

# lme\_mods

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## Packages & Setup

```
# install.packages(c("tidyverse", "purrr", "R.matlab", "readxl", "dplyr"))
library(readxl);
library(purrr)
library(tidyverse);
```

```
## -- Attaching core tidyverse packages ----- tidyverse 2.0.0 --
## v dplyr      1.1.4      v readr      2.1.5
## v forcats    1.0.0      v stringr   1.5.1
## v ggplot2     3.5.0      v tibble    3.2.1
## v lubridate  1.9.3      v tidyr     1.3.1
## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()     masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```
library(tibble)
library(knitr);
library(gtsummary)
```

```
## #StandWithUkraine
```

```
library(kableExtra)
```

```
##
## Attaching package: 'kableExtra'
##
## The following object is masked from 'package:dplyr':
##
##      group_rows
```

```
library(lme4)
```

```
## Loading required package: Matrix
##
## Attaching package: 'Matrix'
```

```
##
## The following objects are masked from 'package:tidyr':
##
##   expand, pack, unpack
```

## GTSUMMARY THEME

```
# my_theme <-
#   list(
#     "tbl_summary-str:default_con_type" = "continuous2",
#     "tbl_summary-str:continuous_stat" = c(
#       "{median} ({p25} - {p75})",
#       "{mean} ({sd})",
#       "{min} - {max}"
#     ),
#     "tbl_summary-str:categorical_stat" = "{n} / {N} ({p}%)",
#     "style_number-arg:big.mark" = "",
#     "tbl_summary-fn:percent_fun" = function(x) style_percent(x, digits = 3)
#   )
# my_theme <-
#   list()
# gtsummary::set_gtsummary_theme(my_theme)
gtsummary::set_gtsummary_theme(theme_gtsummary_journal("jama"))
```

```
## Setting theme 'JAMA'
## Setting theme 'JAMA'
```

```
# reset_gtsummary_theme()
```

## load table

```
# excel_dir <-"M:/jsalminen/GitHub/par_EEGProcessing/src/_data/MIM_dataset/_studies/04162024_MIM_YA0AN8"
excel_dir <-"M:/jsalminen/GitHub/par_EEGProcessing/src/_data/MIM_dataset/_studies/04232024_MIM_YA0AN89_"
eegt <- read_excel(excel_dir,sheet="Sheet1")
```

get unique entries

```
clusters = unique(eegt$cluster_id);
subjects = unique(eegt$subj_char);
groups = unique(eegt$group_char);
kin_measures = c('mean_APexc_COV', 'mean_APexc_mean', 'mean_MLexc_COV', 'mean_MLexc_mean', 'mean_StepDur', 'r');
eeg_measures = c('theta_avg_power', 'alpha_avg_power', 'beta_avg_power', 'aperiodic_exp', 'aperiodic_offset');
```

get speeds only

```
eegt <- filter_at(eegt,vars('cond_char'), any_vars(. %in% c('0.25','0.5','0.75','1.0')))
flat_speeds = unique(eegt$cond_char)
eegt$cond_char <- as.numeric(eegt$cond_char)
eegt$speed_cond_num <- as.numeric(eegt$cond_char)
eegt <- mutate(eegt,across(c('subj_char'), factor))
```

get terrains only (if applicable)

```
# eegt <- filter_at(eegt,vars('cond_char'), any_vars(. %in% c('flat','low','med','high')))
# eegt <- filter_at(eegt,vars('cond_char'), any_vars(. %in% c('high')))
# eegt$terr_ord_speed <- cut(eegt$speed_ms, 4, ordered = TRUE)
```

convert speeds to ordered & groups to factors

```
eegt <- mutate(eegt,across(c('group_char'), factor))
eegt$speed_ord <- cut(eegt$cond_char, 4, ordered = TRUE)
eegt <- mutate(eegt,across(c('cond_char'), factor))
head(eegt)
```

```
## # A tibble: 6 x 139
##   speed_ms subj_id subj_cl_ind subj_char comp_id design_id cond_id cond_char
##   <dbl> <chr>      <dbl> <fct>      <dbl> <chr>      <chr> <fct>
## 1     1.2  5          1 H1011         4 2          1     0.25
## 2     0.69 8          2 H1017         3 2          1     0.25
## 3     0.51 10         3 H1019         4 2          1     0.25
## 4     0.76 11         4 H1020         6 2          1     0.25
## 5     0.59 12         5 H1022         6 2          1     0.25
## 6     0.8  15         6 H1027         3 2          1     0.25
## # i 131 more variables: group_id <chr>, cluster_id <chr>, aperiodic_exp <dbl>,
## #   aperiodic_offset <dbl>, central_freq_1 <dbl>, central_freq_2 <dbl>,
## #   central_freq_3 <dbl>, power_1 <dbl>, power_2 <dbl>, power_3 <dbl>,
## #   r_squared <dbl>, theta_avg_power <dbl>, alpha_avg_power <dbl>,
## #   beta_avg_power <dbl>, theta_1 <dbl>, theta_2 <dbl>, theta_3 <dbl>,
## #   theta_4 <dbl>, theta_5 <dbl>, theta_6 <dbl>, theta_7 <dbl>, theta_8 <dbl>,
## #   'alpha_1' <dbl>, 'alpha_2' <dbl>, 'alpha_3' <dbl>, 'alpha_4' <dbl>, ...
```

```
eegt$group_speed_code = paste(eegt$group_char,eegt$cond_char,sep="_")
```

LME EEG ~ 1+speed+group+speed:group

Cluster:	3								
Characteristic	EEG Theta			EEG Alpha			EEG Beta		
	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value
speed_cond_num	0.16 (-0.03 to 0.34)	0.092	0.14	-0.24 (-0.52 to 0.05)	0.11	0.32	-0.24 (-0.41 to -0.07)	0.006	0.018
group_char		0.086	0.14		0.81	>0.99		0.52	0.52
H1000's	—			—			—		
H2000's	-0.46 (-0.87 to -0.05)			0.38 (-0.84 to 1.6)			0.38 (-0.30 to 1.0)		
H3000's	-0.22 (-0.63 to 0.19)			0.29 (-0.94 to 1.5)			0.07 (-0.60 to 0.74)		
speed_cond_num * group_char		0.64	0.64		>0.99	>0.99		0.43	0.52
speed_cond_num * H2000's	-0.07 (-0.34 to 0.20)			-0.02 (-0.45 to 0.40)			-0.02 (-0.26 to 0.23)		
speed_cond_num * H3000's	0.06 (-0.21 to 0.33)			0.00 (-0.42 to 0.42)			-0.15 (-0.40 to 0.10)		
subj_char.sd (Intercept)	0.56 (NA to NA)			1.8 (NA to NA)			1.0 (NA to NA)		
Residual.sd Observation	0.23 (NA to NA)			0.37 (NA to NA)			0.21 (NA to NA)		

<sup>1</sup> CI = Confidence Interval

<sup>2</sup> False discovery rate correction for multiple testing

Cluster:	4								
Characteristic	EEG Theta			EEG Alpha			EEG Beta		
	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value
speed_cond_num	0.00 (-0.17 to 0.17)	0.99	0.99	-0.61 (-1.1 to -0.16)	0.007	0.022	-0.22 (-0.45 to 0.02)	0.067	0.067
group_char		0.42	0.99		0.74	0.88		0.062	0.067
H1000's	—			—			—		
H2000's	-0.38 (-0.95 to 0.19)			-0.15 (-1.9 to 1.6)			0.95 (0.02 to 1.9)		
H3000's	-0.19 (-0.70 to 0.31)			-0.60 (-2.2 to 0.95)			0.84 (0.01 to 1.7)		
speed_cond_num * group_char		0.78	0.99		0.88	0.88		0.011	0.034
speed_cond_num * H2000's	0.10 (-0.18 to 0.38)			-0.03 (-0.76 to 0.70)			-0.21 (-0.59 to 0.17)		
speed_cond_num * H3000's	0.05 (-0.20 to 0.30)			-0.16 (-0.81 to 0.49)			-0.52 (-0.85 to -0.18)		
subj_char.sd (Intercept)	0.81 (NA to NA)			2.5 (NA to NA)			1.4 (NA to NA)		
Residual.sd Observation	0.24 (NA to NA)			0.62 (NA to NA)			0.32 (NA to NA)		

<sup>1</sup> CI = Confidence Interval

<sup>2</sup> False discovery rate correction for multiple testing

Cluster:	5								
Characteristic	EEG Theta			EEG Alpha			EEG Beta		
	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value
speed_cond_num	0.23 (0.01 to 0.45)	0.039	0.12	-0.30 (-0.69 to 0.09)	0.13	0.39	-0.16 (-0.41 to 0.10)	0.23	0.23
group_char		0.092	0.14		0.48	0.57		0.024	0.072
H1000's	—			—			—		
H2000's	-0.53 (-1.1 to 0.02)			-0.97 (-2.6 to 0.65)			0.56 (-0.71 to 1.8)		
H3000's	-0.47 (-0.97 to 0.03)			-0.20 (-1.7 to 1.3)			1.6 (0.44 to 2.8)		
speed_cond_num * group_char		0.87	0.87		0.57	0.57		0.054	0.081
speed_cond_num * H2000's	0.05 (-0.28 to 0.39)			0.22 (-0.38 to 0.83)			-0.04 (-0.43 to 0.35)		
speed_cond_num * H3000's	-0.04 (-0.35 to 0.27)			-0.10 (-0.65 to 0.45)			-0.41 (-0.77 to -0.05)		
subj_char.sd (Intercept)	0.75 (NA to NA)			2.4 (NA to NA)			1.9 (NA to NA)		
Residual.sd Observation	0.29 (NA to NA)			0.51 (NA to NA)			0.33 (NA to NA)		

<sup>1</sup> CI = Confidence Interval

<sup>2</sup> False discovery rate correction for multiple testing

Cluster:	6								
Characteristic	EEG Theta			EEG Alpha			EEG Beta		
	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value
speed_cond_num	0.05 (-0.21 to 0.32)	0.69	0.69	-0.41 (-0.85 to 0.03)	0.065	0.19	-0.10 (-0.32 to 0.13)	0.41	0.41
group_char		<0.001	<0.001		0.13	0.20		0.029	0.088
H1000's	—			—			—		
H2000's	0.68 (0.12 to 1.2)			-1.2 (-2.4 to 0.04)			-0.52 (-1.2 to 0.13)		
H3000's	1.5 (1.0 to 2.1)			-0.86 (-2.0 to 0.28)			-0.82 (-1.4 to -0.21)		
speed_cond_num * group_char		0.028	0.043		0.59	0.59		0.38	0.41
speed_cond_num * H2000's	-0.03 (-0.43 to 0.37)			-0.03 (-0.69 to 0.62)			-0.23 (-0.57 to 0.10)		
speed_cond_num * H3000's	-0.46 (-0.83 to -0.08)			-0.30 (-0.91 to 0.32)			-0.15 (-0.47 to 0.17)		
subj_char.sd (Intercept)	0.85 (NA to NA)			2.0 (NA to NA)			1.1 (NA to NA)		
Residual.sd Observation	0.39 (NA to NA)			0.64 (NA to NA)			0.33 (NA to NA)		

<sup>1</sup> CI = Confidence Interval

<sup>2</sup> False discovery rate correction for multiple testing

Cluster:	7								
Characteristic	EEG Theta			EEG Alpha			EEG Beta		
	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value
speed_cond_num	0.07 (-0.09 to 0.22)	0.40	0.40	-0.17 (-0.67 to 0.34)	0.52	0.78	-0.39 (-0.66 to -0.12)	0.004	0.013
group_char		0.033	0.10		0.83	0.83		0.019	0.028
H1000's	—			—			—		
H2000's	-0.57 (-1.0 to -0.13)			-0.52 (-2.4 to 1.3)			1.0 (-0.01 to 2.1)		
H3000's	-0.31 (-0.70 to 0.07)			0.01 (-1.6 to 1.6)			1.3 (0.34 to 2.2)		
speed_cond_num * group_char		0.24	0.36		0.21	0.62		0.48	0.48
speed_cond_num * H2000's	0.20 (-0.04 to 0.45)			-0.57 (-1.4 to 0.26)			-0.26 (-0.70 to 0.18)		
speed_cond_num * H3000's	0.13 (-0.09 to 0.35)			-0.60 (-1.3 to 0.13)			-0.15 (-0.54 to 0.24)		
subj_char.sd (Intercept)	0.63 (NA to NA)			2.7 (NA to NA)			1.6 (NA to NA)		
Residual.sd Observation	0.22 (NA to NA)			0.72 (NA to NA)			0.38 (NA to NA)		

<sup>1</sup> CI = Confidence Interval

<sup>2</sup> False discovery rate correction for multiple testing

Cluster:	8								
Characteristic	EEG Theta			EEG Alpha			EEG Beta		
	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value
speed_cond_num	0.43 (0.19 to 0.67)	<0.001	0.001	-0.19 (-0.60 to 0.23)	0.38	0.57	-0.06 (-0.25 to 0.13)	0.55	0.55
group_char		0.14	0.20		0.091	0.27		0.024	0.071
H1000's	—			—			—		
H2000's	-0.58 (-1.2 to 0.01)			-0.31 (-1.2 to 0.60)			0.69 (-0.05 to 1.4)		
H3000's	-0.44 (-1.0 to 0.17)			0.74 (-0.21 to 1.7)			1.0 (0.27 to 1.8)		
speed_cond_num * group_char		0.90	0.90		>0.99	>0.99		0.12	0.18
speed_cond_num * H2000's	-0.08 (-0.42 to 0.26)			-0.01 (-0.61 to 0.58)			-0.28 (-0.56 to -0.01)		
speed_cond_num * H3000's	-0.06 (-0.41 to 0.29)			0.01 (-0.61 to 0.63)			-0.13 (-0.41 to 0.15)		
subj_char.sd (Intercept)	0.84 (NA to NA)			1.3 (NA to NA)			1.1 (NA to NA)		
Residual.sd Observation	0.29 (NA to NA)			0.52 (NA to NA)			0.23 (NA to NA)		

<sup>1</sup> CI = Confidence Interval

<sup>2</sup> False discovery rate correction for multiple testing

Cluster:	9								
Characteristic	EEG Theta			EEG Alpha			EEG Beta		
	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value
speed_cond_num	0.18 (-0.05 to 0.41)	0.12	0.37	-0.28 (-0.69 to 0.13)	0.18	0.28	-0.15 (-0.35 to 0.05)	0.14	0.24
group_char		0.30	0.46		0.13	0.28		0.16	0.24
H1000's	—			—			—		
H2000's	-0.29 (-0.74 to 0.15)			0.13 (-1.4 to 1.7)			0.86 (-0.03 to 1.8)		
H3000's	-0.30 (-0.76 to 0.15)			-1.5 (-3.1 to 0.17)			0.25 (-0.67 to 1.2)		
speed_cond_num * group_char		0.74	0.74		0.88	0.88		0.45	0.45
speed_cond_num * H2000's	0.11 (-0.23 to 0.46)			0.08 (-0.54 to 0.70)			-0.19 (-0.49 to 0.11)		
speed_cond_num * H3000's	0.12 (-0.24 to 0.47)			0.16 (-0.48 to 0.81)			-0.10 (-0.41 to 0.20)		
subj_char.sd (Intercept)	0.61 (NA to NA)			2.5 (NA to NA)			1.4 (NA to NA)		
Residual.sd Observation	0.31 (NA to NA)			0.57 (NA to NA)			0.27 (NA to NA)		

<sup>1</sup> CI = Confidence Interval

<sup>2</sup> False discovery rate correction for multiple testing

Cluster:	10								
Characteristic	EEG Theta			EEG Alpha			EEG Beta		
	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value
speed_cond_num	0.12 (-0.12 to 0.37)	0.33	0.33	-0.10 (-0.35 to 0.14)	0.40	0.71	-0.19 (-0.34 to -0.05)	0.011	0.032
group_char		0.026	0.078		0.79	0.79		0.65	0.74
H1000's	—			—			—		
H2000's	-0.83 (-1.4 to -0.21)			-0.02 (-0.64 to 0.60)			0.31 (-0.37 to 0.99)		
H3000's	-0.54 (-1.2 to 0.12)			-0.22 (-0.88 to 0.44)			0.21 (-0.52 to 0.93)		
speed_cond_num * group_char		0.20	0.29		0.47	0.71		0.74	0.74
speed_cond_num * H2000's	0.34 (-0.03 to 0.70)			0.22 (-0.14 to 0.58)			-0.04 (-0.26 to 0.19)		
speed_cond_num * H3000's	0.11 (-0.29 to 0.50)			0.15 (-0.24 to 0.54)			-0.09 (-0.33 to 0.15)		
subj_char.sd (Intercept)	0.96 (NA to NA)			0.97 (NA to NA)			1.1 (NA to NA)		
Residual.sd Observation	0.35 (NA to NA)			0.35 (NA to NA)			0.21 (NA to NA)		

<sup>1</sup> CI = Confidence Interval

<sup>2</sup> False discovery rate correction for multiple testing

Cluster:	11								
Characteristic	EEG Theta			EEG Alpha			EEG Beta		
	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value
speed_cond_num	0.08 (-0.14 to 0.29)	0.50	0.65	-0.06 (-0.54 to 0.43)	0.82	0.82	-0.12 (-0.40 to 0.16)	0.41	0.61
group_char		0.13	0.40		0.15	0.22		0.68	0.68
H1000's	—			—			—		
H2000's	-0.23 (-0.92 to 0.46)			-1.1 (-2.9 to 0.69)			-0.37 (-1.2 to 0.47)		
H3000's	0.48 (-0.19 to 1.1)			0.73 (-0.98 to 2.4)			-0.22 (-1.0 to 0.58)		
speed_cond_num * group_char		0.65	0.65		0.002	0.005		0.063	0.19
speed_cond_num * H2000's	0.05 (-0.29 to 0.38)			0.05 (-0.69 to 0.80)			0.05 (-0.38 to 0.48)		
speed_cond_num * H3000's	-0.11 (-0.43 to 0.21)			-1.1 (-1.8 to -0.42)			-0.42 (-0.83 to 0.00)		
subj_char.sd (Intercept)	0.90 (NA to NA)			2.4 (NA to NA)			1.1 (NA to NA)		
Residual.sd Observation	0.26 (NA to NA)			0.57 (NA to NA)			0.33 (NA to NA)		

<sup>1</sup> CI = Confidence Interval

<sup>2</sup> False discovery rate correction for multiple testing

Cluster:	12								
Characteristic	EEG Theta			EEG Alpha			EEG Beta		
	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value
speed_cond_num	-0.14 (-0.36 to 0.09)	0.23	0.35	-0.41 (-0.81 to -0.01)	0.042	0.12	-0.16 (-0.33 to 0.01)	0.064	0.10
group_char		0.78	0.78		0.079	0.12		0.85	0.85
H1000's	—			—			—		
H2000's	-0.19 (-0.72 to 0.35)			1.6 (0.04 to 3.1)			-0.17 (-0.90 to 0.57)		
H3000's	-0.04 (-0.52 to 0.44)			1.3 (-0.13 to 2.7)			-0.17 (-0.83 to 0.49)		
speed_cond_num * group_char		0.037	0.11		0.93	0.93		0.034	0.10
speed_cond_num * H2000's	0.46 (0.10 to 0.82)			0.09 (-0.55 to 0.72)			0.24 (-0.03 to 0.51)		
speed_cond_num * H3000's	0.10 (-0.22 to 0.42)			0.10 (-0.47 to 0.67)			-0.12 (-0.37 to 0.12)		
subj_char.sd (Intercept)	0.63 (NA to NA)			2.0 (NA to NA)			0.94 (NA to NA)		
Residual.sd Observation	0.26 (NA to NA)			0.47 (NA to NA)			0.20 (NA to NA)		

<sup>1</sup> CI = Confidence Interval

<sup>2</sup> False discovery rate correction for multiple testing

Cluster:	13								
Characteristic	EEG Theta			EEG Alpha			EEG Beta		
	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value
speed_cond_num	0.27 (0.05 to 0.49)	0.015	0.046	-0.07 (-0.51 to 0.37)	0.75	0.78	-0.05 (-0.29 to 0.19)	0.69	0.69
group_char		0.21	0.21		0.78	0.78		0.30	0.55
H1000's	—			—			—		
H2000's	0.54 (-0.09 to 1.2)			-0.53 (-2.6 to 1.5)			0.18 (-0.71 to 1.1)		
H3000's	0.26 (-0.23 to 0.75)			-0.51 (-2.1 to 1.1)			-0.47 (-1.2 to 0.24)		
speed_cond_num * group_char		0.085	0.13		0.20	0.61		0.36	0.55
speed_cond_num * H2000's	-0.21 (-0.66 to 0.24)			-0.51 (-1.4 to 0.39)			-0.28 (-0.77 to 0.20)		
speed_cond_num * H3000's	0.30 (-0.06 to 0.65)			-0.60 (-1.3 to 0.10)			-0.22 (-0.60 to 0.16)		
subj_char.sd (Intercept)	0.64 (NA to NA)			2.3 (NA to NA)			0.97 (NA to NA)		
Residual.sd Observation	0.30 (NA to NA)			0.59 (NA to NA)			0.32 (NA to NA)		

<sup>1</sup> CI = Confidence Interval

<sup>2</sup> False discovery rate correction for multiple testing

Cluster:	14								
Characteristic	EEG Theta			EEG Alpha			EEG Beta		
	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value	Beta (95% CI)	p-value	q-value
speed_cond_num	0.04 (-0.09 to 0.17)	0.53	0.53	-0.19 (-0.57 to 0.19)	0.32	0.79	-0.09 (-0.31 to 0.12)	0.40	0.72
group_char		0.46	0.53		0.53	0.79		0.72	0.72
H1000's	—			—			—		
H2000's	-0.27 (-0.79 to 0.25)			-0.83 (-2.3 to 0.66)			-0.15 (-0.97 to 0.67)		
H3000's	0.05 (-0.45 to 0.55)			-0.54 (-2.0 to 0.90)			0.21 (-0.59 to 1.0)		
speed_cond_num * group_char		0.51	0.53		0.80	0.80		0.56	0.72
speed_cond_num * H2000's	0.12 (-0.08 to 0.32)			-0.12 (-0.71 to 0.47)			-0.13 (-0.46 to 0.21)		
speed_cond_num * H3000's	0.05 (-0.15 to 0.24)			-0.19 (-0.76 to 0.38)			-0.17 (-0.50 to 0.15)		
subj_char.sd (Intercept)	0.84 (NA to NA)			2.4 (NA to NA)			1.3 (NA to NA)		
Residual.sd Observation	0.18 (NA to NA)			0.55 (NA to NA)			0.31 (NA to NA)		

<sup>1</sup> CI = Confidence Interval

<sup>2</sup> False discovery rate correction for multiple testing