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🌐 Sleep scoring using Neuroscore

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Kapliitt Protocols



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ABSTRACT

Analysis of sleep data using Neuroscore v.30

OPEN  ACCESS



DOI:

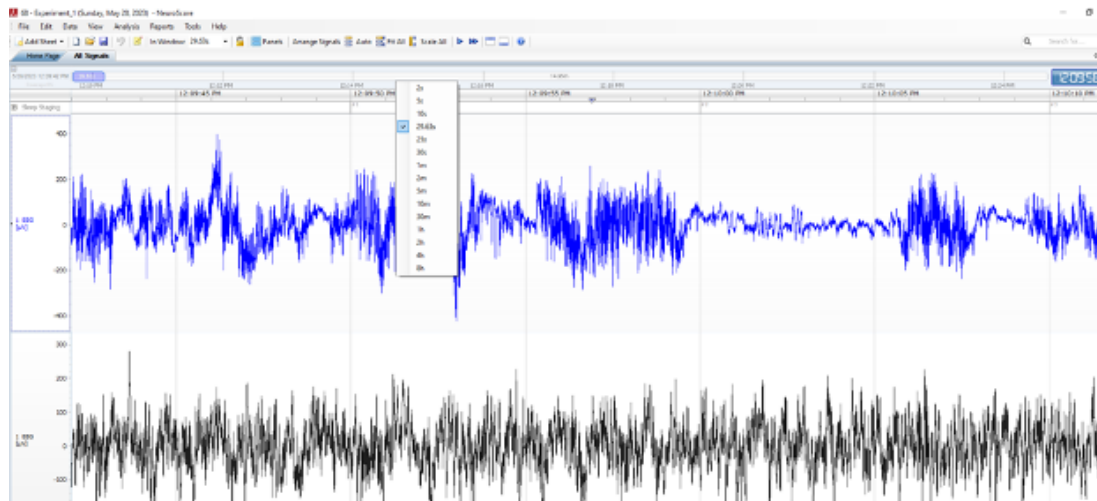
dx.doi.org/10.17504/protocols.io.81wgbxjdolpk/v1

Protocol Citation: daniel.dautan daniel, Per Svenningsson 2024. Sleep scoring using Neuroscore. **protocols.io** <https://dx.doi.org/10.17504/protocols.io.81wgbxjdolpk/v1>

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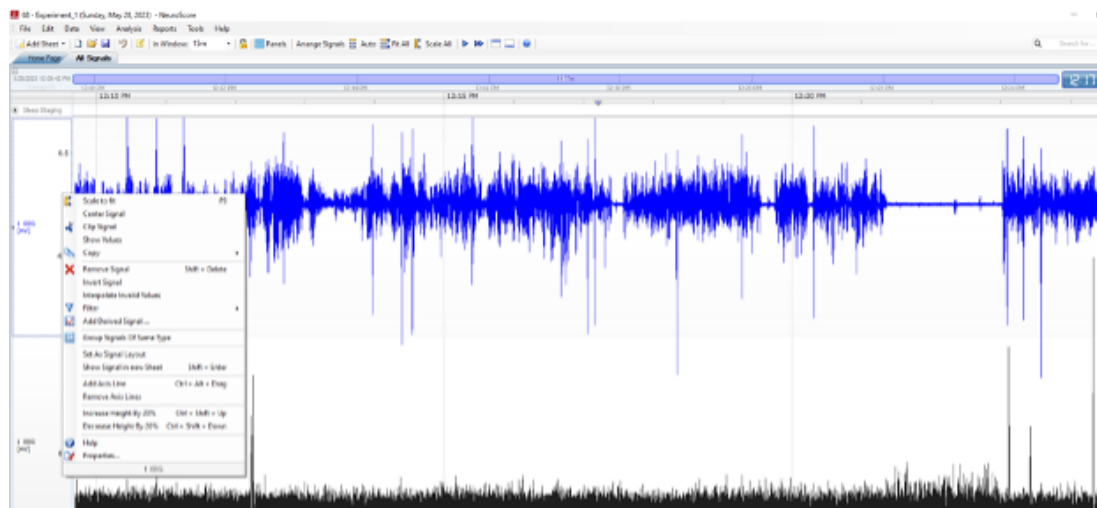
Protocol status: Working
We use this protocol and it's working

Created: Feb 22, 2024

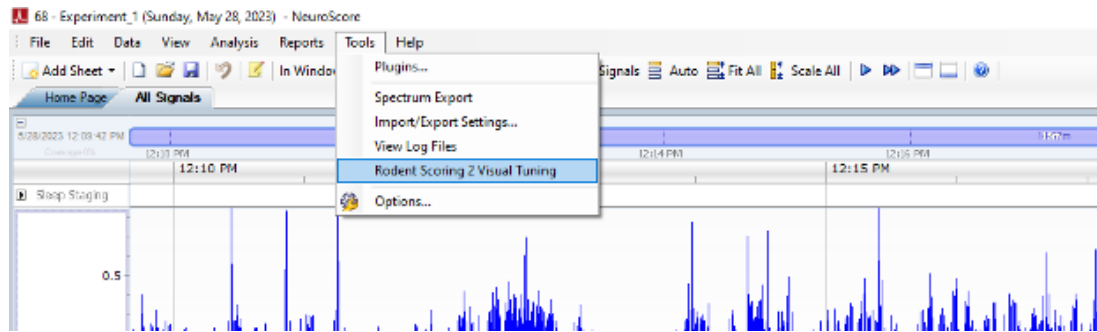


4 If the signal is unusable, just move to another recording. Here the top signal is EMG and bottom is EEG. You can see clear changes in EMG corresponding to movement and nice oscillation in EEG, the signal is as expected.

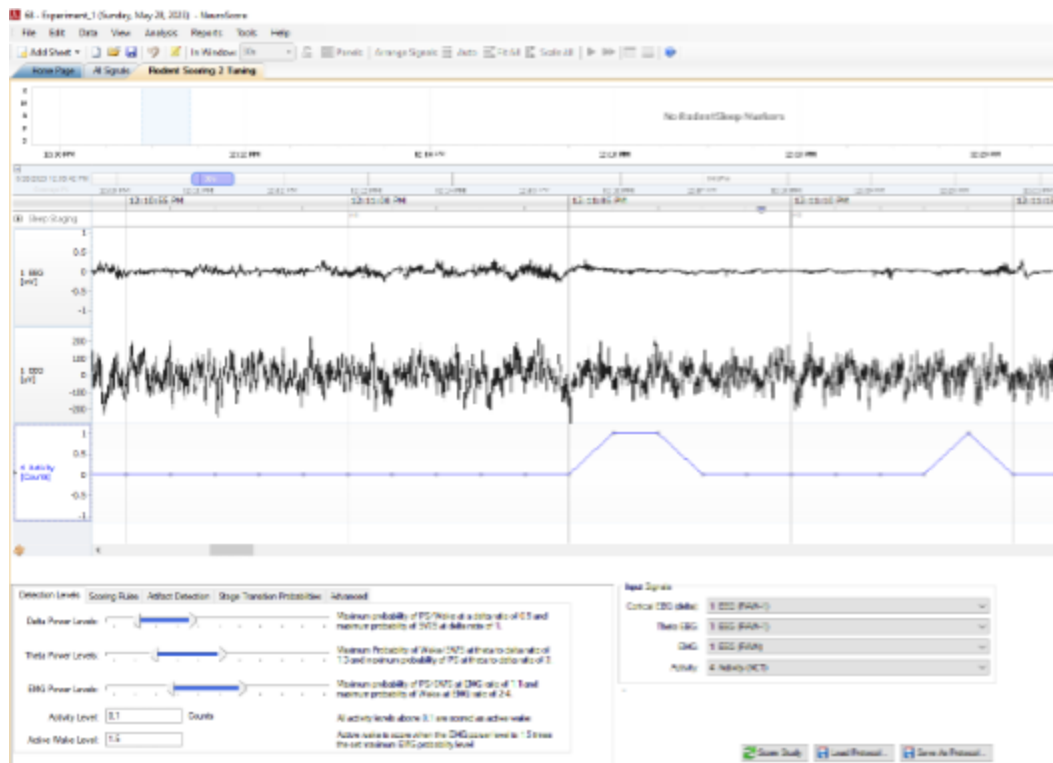
5 You can adjust the vertical scale for each signal using the right+click on the axis and scale to fit.



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."

Detection Levels

Scoring Rules

Artifact Detection

Stage Transition Probabilities

Advanced

☒ Score active wake as wake

☐ Discriminate SWS to SWS1 and SWS2. By checking this box, Rodent SleepEx should be used for reporting and viewing options

Wake Percentage (W+AW):

50

SWS Percentage:

50

Active Wake Percentage:

30

SWS1 Percentage:

50

Paradoxical Sleep Percentage:

50

SWS2 Percentage:

70

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:

0.5

 mV

☒ Detect EMG Artifacts

EMG Artifact Threshold:

0.5

 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 | <div>100</div> | <div>100</div> | <div>90</div> | <div>90</div> |
| Active Wake | <div>100</div> | <div>100</div> | <div>80</div> | <div>70</div> |
| SWS | <div>80</div> | <div>80</div> | <div>100</div> | <div>90</div> |
| Paradoxical Sleep | <div>70</div> | <div>70</div> | <div>80</div> | <div>100</div> |

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: %

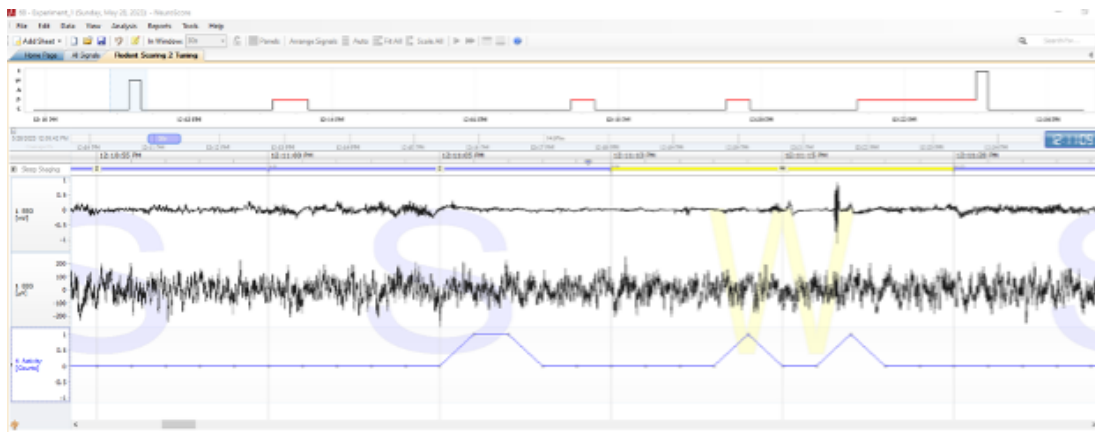
EMG Contribution Factor: %

12 Press score study.

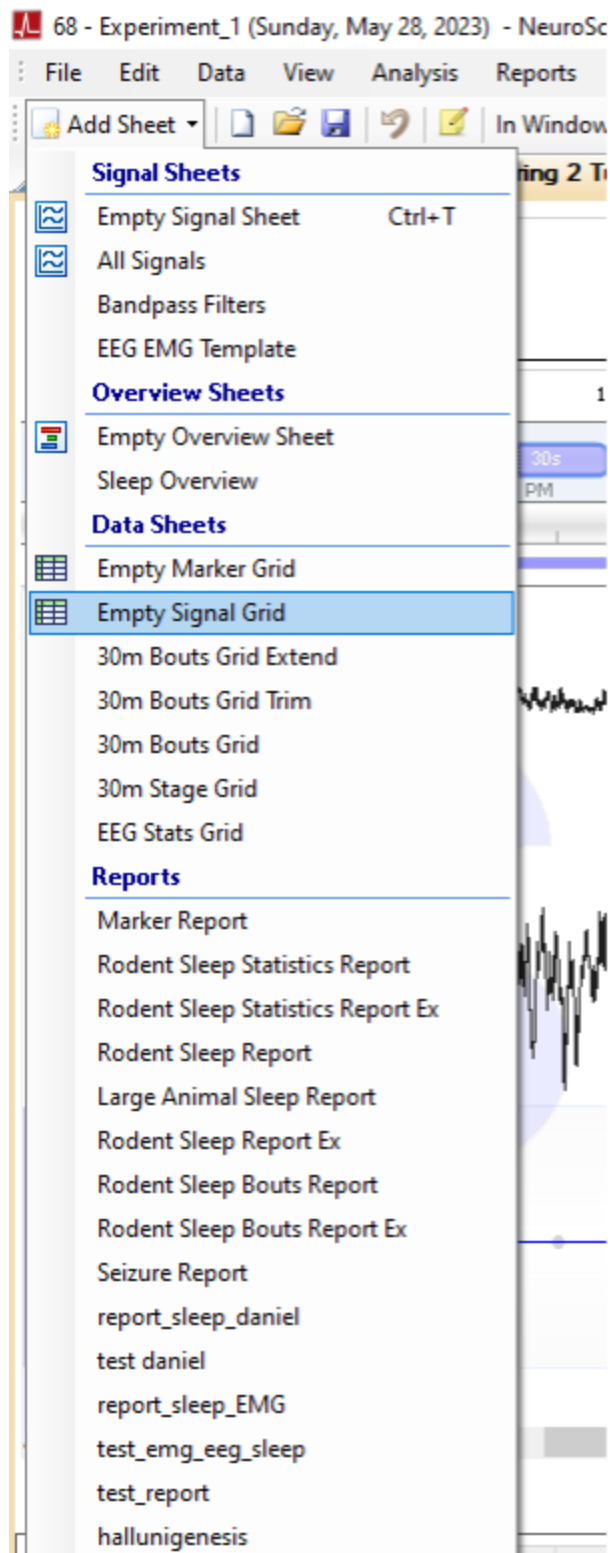
No protocol has been executed in this session [Cancel]

| 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 - Successful 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 |

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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 | 2.06740E-05 | | | 2.57441E-05 | | | 1.85213E-05 | | | 4.23320E-05 | |
| | | STED RMS EMG | 6.85359E-05 | | | 1.68848E-05 | | | 1.03259E-05 | | | 9.88278E-05 | |
| | | NUMBER EVENTS | 4172 | | | 4172 | | | 4172 | | | 4172 | |
| | | COUNT IF SLEEP | 2343 | | | 2788 | | | 3077 | | | 3150 | |
| | | COUNT IF AWAKE | 735 | | | 318 | | | 441 | | | 424 | |
| | | % TIME SLEEP | 59.58011505 | | | 66.5704938 | | | 73.530954 | | | 75.01988832 | |
| | | % TIME AWAKE | 17.61744085 | | | 17.54550618 | | | 16.5704405 | | | 20.16039187 | |
| | | % TIME REM | 26.22243528 | | | 26.05465505 | | | 23.6750048 | | | 34.81325931 | |
| | | number of RBD events | 0 | | | 2 | | | 3 | | | 2 | |
| | | % OF RBD EVENT | 0 | | | 0.318455888 | | | 0.486272509 | | | 0.471888125 | |
| | | 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 | | | 1333 | | | 1351 | | | 1357 | |
| | | Wake event during light | 440 | | | 519 | | | 285 | | | 254 | |
| | | REM event during light | 319 | | | 373 | | | 297 | | | 223 | |
| | | Sleep event during dark | 1090 | | | 948 | | | 1126 | | | 1070 | |
| | | Wake event during dark | 690 | | | 588 | | | 589 | | | 553 | |
| | | REM event during dark | 438 | | | 345 | | | 264 | | | 231 | |
| mouse n: | 5:20:00 PM S | 1.12E-05 | -2.71E-03 | mouse n: | 5:12:00 | 1.81E-05 | mouse n: | 5:45:00 | 0.82 | mouse n: | 5:58:00 | -0.28 | mouse number |
| 2 | 5:20:20 PM S | 0.87E-06 | -2.68E-03 | 5 | 5:05:00 | 2.12E-05 | 4 | 5:40:00 | 1.82 | 5 | 5:30:00 | -0.29 | 0 |
| | 5:20:40 PM S | 1.18E-05 | -2.04E-03 | | 4:22:00 | 1.09E-05 | | 2:42:00 | 0.79 | | 1:05:00 | -0.32 | |
| | 5:21:00 PM S | 1.08E-05 | -2.78E-03 | | 2:40:00 | 2.34E-05 | | 1:23:00 | -0.56 | | 1:02:00 | -0.26 | |
| | 5:21:20 PM S | 1.08E-05 | -2.75E-03 | | 2:40:00 | 5.07E-03 | | 1:47:00 | -0.15 | | 1:22:00 | -0.50 | |
| | 5:21:40 PM S | 0.88E-05 | -2.02E-03 | | 2:10:00 | -1.07E-03 | | 0:77:00 | -0.01 | | 1:52:00 | -0.25 | |
| | 5:22:00 PM S | 0.72E-06 | -2.81E-03 | | 1:08:00 | -2.94E-03 | | 2:13:00 | 0.51 | | 1:38:00 | -0.30 | |
| | 5:22:20 PM S | 0.44E-06 | -2.05E-03 | | 1:04:00 | -4.97E-03 | | 0:77:00 | -0.25 | | 1:08:00 | -0.32 | |

- b) You can extract the % of time in dark/light phase based on the timestamps
- c) You can average/stdev EMG signal and thus express is 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 |
| | | | | 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 |

=STDEV(I:I)

| Formula Bar | | H | I | J | K |
|-------------|---|---|--------------------------|-------------|---|
| | F | | | | |
| | | | 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 | I |
|--|---|---|---|--------------------------|-------------|---|---|---|
| | | | | 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 | | | |
| | | | | | | | | |