIME SLEEP	56.16011505			56.16011505				56.16011505				56.16011505
		% TIME rem	17.61744966			17.61744966				17.61744966				17.61744966
		%TIME Awake	26.22243528			26.22243528				26.22243528				26.22243528
		number of RBD events	0			0				0				0
		% OF rbd EVENT	0			0				0				0
		start light	7:00:00 AM			7:00:00 AM				7:00:00 AM				7:00:00 AM
		start dark	7:00:00 PM			7:00:00 PM				7:00:00 PM				7:00:00 PM
		Sleep event during light	1253			1253				1253				1253
		Wake event during light	440			440				440				440
		REM event during light	319			319				319				319
		Sleep event during dark	1090			1090				1090				1090
		Wake event during dark	650			650				650				650
		REM event during dark	416			416				416				416

mouse n:	5:20:00 PM S	1.12E-05	-2.73E-05	mouse n:	5:20:00 PM S	5.12E-05	1.63E-05	mouse n:	5:20:00 PM S	2.45E-05	0.82	mouse n:	5:20:00 PM S	3.58E-05	-0.28	mouse number:
2	5:20:00 PM S	0.97E-05	-2.88E-05	5	5:20:00 PM S	5.95E-05	2.11E-05	8	5:20:00 PM S	3.48E-05	1.82	5	5:20:00 PM S	3.33E-05	-0.29	5
	5:20:40 PM S	1.18E-05	-2.69E-05	6	5:20:40 PM S	4.22E-05	1.09E-05	9	5:20:40 PM S	2.42E-05	0.79	6	5:20:40 PM S	1.05E-05	-0.52	6
	5:21:00 PM S	1.08E-05	-2.78E-05	7	5:21:00 PM S	2.74E-05	3.24E-05	10	5:21:00 PM S	1.13E-05	-0.36	7	5:21:00 PM S	3.62E-05	-0.36	7
	5:21:20 PM S	1.08E-05	-2.75E-05	8	5:21:20 PM S	2.40E-05	5.07E-05	11	5:21:20 PM S	1.47E-05	-0.13	8	5:21:20 PM S	3.25E-05	-0.50	8
	5:21:40 PM S	0.88E-05	-2.62E-05	9	5:21:40 PM S	2.19E-05	-1.07E-05	12	5:21:40 PM S	9.77E-06	-0.83	9	5:21:40 PM S	1.70E-05	-0.25	9
	5:22:00 PM S	0.72E-05	-2.61E-05	10	5:22:00 PM S	3.98E-05	-2.94E-05	13	5:22:00 PM S	2.13E-05	0.51	10	5:22:00 PM S	3.29E-05	-0.30	10
	5:22:20 PM S	0.44E-05	-2.89E-05	11	5:22:20 PM S	3.54E-05	-4.97E-05	14	5:22:20 PM S	9.77E-06	-0.20	11	5:22:20 PM S	3.08E-05	-0.53	11

- b) You can extract the % of time in dark/light phase based on the timestamps
- c) You can average/stddev EMG signal and thus express it as a z score

=AVERAGE(I:I)

	F	G	H	I	J
				mean RMS EMG	2.96749E-05
				STED RMS EMG	6.85335E-05
				NUMBER EVENTS	4172
				COUNT IF SLEEP	2343
				COUNT IF rem	735
				COUNT IF Wake	1090
				% TIME SLEEP	56.16011505
				% TIME rem	17.61744966
				%TIME Awake	26.22243528
				number of RBD events	0
				% OF rbd EVENT	0
				start light	7:00:00 AM
				start dark	7:00:00 PM
				Sleep event during light	1253
				Wake event during light	440
				REM event during light	319
				Sleep event during dark	1090
				Wake event during dark	650
				REM event during dark	416



=STDEV(I:I)

Formula Bar		H	I	J	K
			mean RMS EMG	2.96749E-05	
			STED RMS EMG	6.85335E-05	
			NUMBER EVENTS	4172	
			COUNT IF SLEEP	2343	
			CONT IF rem	735	
			COUNT IF Wake	1090	
			% TIME SLEEP	56.16011505	
			% TIME rem	17.61744966	
			%TIME Awake	26.22243528	
			number of RBD events	0	
			% OF rbd EVENT	0	
			start light	7:00:00 AM	
			start dark	7:00:00 PM	
			Sleep event during light	1253	
			Wake event during light	440	
			REM event during light	319	
			Sleep event during dark	1090	
			Wake event during dark	650	
			REM event during dark	416	

Using the z-score of the EMG, you can detect significant increase ($SD > 2SD$) during REM events. This will be the rem sleep behavior disorders events.



=COUNTIFS(H\$23:H\$1048576,"P",J\$23:J\$1048576,">2")

COUNTIFS(criteria_range1, criteria1, [criteria_range2, criteria2], [criteria_range3, ...])					K	L
			mean RMS EMG	2.96749E-05		
			STED RMS EMG	6.85335E-05		
			NUMBER EVENTS	4172		
			COUNT IF SLEEP	2343		
			CONT IF rem	735		
			COUNT IF Wake	1090		
			% TIME SLEEP	56.16011505		
			% TIME rem	17.61744966		
			%TIME Awake	26.22243528		
			number of RBD events	H\$1048576,		
			% OF rbd EVENT	0		
			start light	7:00:00 AM		
			start dark	7:00:00 PM		
			Sleep event during light	1253		
			Wake event during light	440		
			REM event during light	319		
			Sleep event during dark	1090		
			Wake event during dark	650		
			REM event during dark	416		
mouse n	5:20:00 PM	S	1.10E-05	-2.72E-01	mouse n	##### W
2	5:20:20 PM	S	9.97E-06	-2.88E-01	3	##### W
	5:20:40 PM	S	1.16E-05	-2.64E-01		##### W
	5:21:00 PM	S	1.06E-05	-2.78E-01		##### W
	5:21:20 PM	S	1.08E-05	-2.75E-01		##### W
	5:21:40 PM	S	9.68E-06	-2.92E-01		##### W
	5:22:00 PM	S	9.72E-06	-2.91E-01		##### W
	5:22:20 PM	S	9.44E-06	-2.95E-01		##### S
	5:22:40 PM	S	9.60E-06	-2.93E-01		##### S

$=(J10*100)/J5$

	F	G	H	I	J	K	L	M
				mean RMS EMG	2.96749E-05			
				STED RMS EMG	6.85335E-05			
				NUMBER EVENTS	4172			
				COUNT IF SLEEP	2343			
				CONT IF rem	735			
				COUNT IF Wake	1090			
				% TIME SLEEP	56.16011505			
				% TIME rem	17.61744966			
				%TIME Awake	26.22243528			
				number of RBD events	0			
				% OF rbd EVENT	0			
				start light	7:00:00 AM			
				start dark	7:00:00 PM			
				Sleep event during light	1253			
				Wake event during light	440			
				REM event during light	319			
				Sleep event during dark	1090			
				Wake event during dark	650			
				REM event during dark	416			