MOT ADHD: Behavioral data analysis

Ben Cowley (adapted from Sami Karadeniz)

Contents

Setup

Preprocessing

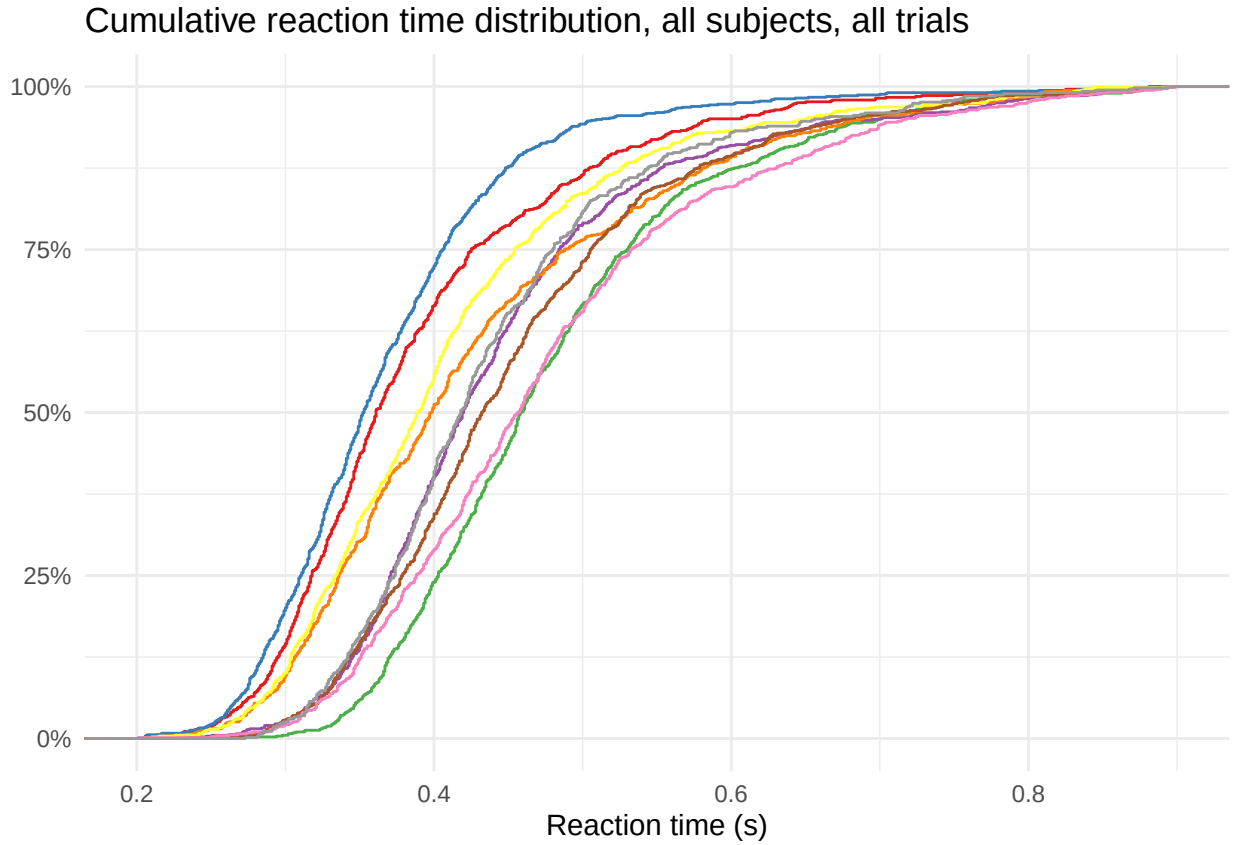
Pruning

Discarding subjects before preprocessing. First, we use the following criteria for choosing the subjects to be preprocessed in the first place:

- subjects have been measured with the photodetector
- subjects have the full number of usable sets (= 4)
- subjects do not have too many trial-rejections

Trim RT distributions?

Let's take a look at the reaction time distribution for each subject.



It appears that provided data has already been trimmed between 200 and 900ms! **If** we believe that the RT distribution tails reflect theoretically invalid processes, we could justify trimming them to some theoretical limit, E.g. 180 ms (which is mean minus 2SD, based on Table 2 from Woods, et al., 2015 Front Hum Neurosci. 2015; 9:131).

However, we actually have no strong motivation for this approach, since

(a) it is not that clear where the threshold should be
(b) we aim to use parametric test statistics (based on fitting ex-gaussian distribution), for which it is better to have the original data for fitting and rely on the robustness of the statistics to account for outliers.

In summary, if we can get the untrimmed RTs, I would prefer to use that.

Generate IVs

Results

Results are given for each **task** x **distractor state** combination at the group and single subject levels. For each DV below, we first show QQ-plots and conditional distributions/boxplots/bar-charts, and test the effect of response handedness for Controls. We then test the main effects and interactions with repeated-measures ANOVA and also LMM models.

We perform contrast analysis using 'emmeans' package: this provides an ANOVA-like table from F-contrasts for each combination of factors. Any specific contrast not included in these combinations is provided by general linear hypothesis test (GLHT) with custom-defined coefficients for the LMM model DV = ALL x ALL.

Speed

- reaction time mean, estimated from ex-gaussian fit (mu of the gaussian part)
- reaction time variability, estimated from ex-gaussian fit (sigma of the gaussian part)
- reaction time slowing, estimated from long-tail of ex-gaussian fit (tau)

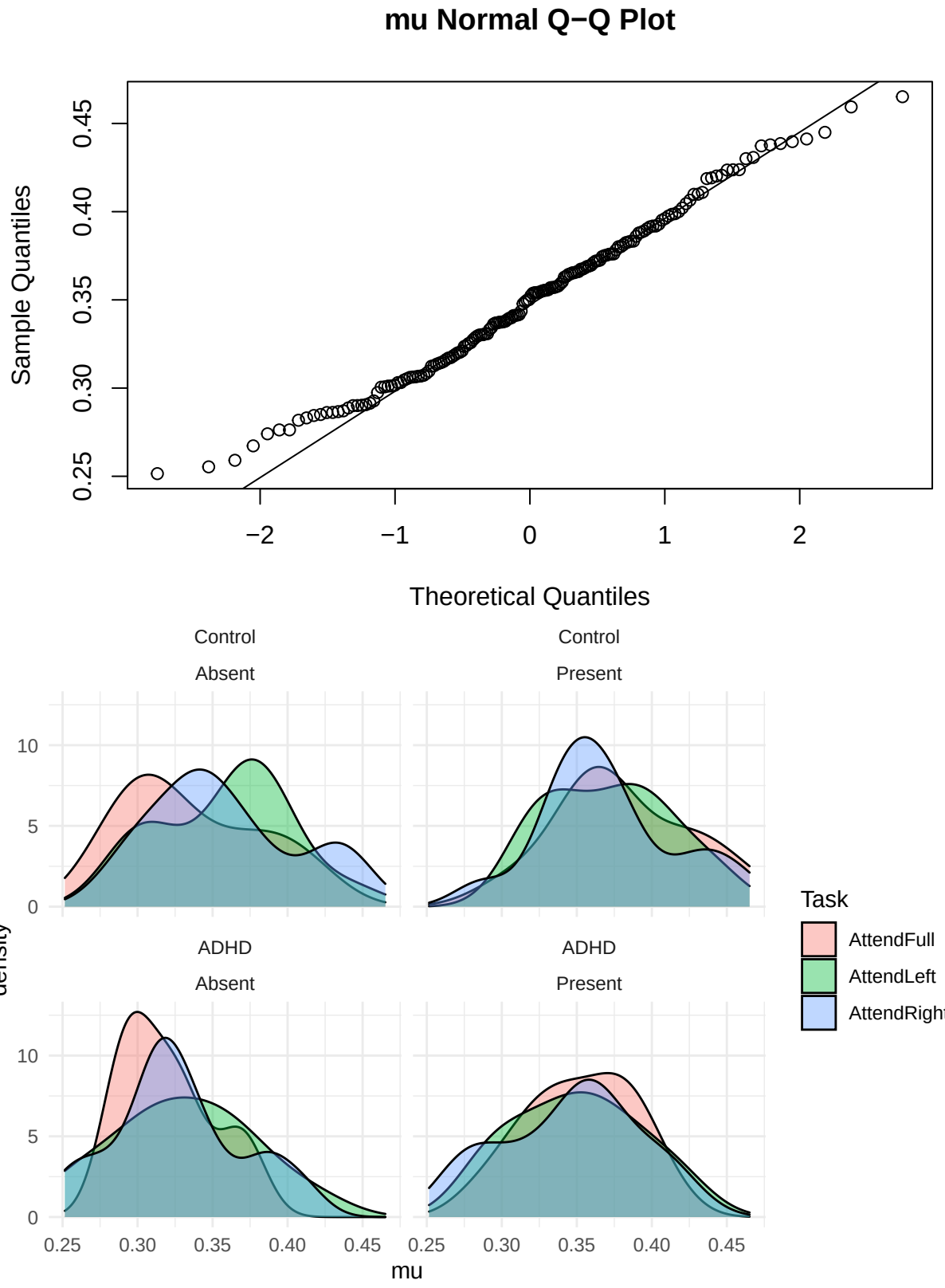
Accuracy

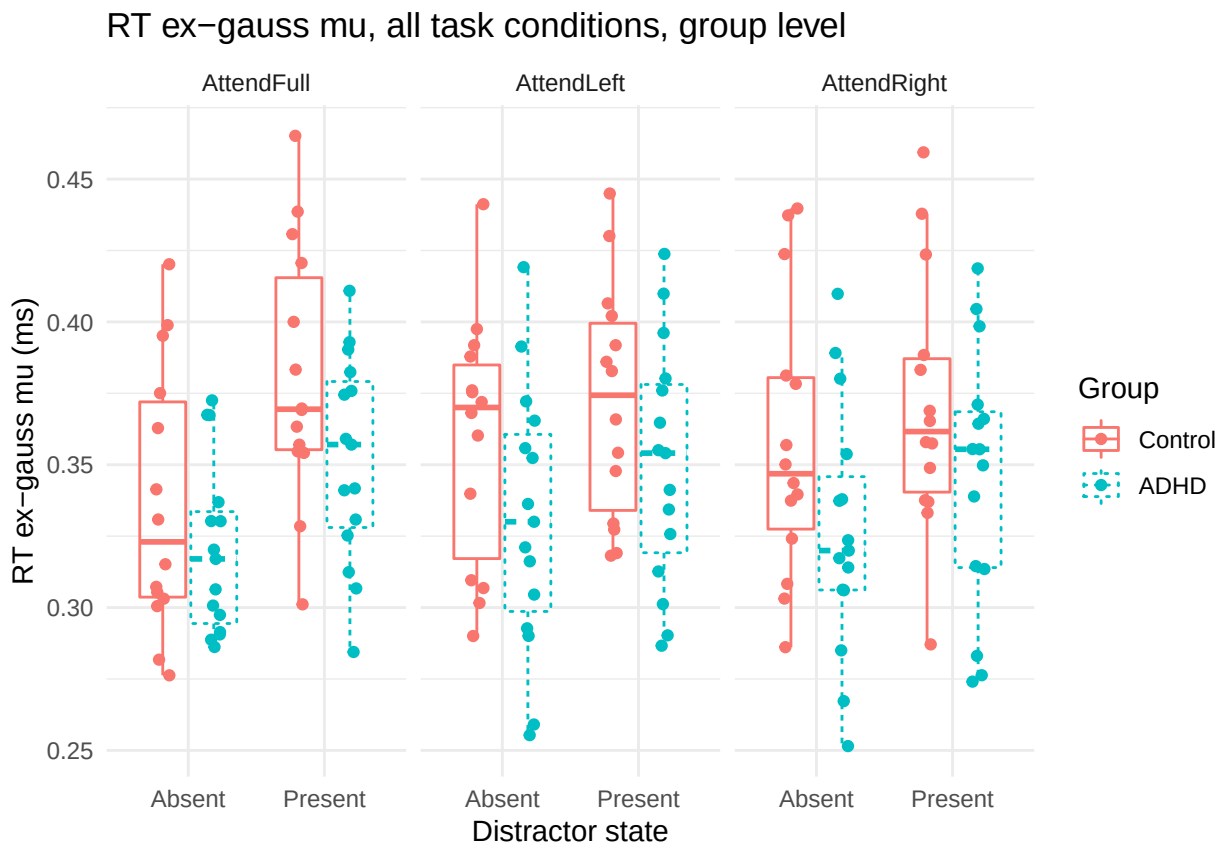
- hit rates
- false alarm rates
- distractor effects (calculated in the following way)

$$\frac{HR_{distractors\ absent} - HR_{distractors\ present}}{HR_{distractors\ absent} + HR_{distractors\ present}}$$

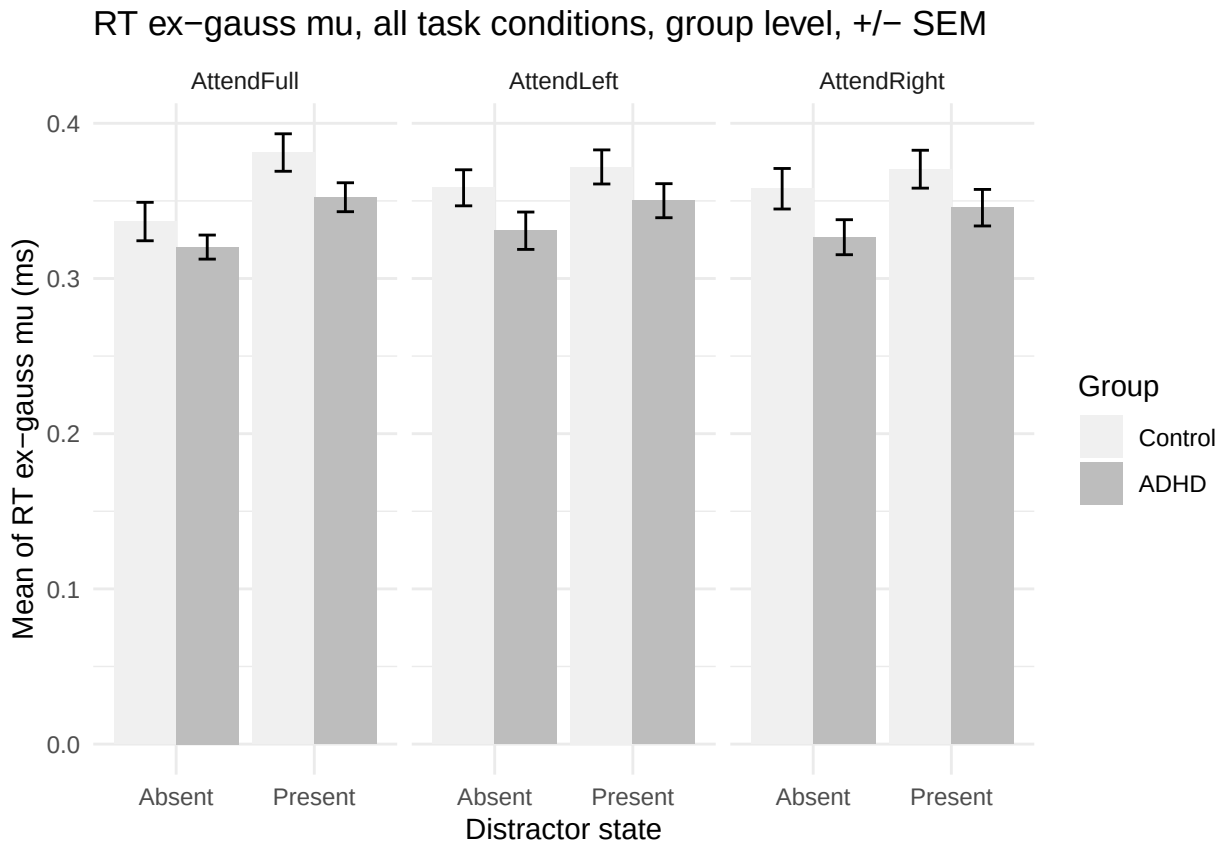
MU

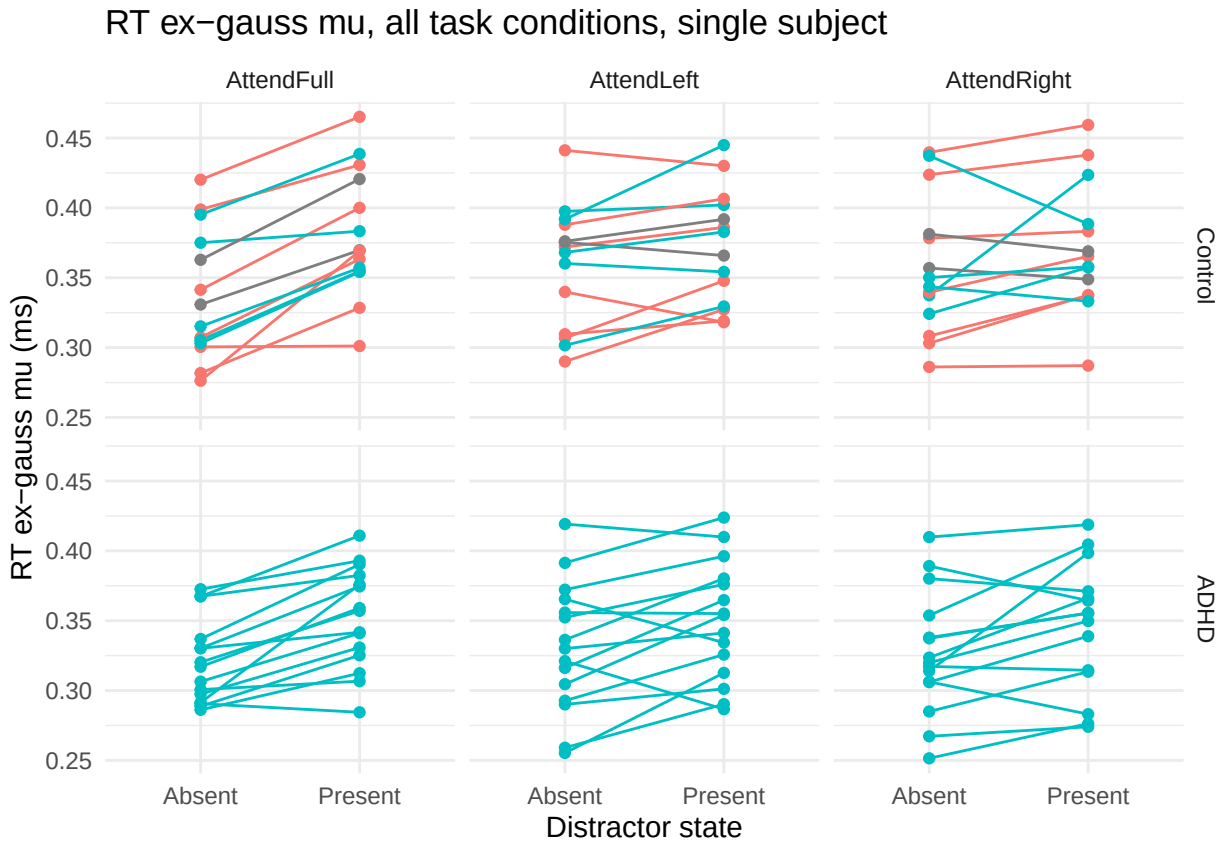
Ex-Gaussian stats of Reaction time - mu (gaussian central estimate)


mu Normal Q−Q Plot
Sample Quantiles
Theoretical Quantiles
0.25
0.30
0.35
0.40
0.45
−2
−1
0
1
2
Control
Absent
Control
Present
ADHD
Absent
ADHD
Present
density
mu
Task
AttendFull
AttendLeft
AttendRight



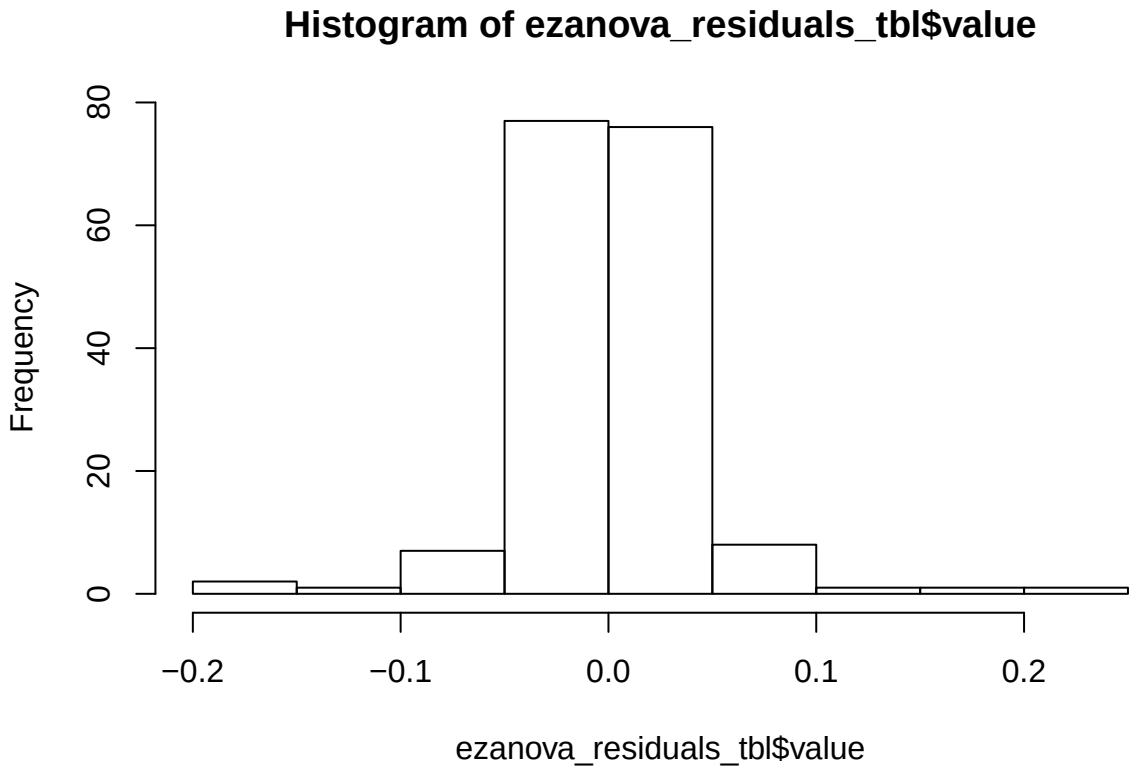

```
## `summarise()` regrouping output by 'Group', 'Task' (override with `.groups` argument)
```


RT ex−gauss mu, all task conditions, group level, +/− SEM
AttendFull
AttendLeft
AttendRight
Mean of RT ex−gauss mu (ms)
0.4
0.3
0.2
0.1
0.0
Absent
Present
Distractor state
Group
Control
ADHD


RT ex−gauss mu, all task conditions, single subject
AttendFull
AttendLeft
AttendRight
RT ex−gauss mu (ms)
0.45
0.40
0.35
0.30
0.25
Absent
Present
Distractor state
Control
ADHD

```
##
##  Two-sample Kolmogorov-Smirnov test
##
## data:  exgauss[Group == "Control" & dom_resp == FALSE, ]$mu and exgauss[Group == "Control" & dom_resp
## D = 0.23333, p-value = 0.254
## alternative hypothesis: two-sided
```

Statistics for RT ex-gauss mu



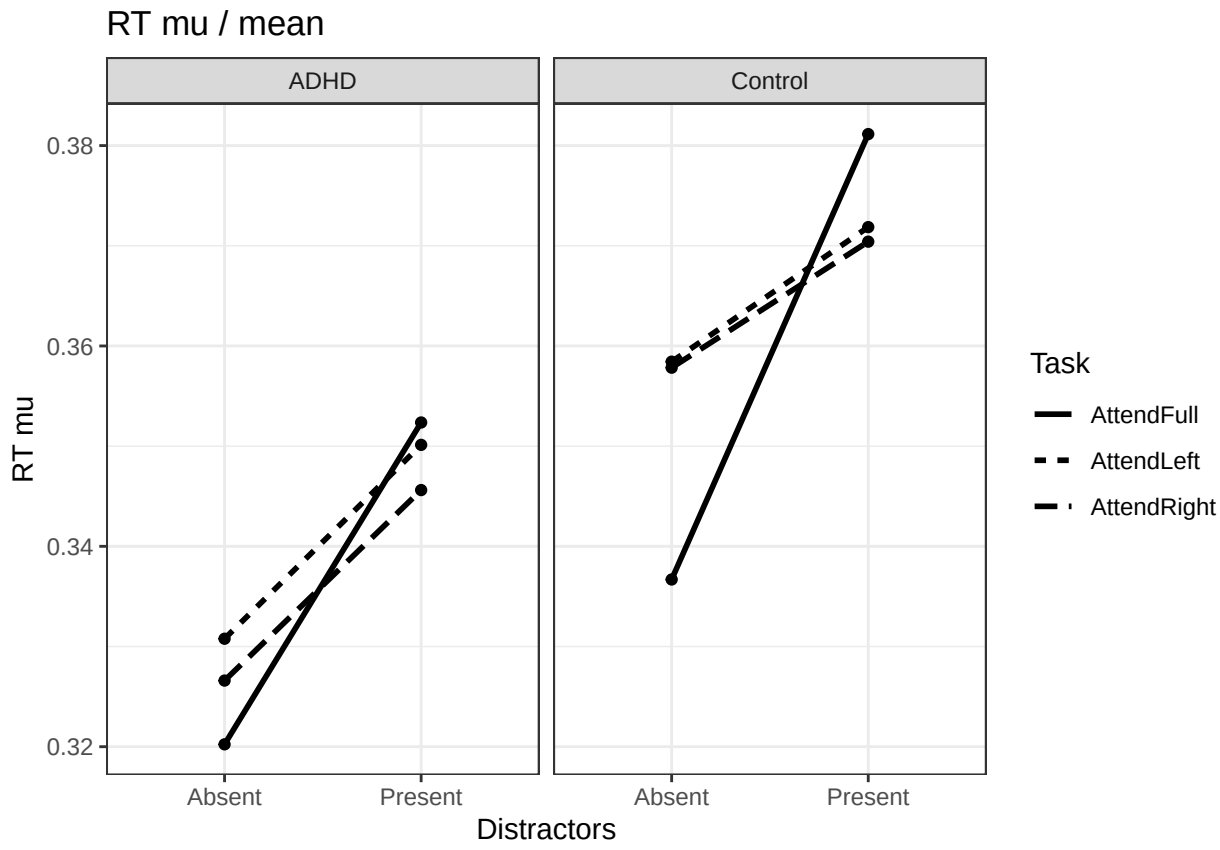

```
## $ANOVA
##                   Effect DFn DFd        F        p p<.05      ges
## 2                  Group   1  27 2.95e+00 9.74e-02       8.33e-02
## 3                   Task   2  54 8.90e-01 4.17e-01       2.58e-03
## 5            Distractors   1  27 5.47e+01 5.85e-08     * 7.37e-02
## 4             Group:Task   2  54 2.44e-01 7.84e-01       7.10e-04
## 6      Group:Distractors   1  27 1.86e-06 9.99e-01       2.69e-09
## 7       Task:Distractors   2  54 8.47e+00 6.32e-04     * 1.55e-02
## 8 Group:Task:Distractors   2  54 1.47e+00 2.38e-01       2.74e-03
##
## $`Mauchly's Test for Sphericity`
##                   Effect     W      p p<.05
## 3                   Task 0.861 0.1435
## 4             Group:Task 0.861 0.1435
## 7       Task:Distractors 0.808 0.0623
## 8 Group:Task:Distractors 0.808 0.0623
##
## $`Sphericity Corrections`
##                   Effect   GGe   p[GG] p[GG]<.05   HFe   p[HF] p[HF]<.05
## 3                   Task 0.878 0.40549           0.934 0.41087
```

```
## 4             Group:Task 0.878 0.75568           0.934 0.76943
## 7       Task:Distractors 0.839 0.00137         * 0.888 0.00108         *
## 8 Group:Task:Distractors 0.839 0.24002           0.888 0.23967
##
## $aov
##
## Call:
## aov(formula = formula(aov_formula), data = data)
##
## Grand Mean: 0.3497415
##
## Stratum 1: ID
##
## Terms:
##                       Group  Residuals
## Sum of Squares  0.02739484 0.25083877
## Deg. of Freedom          1         27
##
## Residual standard error: 0.09638633
## 5 out of 6 effects not estimable
## Estimated effects are balanced
##
## Stratum 2: ID:Task
##
## Terms:
##                         Task  Group:Task   Residuals
## Sum of Squares  0.000771667 0.000214281 0.023690890
## Deg. of Freedom           2           2          54
##
## Residual standard error: 0.02094565
## 4 out of 8 effects not estimable
## Estimated effects may be unbalanced
##
## Stratum 3: ID:Distractors
##
## Terms:
##                 Distractors Group:Distractors   Residuals
## Sum of Squares  0.024009408       0.000000001 0.011826235
## Deg. of Freedom           1                 1          27
##
## Residual standard error: 0.02092866
## 4 out of 6 effects not estimable
## Estimated effects may be unbalanced
##
## Stratum 4: ID:Task:Distractors
##
## Terms:
##                 Task:Distractors Group:Task:Distractors   Residuals
## Sum of Squares       0.004629319            0.000827573 0.015172424
## Deg. of Freedom                2                      2          54
##
## Residual standard error: 0.01676218
## Estimated effects may be unbalanced
```

Constrasts for exgauss mu

Joint tests (F-contrasts) with facet line plot of interactions

```
##  [1] "Control.Absent.AttendFull"   "ADHD.Absent.AttendFull"
##  [3] "Control.Present.AttendFull"  "ADHD.Present.AttendFull"
##  [5] "Control.Absent.AttendLeft"   "ADHD.Absent.AttendLeft"
##  [7] "Control.Present.AttendLeft"  "ADHD.Present.AttendLeft"
##  [9] "Control.Absent.AttendRight"  "ADHD.Absent.AttendRight"
## [11] "Control.Present.AttendRight" "ADHD.Present.AttendRight"
```




```
##  model term             df1 df2 F.ratio p.value
##  Group                    1  27   2.949 0.0974
##  Distractors              1  27  54.749 <.0001
##  Task                     2  54   0.890 0.4167
##  Group:Distractors        1  27   0.000 0.9989
##  Group:Task               2  54   0.244 0.7842
##  Distractors:Task         2  54   8.470 0.0006
##  Group:Distractors:Task   2  54   1.473 0.2384
```

```
## [1] "Split by GROUP:"
```

```
## Group = Control:
##  model term       df1 df2 F.ratio p.value
##  Distractors        1  27  26.452 <.0001
##  Task               2  54   0.711 0.4955
##  Distractors:Task   2  54   8.220 0.0008
##
## Group = ADHD:
```

```
##  model term       df1 df2 F.ratio p.value
##  Distractors        1  27  28.363 <.0001
##  Task               2  54   0.412 0.6643
##  Distractors:Task   2  54   1.491 0.2343
```

```
## [1] "Contrast GROUP over all conditions:"
```

```
## Distractors = Absent, Task = AttendFull:
##  model term df1   df2 F.ratio p.value
##  Group        1 38.69   1.054 0.3111
##
## Distractors = Present, Task = AttendFull:
##  model term df1   df2 F.ratio p.value
##  Group        1 38.69   3.224 0.0804
##
## Distractors = Absent, Task = AttendLeft:
##  model term df1   df2 F.ratio p.value
##  Group        1 38.69   2.976 0.0925
##
## Distractors = Present, Task = AttendLeft:
##  model term df1   df2 F.ratio p.value
##  Group        1 38.69   1.838 0.1831
##
## Distractors = Absent, Task = AttendRight:
##  model term df1   df2 F.ratio p.value
##  Group        1 38.69   3.795 0.0587
##
## Distractors = Present, Task = AttendRight:
##  model term df1   df2 F.ratio p.value
##  Group        1 38.69   2.392 0.1301
```

```
## [1] "Split by DISTRACTOR:"
```

```
## Distractors = Absent:
##  model term df1    df2 F.ratio p.value
##  Group        1  29.54   2.817 0.1038
##  Task         2 103.05   6.109 0.0031
##  Group:Task   2 103.05   1.196 0.3066
##
## Distractors = Present:
##  model term df1    df2 F.ratio p.value
##  Group        1  29.54   2.815 0.1039
##  Task         2 103.05   1.589 0.2090
##  Group:Task   2 103.05   0.252 0.7779
```

```
## [1] "Contrast DISTRACTOR over all conditions:"
```

```
## Task = AttendFull, Group = Control:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 77.19  41.507 <.0001
##
## Task = AttendLeft, Group = Control:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 77.19   3.787 0.0553
##
## Task = AttendRight, Group = Control:
##  model term  df1   df2 F.ratio p.value
```

```
##  Distractors   1 77.19   3.324 0.0722
##
## Task = AttendFull, Group = ADHD:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 77.19  23.222 <.0001
##
## Task = AttendLeft, Group = ADHD:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 77.19   8.426 0.0048
##
## Task = AttendRight, Group = ADHD:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 77.19   8.137 0.0056
```

```
## [1] "Split by TASK:"
```

```
## Task = AttendFull:
##  model term        df1   df2 F.ratio p.value
##  Group               1 32.20   2.187 0.1489
##  Distractors         1 77.19  63.708 <.0001
##  Group:Distractors   1 77.19   1.652 0.2025
##
## Task = AttendLeft:
##  model term        df1   df2 F.ratio p.value
##  Group               1 32.20   2.606 0.1162
##  Distractors         1 77.19  11.672 0.0010
##  Group:Distractors   1 77.19   0.381 0.5389
##
## Task = AttendRight:
##  model term        df1   df2 F.ratio p.value
##  Group               1 32.20   3.353 0.0763
##  Distractors         1 77.19  10.845 0.0015
##  Group:Distractors   1 77.19   0.450 0.5043
```

```
## [1] "Contrast TASK over all conditions:"
```

```
## Distractors = Absent, Group = Control:
##  model term df1    df2 F.ratio p.value
##  Task         2 103.05   5.965 0.0035
##
## Distractors = Present, Group = Control:
##  model term df1    df2 F.ratio p.value
##  Task         2 103.05   1.320 0.2715
##
## Distractors = Absent, Group = ADHD:
##  model term df1    df2 F.ratio p.value
##  Task         2 103.05   1.175 0.3130
##
## Distractors = Present, Group = ADHD:
##  model term df1    df2 F.ratio p.value
##  Task         2 103.05   0.492 0.6128
```

Interaction of distractor state by Task:Full vs Right+Left is highly significant for CTRL, in contrast to ADHD.

```
## Contrast of DISTRACTOR x TASK(Full vs Right+Left) for CONTROL, ADHD, and between
##  0.5 0 -0.5 0 -0.25 0 0.25 0 -0.25 0 0.25 0
```

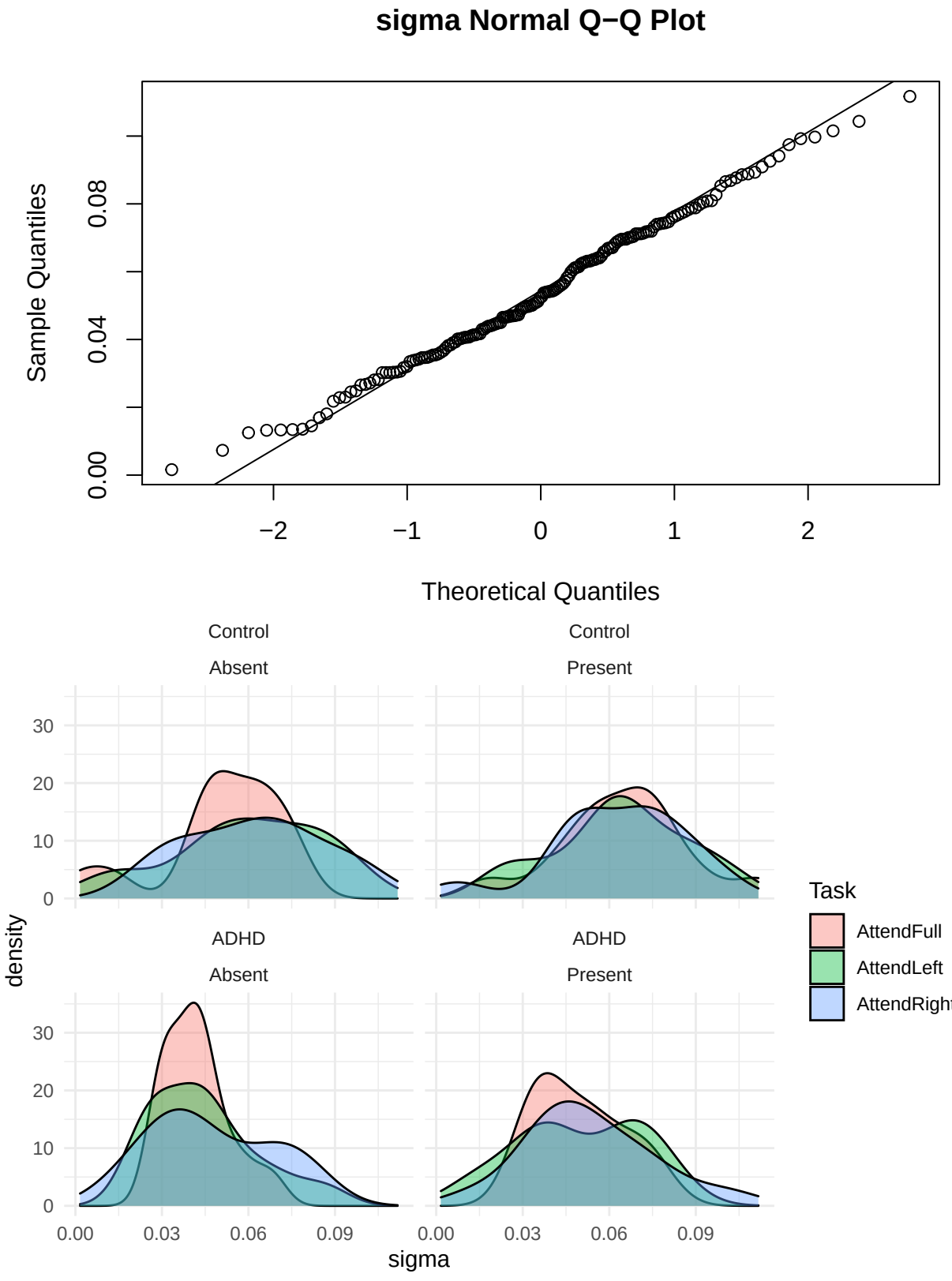
```
##  0 0.5 0 -0.5 0 -0.25 0 0.25 0 -0.25 0 0.25
##  0.25 -0.25 -0.25 0.25 -0.125 0.125 0.125 -0.125 -0.125 0.125 0.125 -0.125
##
##   General Linear Hypotheses
##
## Multiple Comparisons of Means: User-defined Contrasts
##
##
## Linear Hypotheses:
##                Estimate
## drAF_ctrl == 0 -0.01573
##
## Global Test:
##      F DF1 DF2    Pr(>F)
## 1 12.3   1 160 0.0005895
##
##   General Linear Hypotheses
##
## Multiple Comparisons of Means: User-defined Contrasts
##
##
## Linear Hypotheses:
##                 Estimate
## drAF_adhd == 0 -0.006471
##
## Global Test:
##      F DF1 DF2 Pr(>F)
## 1 2.23   1 160 0.1373
##
##   General Linear Hypotheses
##
## Multiple Comparisons of Means: User-defined Contrasts
##
##
## Linear Hypotheses:
##                Estimate
## drAF_CvA == 0 -0.004628
##
## Global Test:
##       F DF1 DF2 Pr(>F)
## 1 2.203   1 160 0.1397
```

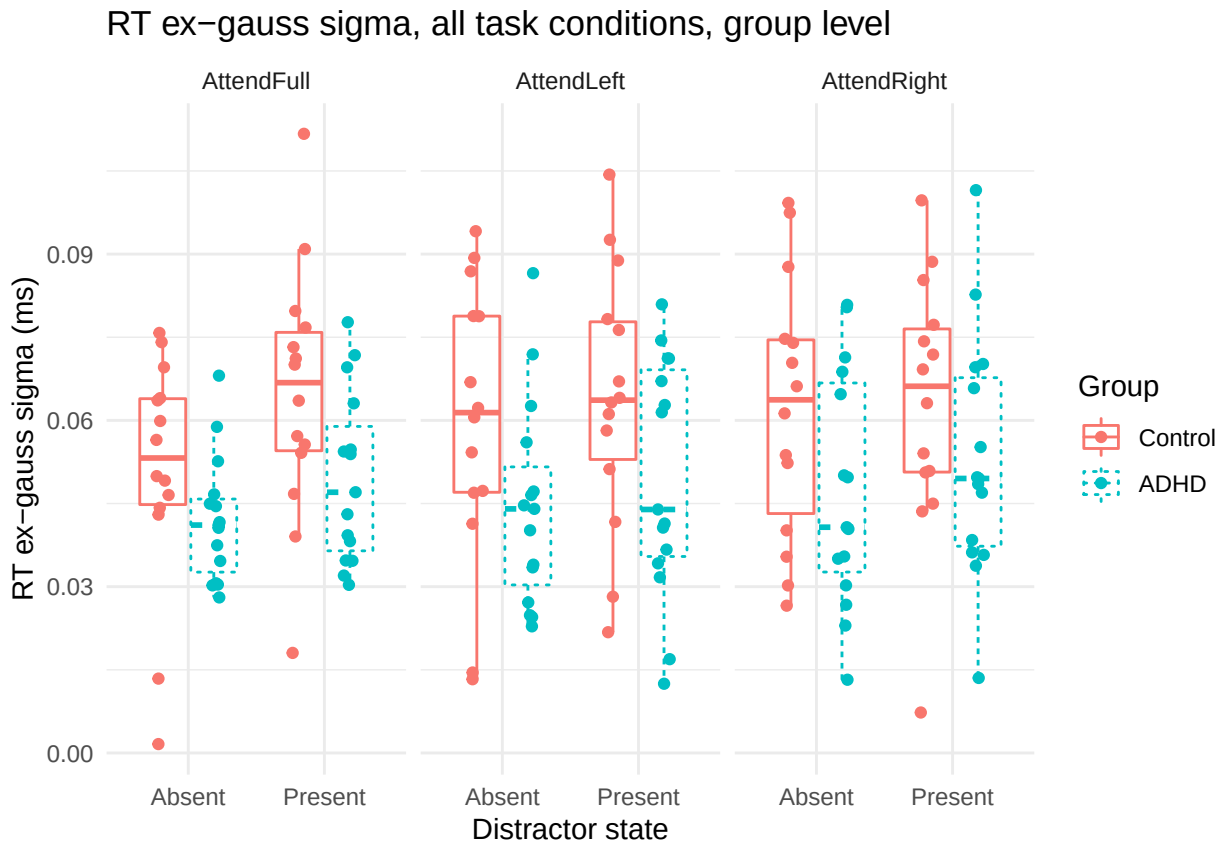
MU summary

CTRL consistently slower than ADHD (not due to response hand effect), with largest difference in 'Task = attend-Right' and in 'Distractor = Present, Task = attend-Full'. Of note, Distractors affect CTRL weakly in Task = attend-Left/Right (F = 3.8, 3.3), but strongly in Task = attend-Full (F = 41.5), causing a strong interaction effect (F = 12.3) not present in ADHD (F = 2.2).

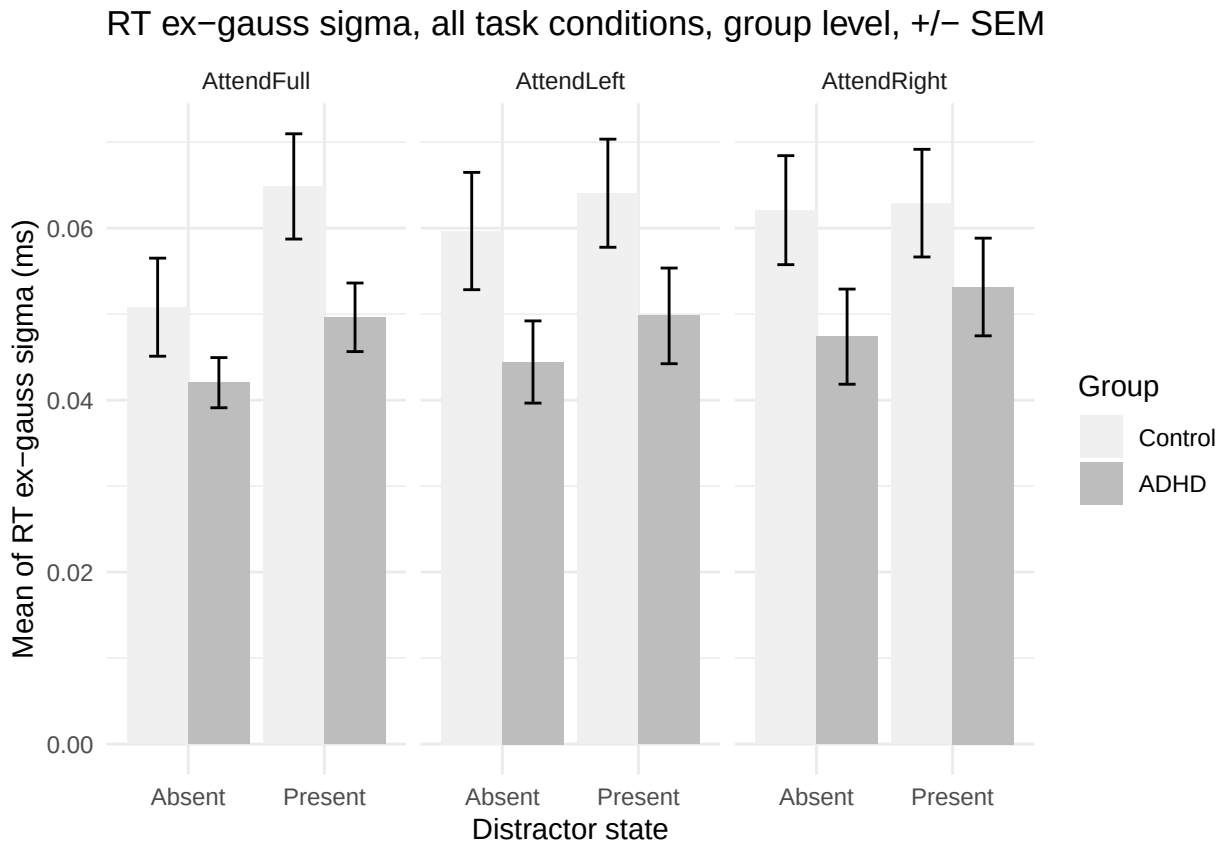
SIGMA

Ex-Gaussian stats of Reaction time - sigma (gaussian dispersion)





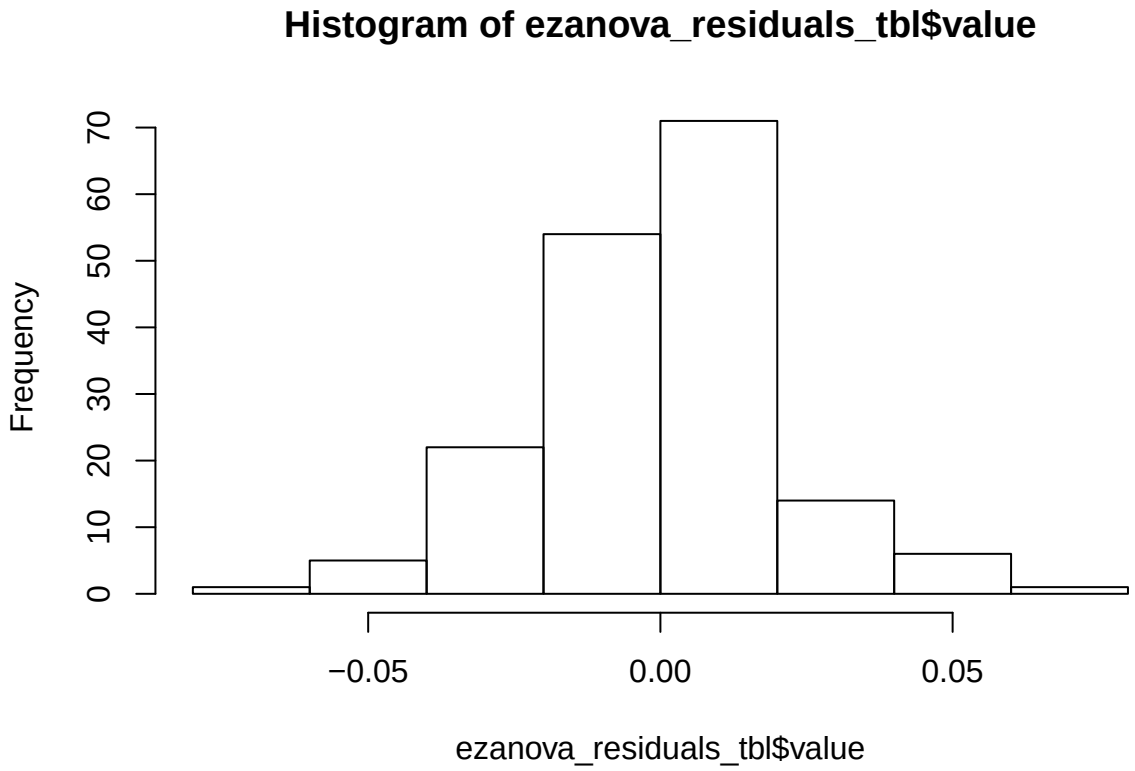

```
## `summarise()` regrouping output by 'Group', 'Task' (override with `.groups` argument)
```


RT ex−gauss sigma, all task conditions, group level, +/− SEM
AttendFull
AttendLeft
AttendRight
Mean of RT ex−gauss sigma (ms)
0.06
0.04
0.02
0.00
Absent
Present
Distractor state
Group
Control
ADHD


RT ex−gauss sigma, all task conditions, single subject
AttendFull
AttendLeft
AttendRight
RT ex−gauss sigma (ms)
0.09
0.06
0.03
0.00
Absent
Present
Distractor state
Control
ADHD

```
##
##  Two-sample Kolmogorov-Smirnov test
##
## data:  exgauss[Group == "Control" & dom_resp == FALSE, ]$sigma and exgauss[Group == "Control" & dom_
## D = 0.2381, p-value = 0.2342
## alternative hypothesis: two-sided
```

Statistics for RTV - exgauss sigma:




```
## $ANOVA
##                   Effect DFn DFd           F          p p<.05          ges
## 2                  Group   1  27 4.372677168 0.04606248     * 9.189650e-02
## 3                   Task   2  54 1.249324307 0.29485187       8.298936e-03
## 5            Distractors   1  27 5.795958889 0.02316748     * 2.348284e-02
## 4             Group:Task   2  54 0.138527943 0.87094732       9.270455e-04
## 6      Group:Distractors   1  27 0.001054741 0.97433074       4.376120e-06
## 7       Task:Distractors   2  54 2.065145049 0.13669867       6.252890e-03
## 8 Group:Task:Distractors   2  54 1.097591422 0.34100137       3.333075e-03
##
## $`Mauchly's Test for Sphericity`
##                   Effect         W         p p<.05
## 3                   Task 0.9994394 0.9927361
## 4             Group:Task 0.9994394 0.9927361
## 7       Task:Distractors 0.9754472 0.7238507
## 8 Group:Task:Distractors 0.9754472 0.7238507
##
## $`Sphericity Corrections`
##                   Effect       GGe     p[GG] p[GG]<.05      HFe     p[HF]
## 3                   Task 0.9994397 0.2948431           1.079324 0.2948519
```

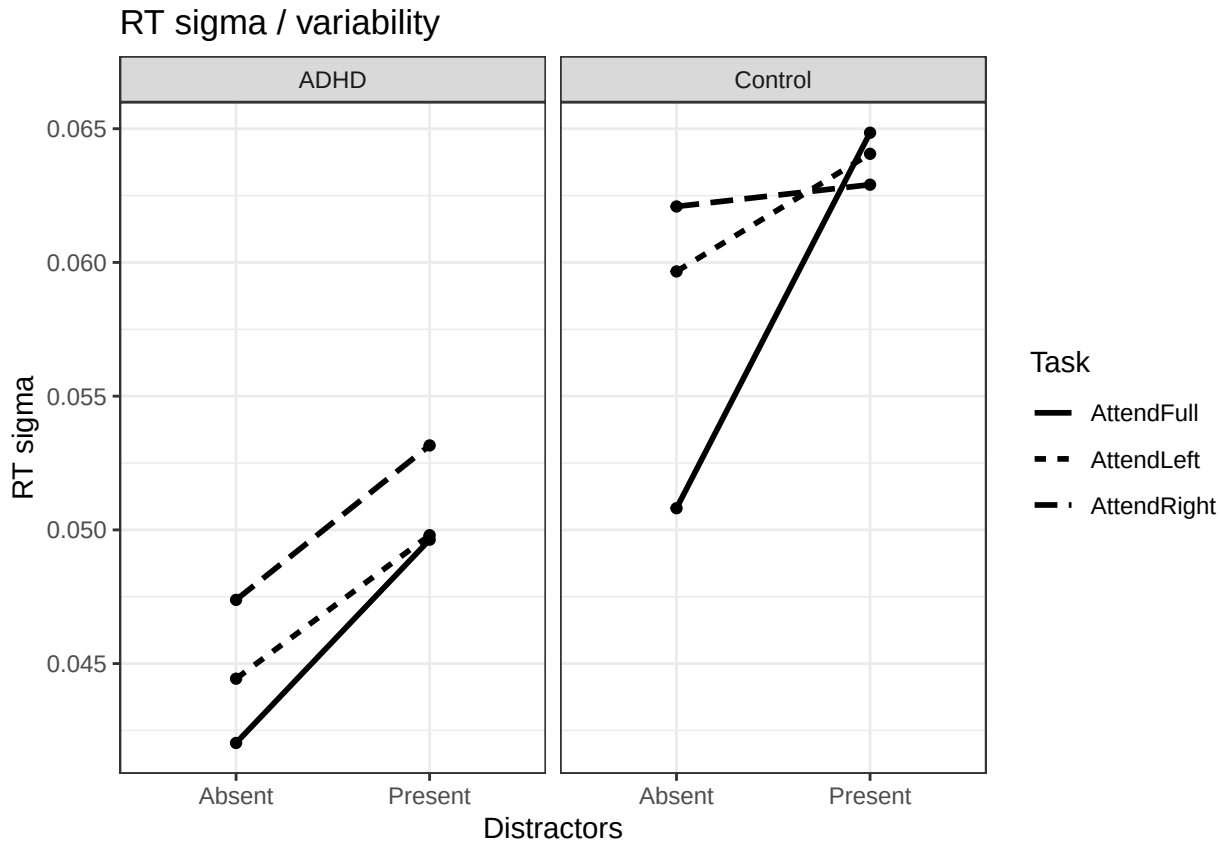
```
## 4             Group:Task 0.9994397 0.8708397           1.079324 0.8709473
## 7       Task:Distractors 0.9760356 0.1380059           1.051145 0.1366987
## 8 Group:Task:Distractors 0.9760356 0.3399814           1.051145 0.3410014
##   p[HF]<.05
## 3
## 4
## 7
## 8
##
## $aov
##
## Call:
## aov(formula = formula(aov_formula), data = data)
##
## Grand Mean: 0.05401102
##
## Stratum 1: ID
##
## Terms:
##                       Group  Residuals
## Sum of Squares  0.00733327 0.04528077
## Deg. of Freedom          1         27
##
## Residual standard error: 0.04095199
## 5 out of 6 effects not estimable
## Estimated effects are balanced
##
## Stratum 2: ID:Task
##
## Terms:
##                         Task  Group:Task   Residuals
## Sum of Squares  0.000604827 0.000067242 0.013105816
## Deg. of Freedom           2           2          54
##
## Residual standard error: 0.01557884
## 4 out of 8 effects not estimable
## Estimated effects may be unbalanced
##
## Stratum 3: ID:Distractors
##
## Terms:
##                 Distractors Group:Distractors   Residuals
## Sum of Squares  0.001743079       0.000000317 0.008117886
## Deg. of Freedom           1                 1          27
##
## Residual standard error: 0.01733962
## 4 out of 6 effects not estimable
## Estimated effects may be unbalanced
##
## Stratum 4: ID:Task:Distractors
##
## Terms:
##                 Task:Distractors Group:Task:Distractors   Residuals
## Sum of Squares       0.000434113            0.000242342 0.005961450
```

```
## Deg. of Freedom                2                          2          54
##
## Residual standard error: 0.01050701
## Estimated effects may be unbalanced
```

Constrasts for exgauss sigma

SIGMA by LMM - joint tests and facet line plot of interactions

```
##  [1] "Control.Absent.AttendFull"   "ADHD.Absent.AttendFull"
##  [3] "Control.Present.AttendFull"  "ADHD.Present.AttendFull"
##  [5] "Control.Absent.AttendLeft"   "ADHD.Absent.AttendLeft"
##  [7] "Control.Present.AttendLeft"  "ADHD.Present.AttendLeft"
##  [9] "Control.Absent.AttendRight"  "ADHD.Absent.AttendRight"
## [11] "Control.Present.AttendRight" "ADHD.Present.AttendRight"
```




```
##  model term             df1 df2 F.ratio p.value
##  Group                    1  27   4.373 0.0461
##  Distractors              1  27   5.796 0.0232
##  Task                     2  54   1.249 0.2949
##  Group:Distractors        1  27   0.001 0.9743
##  Group:Task               2  54   0.139 0.8709
##  Distractors:Task         2  54   2.065 0.1367
##  Group:Distractors:Task   2  54   1.098 0.3410
```

```
## Group = Control:
##  model term       df1 df2 F.ratio p.value
##  Distractors        1  27   2.878 0.1013
```

```
##  Task               2  54   0.740 0.4819
##  Distractors:Task   2  54   2.967 0.0599
##
## Group = ADHD:
##  model term       df1 df2 F.ratio p.value
##  Distractors        1  27   2.921 0.0989
##  Task               2  54   0.645 0.5289
##  Distractors:Task   2  54   0.096 0.9083

## Distractors = Absent, Task = AttendFull:
##  model term df1   df2 F.ratio p.value
##  Group        1 63.87   1.248 0.2682
##
## Distractors = Present, Task = AttendFull:
##  model term df1   df2 F.ratio p.value
##  Group        1 63.87   3.749 0.0573
##
## Distractors = Absent, Task = AttendLeft:
##  model term df1   df2 F.ratio p.value
##  Group        1 63.87   3.754 0.0571
##
## Distractors = Present, Task = AttendLeft:
##  model term df1   df2 F.ratio p.value
##  Group        1 63.87   3.293 0.0743
##
## Distractors = Absent, Task = AttendRight:
##  model term df1   df2 F.ratio p.value
##  Group        1 63.87   3.503 0.0658
##
## Distractors = Present, Task = AttendRight:
##  model term df1   df2 F.ratio p.value
##  Group        1 63.87   1.539 0.2193

## Distractors = Absent:
##  model term df1   df2 F.ratio p.value
##  Group        1 36.38   3.659 0.0637
##  Task         2 94.70   2.956 0.0569
##  Group:Task   2 94.70   0.527 0.5922
##
## Distractors = Present:
##  model term df1   df2 F.ratio p.value
##  Group        1 36.38   3.757 0.0604
##  Task         2 94.70   0.053 0.9485
##  Group:Task   2 94.70   0.350 0.7057

## Task = AttendFull, Group = Control:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 63.97   7.941 0.0064
##
## Task = AttendLeft, Group = Control:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 63.97   0.779 0.3806
##
## Task = AttendRight, Group = Control:
##  model term  df1   df2 F.ratio p.value
```

```
##  Distractors   1 63.97   0.027 0.8707
##
## Task = AttendFull, Group = ADHD:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 63.97   2.494 0.1192
##
## Task = AttendLeft, Group = ADHD:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 63.97   1.242 0.2693
##
## Task = AttendRight, Group = ADHD:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 63.97   1.439 0.2346
```

```
## Task = AttendFull:
##  model term        df1   df2 F.ratio p.value
##  Group               1 43.09   2.892 0.0962
##  Distractors         1 63.97   9.758 0.0027
##  Group:Distractors   1 63.97   0.864 0.3561
##
## Task = AttendLeft:
##  model term        df1   df2 F.ratio p.value
##  Group               1 43.09   4.369 0.0425
##  Distractors         1 63.97   1.986 0.1636
##  Group:Distractors   1 63.97   0.019 0.8896
##
## Task = AttendRight:
##  model term        df1   df2 F.ratio p.value
##  Group               1 43.09   3.005 0.0901
##  Distractors         1 63.97   0.905 0.3451
##  Group:Distractors   1 63.97   0.513 0.4766
```

```
## Distractors = Absent, Group = Control:
##  model term df1  df2 F.ratio p.value
##  Task         2 94.7   2.797 0.0660
##
## Distractors = Present, Group = Control:
##  model term df1  df2 F.ratio p.value
##  Task         2 94.7   0.076 0.9271
##
## Distractors = Absent, Group = ADHD:
##  model term df1  df2 F.ratio p.value
##  Task         2 94.7   0.610 0.5453
##
## Distractors = Present, Group = ADHD:
##  model term df1  df2 F.ratio p.value
##  Task         2 94.7   0.336 0.7154
```

Illustration of weak effect of Distractors per group, and interaction of Distractor and Task=Full vs Left/Right in CTRL

```
## CONTRAST main effect of distractor within ADHD 0 0.3333333 0 -0.3333333 0 0.3333333 0 -0.3333333 0 0
```

```
##
##   General Linear Hypotheses
##
```

```
## Multiple Comparisons of Means: User-defined Contrasts
##
##
## Linear Hypotheses:
##                  Estimate
## dstr_adhd == 0 -0.006248
##
## Global Test:
##       F DF1 DF2  Pr(>F)
## 1 4.361   1 160 0.03835
```

```
## CONTRAST main effect of distractor within CTRL 0.3333333 0 -0.3333333 0 0.3333333 0 -0.3333333 0 0.33
```

```
##
##   General Linear Hypotheses
##
## Multiple Comparisons of Means: User-defined Contrasts
##
##
## Linear Hypotheses:
##                  Estimate
## dstr_ctrl == 0 -0.006419
##
## Global Test:
##       F DF1 DF2 Pr(>F)
## 1 4.296   1 160 0.0398
```

```
## CONTRAST interaction of distractor and task levels in CTRL 0.5 0 -0.5 0 -0.25 0 0.25 0 -0.25 0 0.25 0
```

```
##
##   General Linear Hypotheses
##
## Multiple Comparisons of Means: User-defined Contrasts
##
##
## Linear Hypotheses:
##                  Estimate
## drAF_ctrl == 0 -0.005718
##
## Global Test:
##      F DF1 DF2  Pr(>F)
## 1 3.03   1 160 0.08364
```

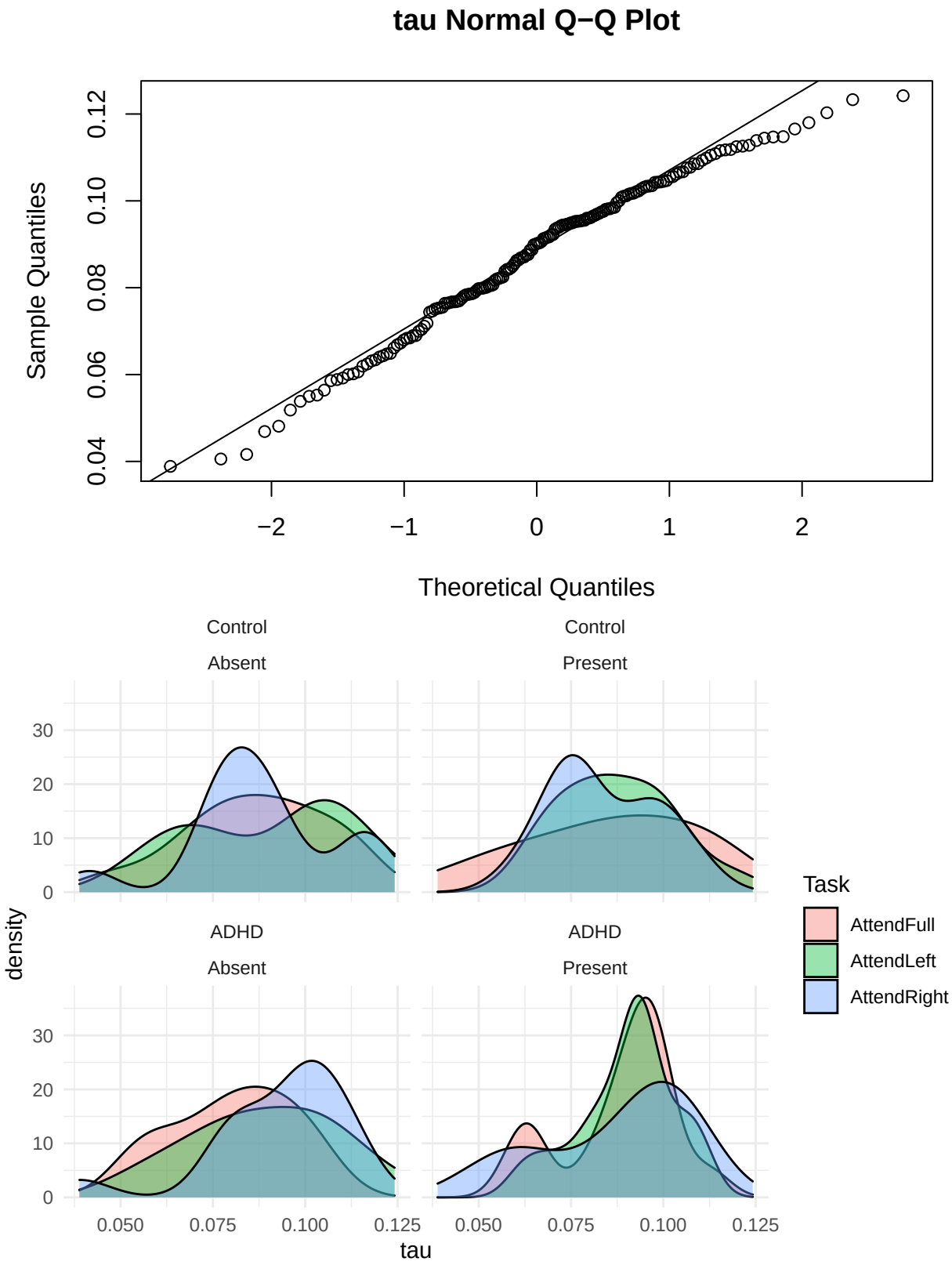
SIGMA summary

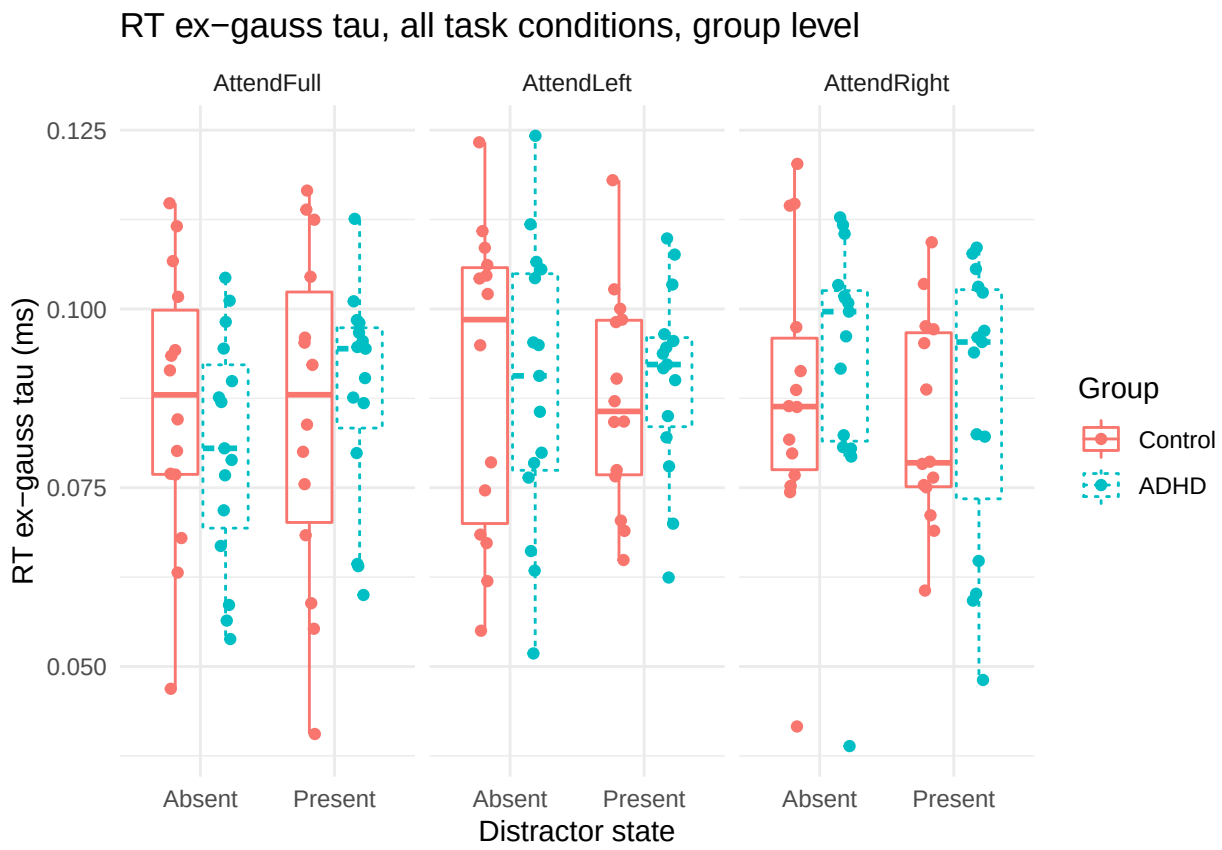
Sigma is consistently more variable for CTRL than for ADHD (F = 4.4). This is true in all conditions (F = 3.3 - 3.8) except Distractors = Absent Task = attend-Full, and Distractors = Present Task = attend-Right. The difference is strongest in Task = attend-Left (F = 4.4).

Distractors have smaller effect here than for other DVs (F = 5.8), in fact the effect comes mainly from one condition, CTRL group Task = attend-Full (F = 7.9). Thus again the effect of Distractors on CTRL in attend-Full is unusually large (compared to ADHD or lateralised attending).

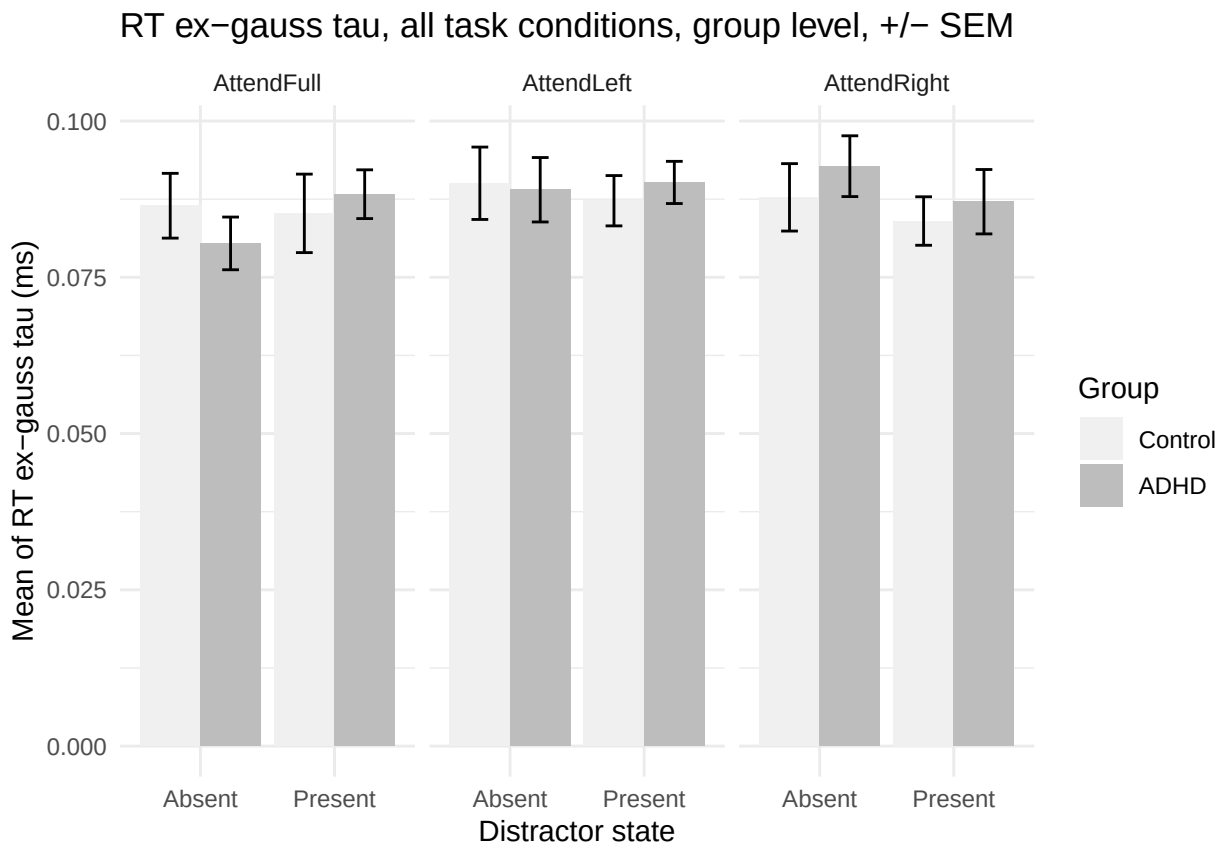
TAU

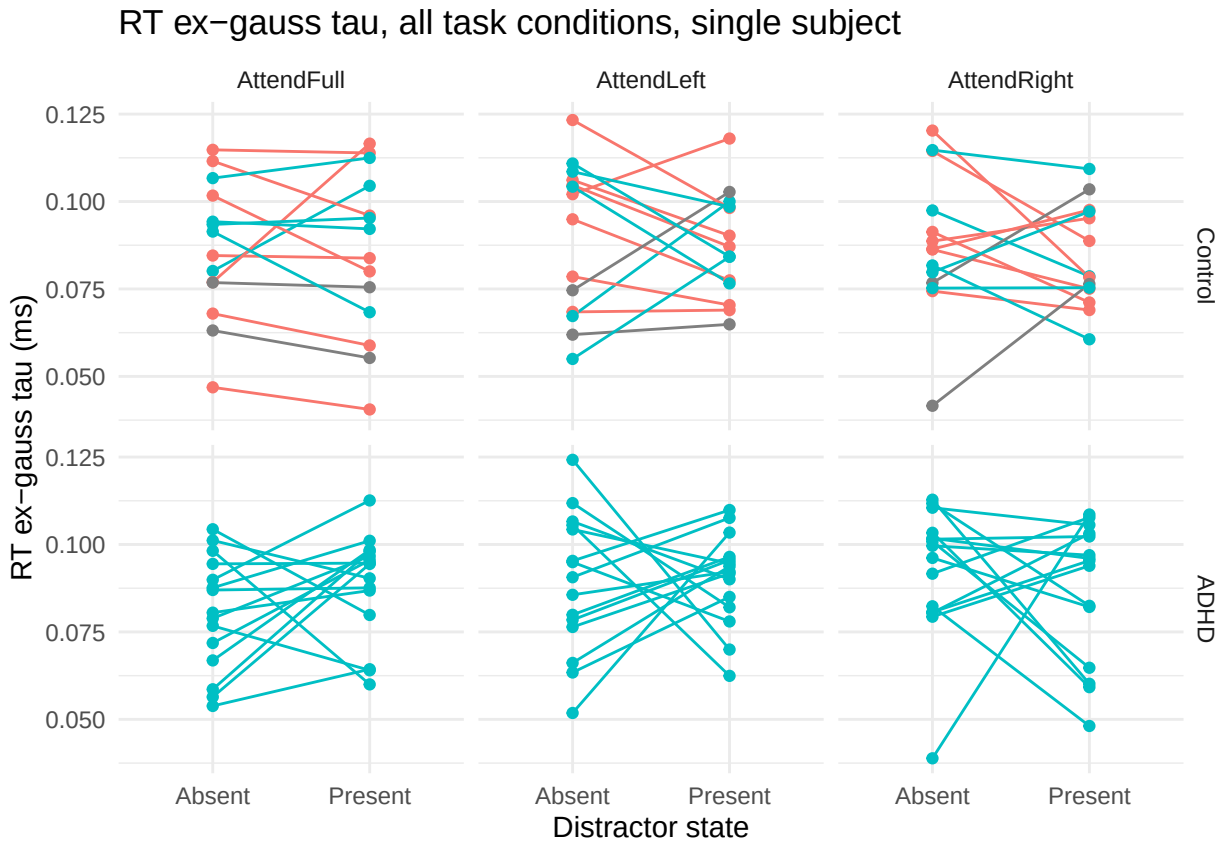
Ex-Gaussian stats of Reaction time - tau (exponential tail)





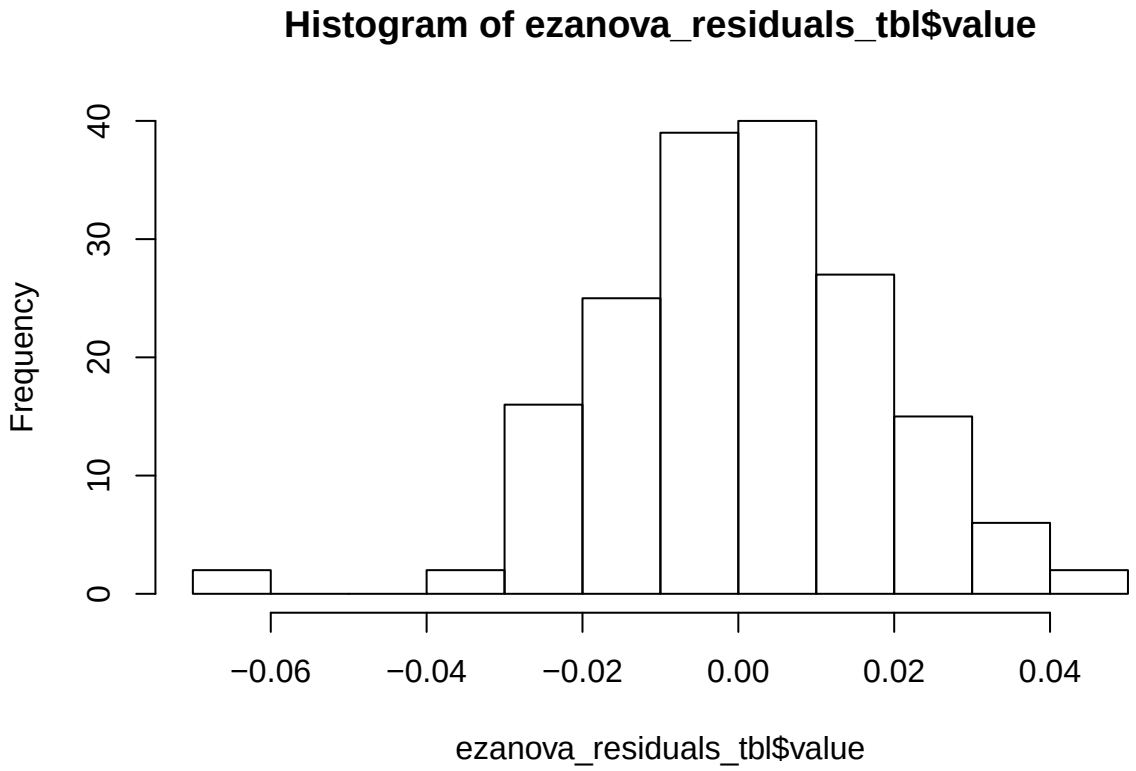

```
## `summarise()` regrouping output by 'Group', 'Task' (override with `.groups` argument)
```


RT ex−gauss tau, all task conditions, group level, +/− SEM
AttendFull
AttendLeft
AttendRight
Mean of RT ex−gauss tau (ms)
0.100
0.075
0.050
0.025
0.000
Absent
Present
Distractor state
Group
Control
ADHD


RT ex−gauss tau, all task conditions, single subject
AttendFull
AttendLeft
AttendRight
RT ex−gauss tau (ms)
0.125
0.100
0.075
0.050
Absent
Present
Distractor state
Control
ADHD

```
##
##  Two-sample Kolmogorov-Smirnov test
##
## data:  exgauss[Group == "Control" & dom_resp == FALSE, ]$tau and exgauss[Group == "Control" & dom_res
## D = 0.1619, p-value = 0.6877
## alternative hypothesis: two-sided
```

Statistics for RT ex-gauss tau:




```
## $ANOVA
##                   Effect DFn DFd          F         p p<.05          ges
## 2                  Group   1  27 0.07631259 0.7844617       0.0010830259
## 3                   Task   2  54 1.39517295 0.2565781       0.0089559367
## 5            Distractors   1  27 0.07716397 0.7832942       0.0004362719
## 4             Group:Task   2  54 0.62658427 0.5382542       0.0040421317
## 6      Group:Distractors   1  27 0.48632417 0.4915334       0.0027432474
## 7       Task:Distractors   2  54 0.80645202 0.4517426       0.0085521564
## 8 Group:Task:Distractors   2  54 0.37485044 0.6891666       0.0039934426
##
## $`Mauchly's Test for Sphericity`
##                   Effect         W         p p<.05
## 3                   Task 0.9418604 0.4590133
## 4             Group:Task 0.9418604 0.4590133
## 7       Task:Distractors 0.9659766 0.6376254
## 8 Group:Task:Distractors 0.9659766 0.6376254
##
## $`Sphericity Corrections`
##                   Effect       GGe     p[GG] p[GG]<.05      HFe     p[HF]
## 3                   Task 0.9450549 0.2567726           1.014004 0.2565781
```

```
## 4             Group:Task 0.9450549 0.5297651           1.014004 0.5382542
## 7       Task:Distractors 0.9670961 0.4482268           1.040409 0.4517426
## 8 Group:Task:Distractors 0.9670961 0.6822427           1.040409 0.6891666
##   p[HF]<.05
## 3
## 4
## 7
## 8
##
## $aov
##
## Call:
## aov(formula = formula(aov_formula), data = data)
##
## Grand Mean: 0.08739718
##
## Stratum 1: ID
##
## Terms:
##                       Group   Residuals
## Sum of Squares  0.000059174 0.020936263
## Deg. of Freedom           1          27
##
## Residual standard error: 0.02784631
## 5 out of 6 effects not estimable
## Estimated effects are balanced
##
## Stratum 2: ID:Task
##
## Terms:
##                        Task  Group:Task   Residuals
## Sum of Squares  0.000508445 0.000221509 0.009544999
## Deg. of Freedom           2           2          54
##
## Residual standard error: 0.01329508
## 4 out of 8 effects not estimable
## Estimated effects may be unbalanced
##
## Stratum 3: ID:Distractors
##
## Terms:
##                 Distractors Group:Distractors   Residuals
## Sum of Squares  0.000019899       0.000150134 0.008335238
## Deg. of Freedom           1                 1          27
##
## Residual standard error: 0.01757022
## 4 out of 6 effects not estimable
## Estimated effects may be unbalanced
##
## Stratum 4: ID:Task:Distractors
##
## Terms:
##                 Task:Distractors Group:Task:Distractors   Residuals
## Sum of Squares       0.000493742            0.000218830 0.015762064
```

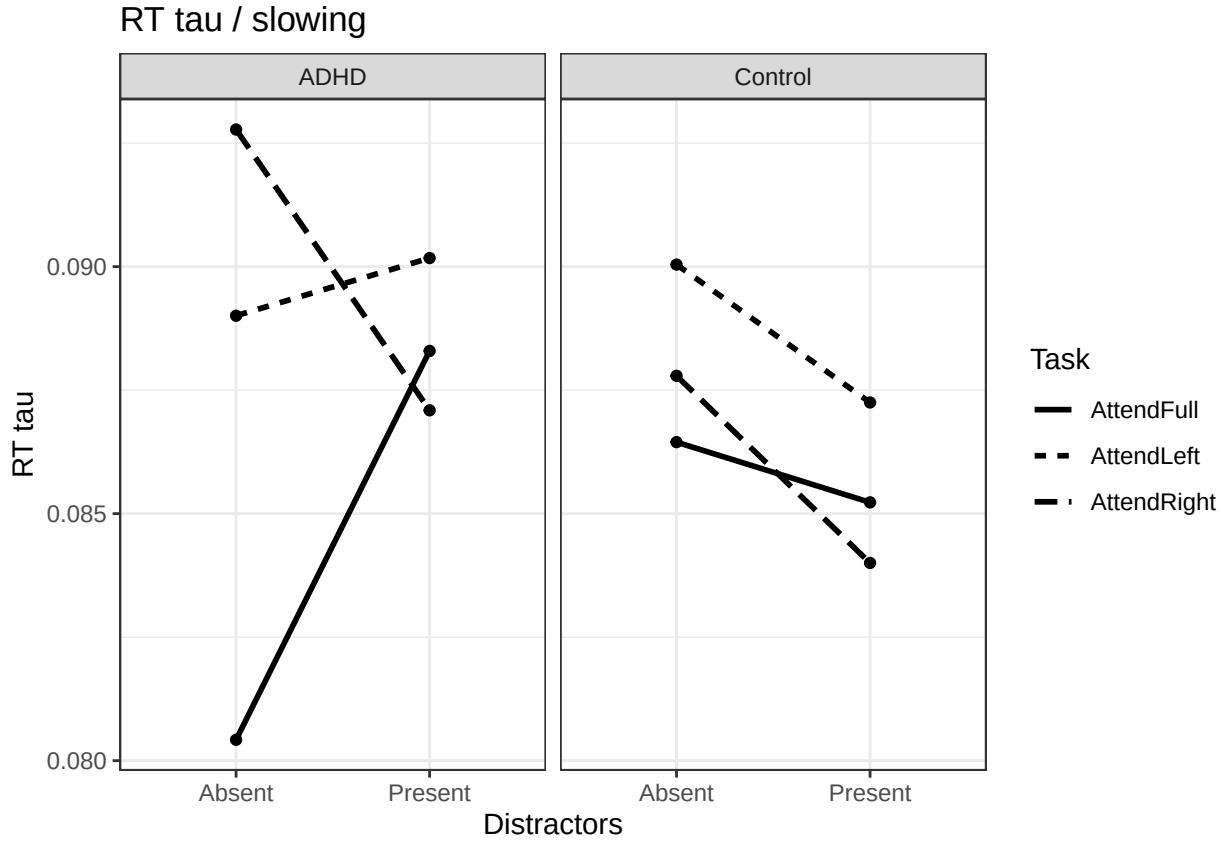
```
## Deg. of Freedom                2                          2          54
##
## Residual standard error: 0.01708479
## Estimated effects may be unbalanced
```

```
## boundary (singular) fit: see ?isSingular
```

Constrasts for exgauss tau

TAU by LMM - joint tests and facet line plot of interactions

```
##  [1] "Control.Absent.AttendFull"   "ADHD.Absent.AttendFull"
##  [3] "Control.Present.AttendFull"  "ADHD.Present.AttendFull"
##  [5] "Control.Absent.AttendLeft"   "ADHD.Absent.AttendLeft"
##  [7] "Control.Present.AttendLeft"  "ADHD.Present.AttendLeft"
##  [9] "Control.Absent.AttendRight"  "ADHD.Absent.AttendRight"
## [11] "Control.Present.AttendRight" "ADHD.Present.AttendRight"
```




```
##  model term             df1 df2 F.ratio p.value
##  Group                    1  27   0.076 0.7845
##  Distractors              1  27   0.077 0.7833
##  Task                     2  54   1.052 0.3561
##  Group:Distractors        1  27   0.486 0.4915
##  Group:Task               2  54   0.473 0.6259
##  Distractors:Task         2  54   1.005 0.3729
##  Group:Distractors:Task   2  54   0.467 0.6294
```

```
## Group = Control:
```

```
##  model term       df1 df2 F.ratio p.value
##  Distractors        1  27   0.460 0.5036
##  Task               2  54   0.308 0.7364
##  Distractors:Task   2  54   0.050 0.9512
##
## Group = ADHD:
##  model term       df1 df2 F.ratio p.value
##  Distractors        1  27   0.091 0.7650
##  Task               2  54   1.250 0.2947
##  Distractors:Task   2  54   1.470 0.2389

## Distractors = Absent, Task = AttendFull:
##  model term df1    df2 F.ratio p.value
##  Group        1 120.42   0.780 0.3788
##
## Distractors = Present, Task = AttendFull:
##  model term df1    df2 F.ratio p.value
##  Group        1 120.42   0.202 0.6540
##
## Distractors = Absent, Task = AttendLeft:
##  model term df1    df2 F.ratio p.value
##  Group        1 120.42   0.023 0.8796
##
## Distractors = Present, Task = AttendLeft:
##  model term df1    df2 F.ratio p.value
##  Group        1 120.42   0.184 0.6690
##
## Distractors = Absent, Task = AttendRight:
##  model term df1    df2 F.ratio p.value
##  Group        1 120.42   0.534 0.4663
##
## Distractors = Present, Task = AttendRight:
##  model term df1    df2 F.ratio p.value
##  Group        1 120.42   0.205 0.6514

## Distractors = Absent:
##  model term df1    df2 F.ratio p.value
##  Group        1  45.56   0.019 0.8905
##  Task         2 108.00   1.742 0.1801
##  Group:Task   2 108.00   0.939 0.3941
##
## Distractors = Present:
##  model term df1    df2 F.ratio p.value
##  Group        1  45.56   0.367 0.5477
##  Task         2 108.00   0.315 0.7303
##  Group:Task   2 108.00   0.000 0.9998

## Task = AttendFull, Group = Control:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 79.54   0.040 0.8417
##
## Task = AttendLeft, Group = Control:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 79.54   0.211 0.6476
##
```

```
## Task = AttendRight, Group = Control:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 79.54   0.388 0.5354
##
## Task = AttendFull, Group = ADHD:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 79.54   1.793 0.1843
##
## Task = AttendLeft, Group = ADHD:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 79.54   0.039 0.8431
##
## Task = AttendRight, Group = ADHD:
##  model term  df1   df2 F.ratio p.value
##  Distractors   1 79.54   0.935 0.3365
```

```
## Task = AttendFull:
##  model term        df1   df2 F.ratio p.value
##  Group               1 58.77   0.077 0.7831
##  Distractors         1 79.54   0.618 0.4340
##  Group:Distractors   1 79.54   1.155 0.2858
##
## Task = AttendLeft:
##  model term        df1   df2 F.ratio p.value
##  Group               1 58.77   0.031 0.8606
##  Distractors         1 79.54   0.037 0.8482
##  Group:Distractors   1 79.54   0.219 0.6411
##
## Task = AttendRight:
##  model term        df1   df2 F.ratio p.value
##  Group               1 58.77   0.569 0.4536
##  Distractors         1 79.54   1.254 0.2663
##  Group:Distractors   1 79.54   0.050 0.8232
```

```
## Distractors = Absent, Group = Control:
##  model term df1 df2 F.ratio p.value
##  Task         2 108   0.197 0.8214
##
## Distractors = Present, Group = Control:
##  model term df1 df2 F.ratio p.value
##  Task         2 108   0.161 0.8517
##
## Distractors = Absent, Group = ADHD:
##  model term df1 df2 F.ratio p.value
##  Task         2 108   2.566 0.0815
##
## Distractors = Present, Group = ADHD:
##  model term df1 df2 F.ratio p.value
##  Task         2 108   0.154 0.8570
```

ADHD has interaction of Distractor and Task: more slowing for attend-Right in Absent than in Present, in contrast to other Task conditions

```
## CONTRAST Task=attend-Full vs Left/Right when Distractor=Absent in ADHD 0 0.5 0 0 0 -0.25 0 0 0 -0.25
##
```

```
##   General Linear Hypotheses
##
## Multiple Comparisons of Means: User-defined Contrasts
##
##
## Linear Hypotheses:
##                      Estimate
## FvLR_Abs_adhd == 0 -0.005234
##
## Global Test:
##       F DF1 DF2  Pr(>F)
## 1 4.398   1 160 0.03756
```

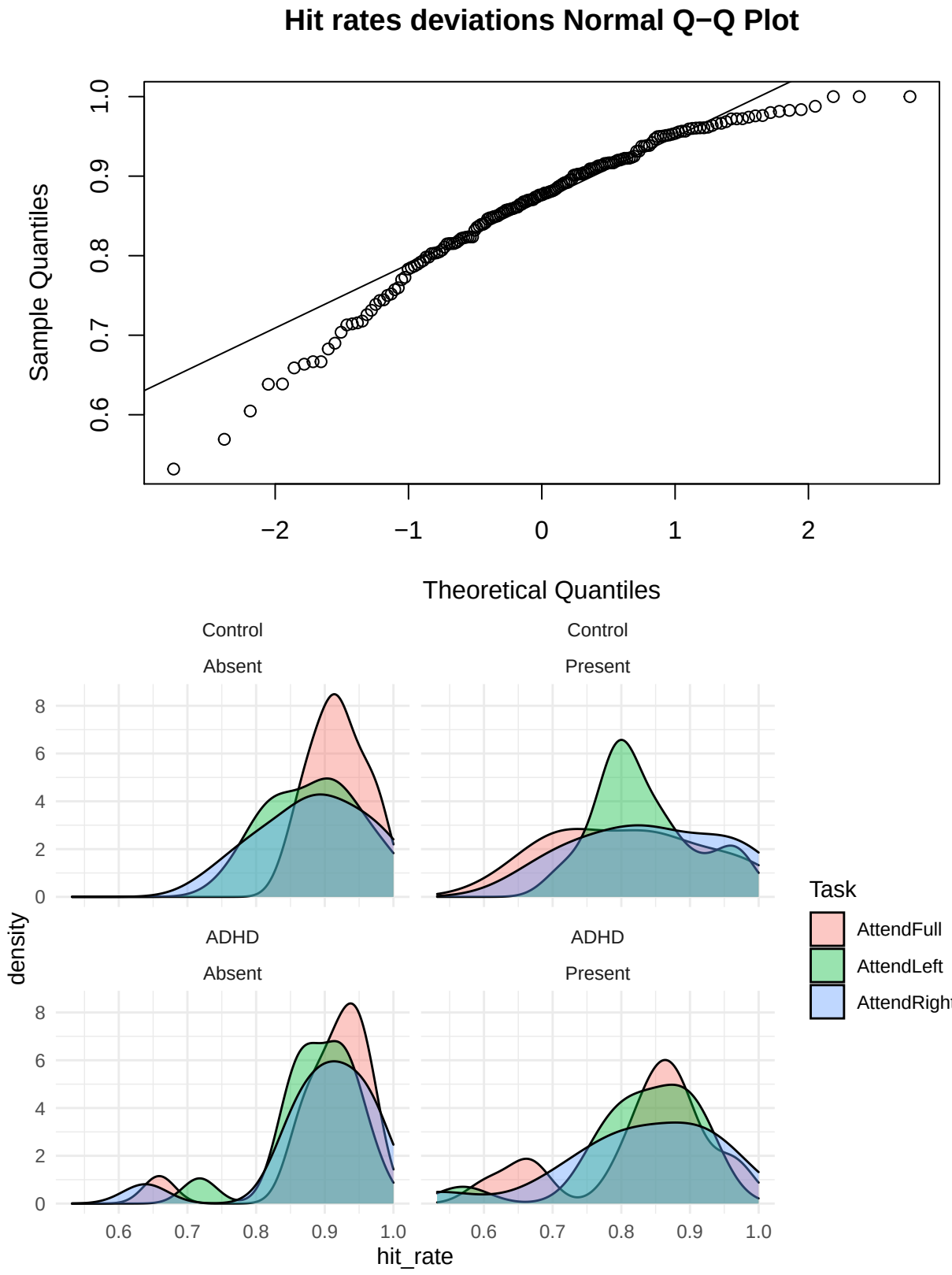
```
## CONTRAST Task=attendFull vs Left/Right in ADHD 0 -0.25 0 0.25 0 -0.25 0 0.25 0 0.5 0 -0.5
```

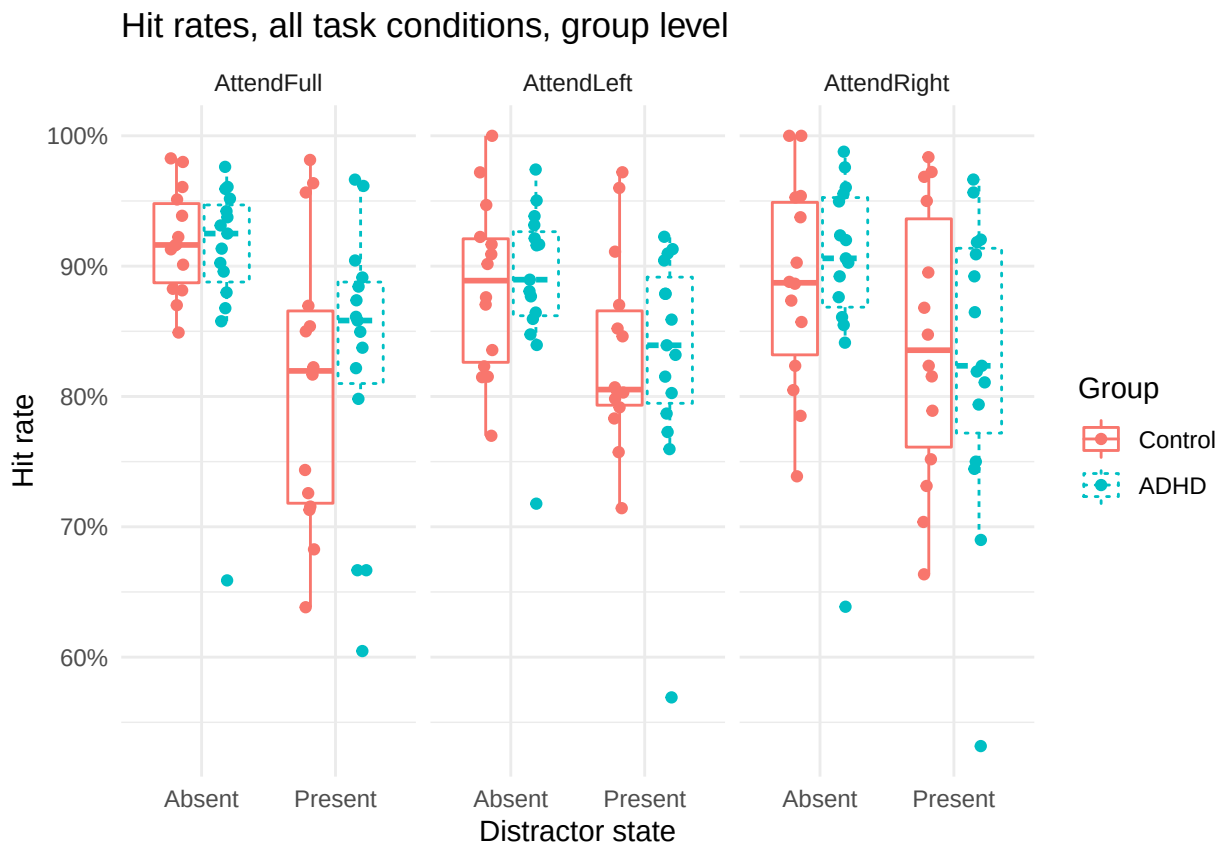
```
##
##   General Linear Hypotheses
##
## Multiple Comparisons of Means: User-defined Contrasts
##
##
## Linear Hypotheses:
##                Estimate
## drAR_adhd == 0 0.005102
##
## Global Test:
##       F DF1 DF2 Pr(>F)
## 1 2.089   1 160 0.1503
```

TAU summary

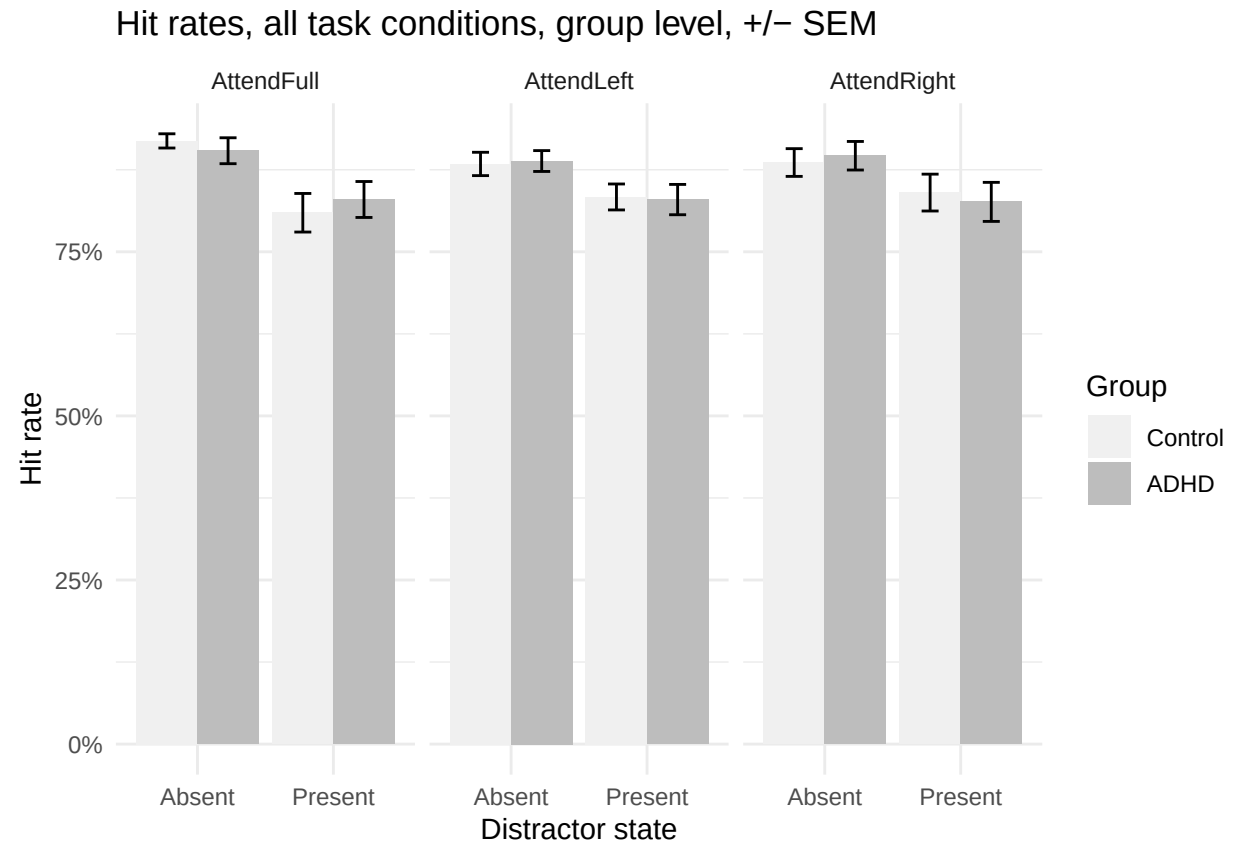
There were no main effects or noticeable trends for TAU. The only noteworthy effect is Task=attend-Full vs Left/Right when Distractor=Absent in ADHD (F = 4.4). The visible difference in ADHD between Distractors' effect in Task=attend-Right (reduced slowing) and the other Task conditions (increased slowing) does not match a notable effect (F = 2.1)

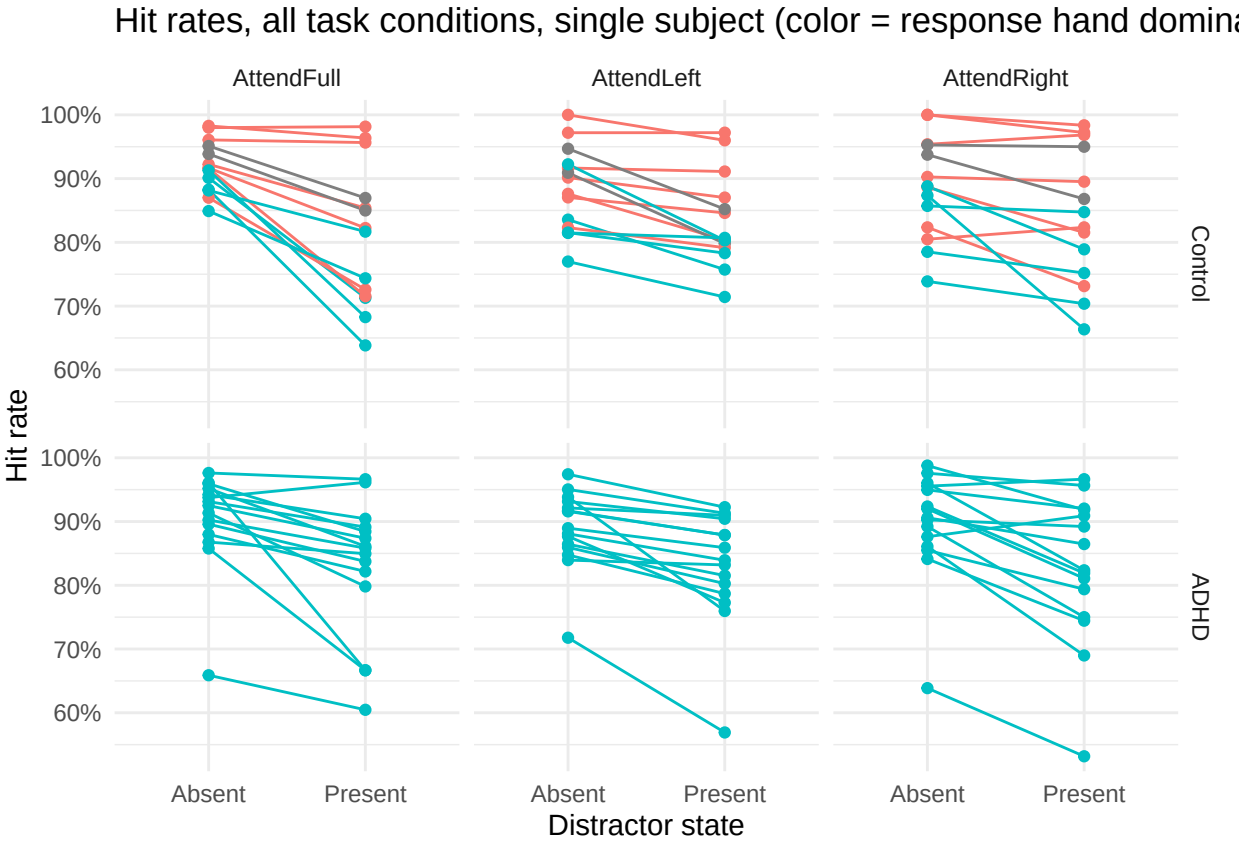
HIT RATES


Hit rates deviations Normal Q−Q Plot
Sample Quantiles
Theoretical Quantiles
Control
Absent
Control
Present
ADHD
Absent
ADHD
Present
density
hit_rate
Task
AttendFull
AttendLeft
AttendRight



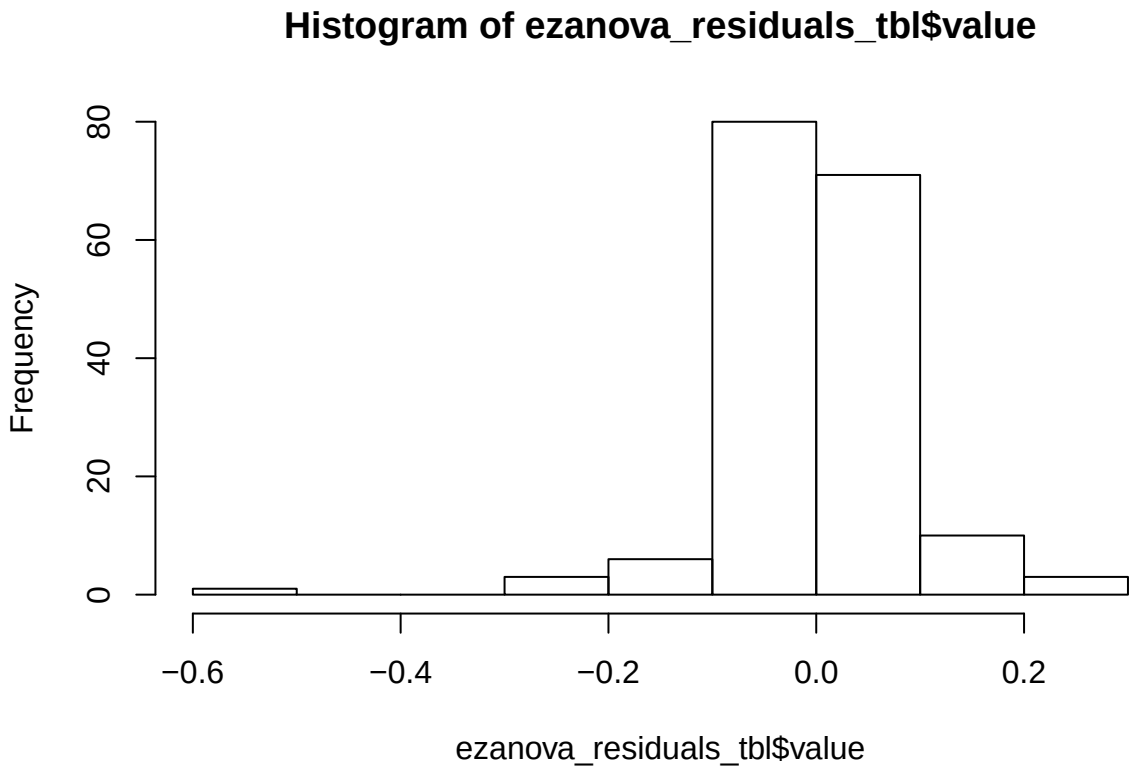

```
## `summarise()` regrouping output by 'Group', 'Task' (override with `.groups` argument)
```


Hit rates, all task conditions, group level, +/− SEM
AttendFull
AttendLeft
AttendRight
75%
50%
25%
0%
Hit rate
Absent
Present
Distractor state
Group
Control
ADHD


Hit rates, all task conditions, single subject (color = response hand domina
AttendFull
AttendLeft
AttendRight
100%
90%
80%
70%
60%
Hit rate
Control
ADHD
Absent
Present
Distractor state

```
##
##  Two-sample Kolmogorov-Smirnov test
##
## data:  hit_rates[Group == "Control" & dom_resp == FALSE, ]$hit_rate and hit_rates[Group == "Control"
## D = 0.48095, p-value = 0.0006095
## alternative hypothesis: two-sided
```

Statistics for hit rates




```
## $ANOVA
##                   Effect DFn DFd            F            p p<.05          ges
## 2                  Group   1  27 1.184201e-04 9.913975e-01       3.503582e-06
## 3                   Task   2  54 4.150472e-01 6.623975e-01       1.069931e-03
## 5            Distractors   1  27 7.184181e+01 4.342724e-09     * 1.416731e-01
## 4             Group:Task   2  54 4.748406e-02 9.536654e-01       1.225230e-04
## 6      Group:Distractors   1  27 2.126028e-03 9.635628e-01       4.884545e-06
## 7       Task:Distractors   2  54 3.916128e+00 2.581213e-02     * 9.974818e-03
## 8 Group:Task:Distractors   2  54 2.198191e+00 1.208401e-01       5.623646e-03
##
## $`Mauchly's Test for Sphericity`
##                   Effect         W         p p<.05
## 3                   Task 0.9639195 0.6201978
## 4             Group:Task 0.9639195 0.6201978
## 7       Task:Distractors 0.9009637 0.2577478
## 8 Group:Task:Distractors 0.9009637 0.2577478
##
## $`Sphericity Corrections`
##                   Effect       GGe      p[GG] p[GG]<.05       HFe      p[HF]
## 3                   Task 0.9651760 0.65531325           1.0381051 0.66239749
```

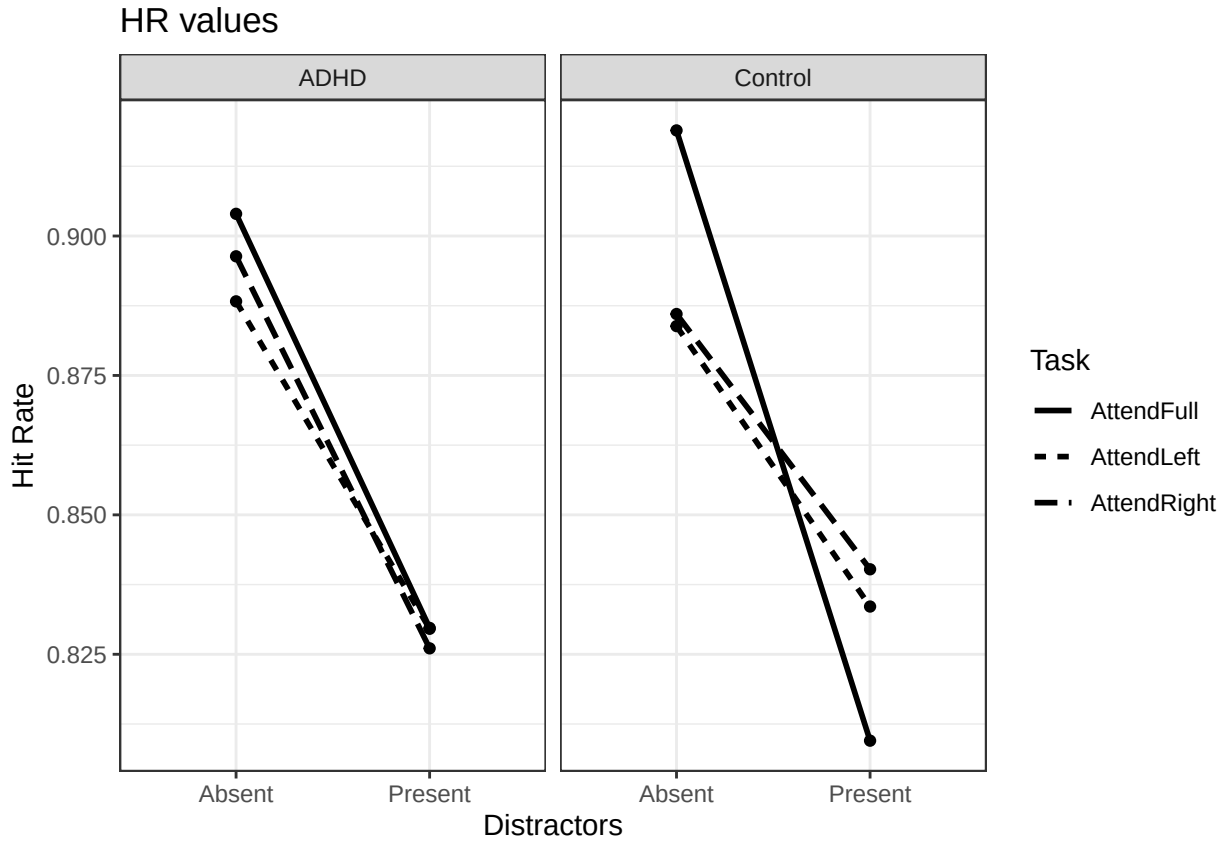
```
## 4             Group:Task 0.9651760 0.94946032           1.0381051 0.95366544
## 7       Task:Distractors 0.9098881 0.02989337         * 0.9720671 0.02701283
## 8 Group:Task:Distractors 0.9098881 0.12613623           0.9720671 0.12246783
##   p[HF]<.05
## 3
## 4
## 7         *
## 8
##
## $aov
##
## Call:
## aov(formula = formula(aov_formula), data = data)
##
## Grand Mean: 0.8621807
##
## Stratum 1: ID
##
## Terms:
##                     Group Residuals
## Sum of Squares  0.0000043 0.9758254
## Deg. of Freedom         1        27
##
## Residual standard error: 0.1901097
## 5 out of 6 effects not estimable
## Estimated effects are balanced
##
## Stratum 2: ID:Task
##
## Terms:
##                       Task Group:Task  Residuals
## Sum of Squares  0.00132633 0.00014969 0.08511514
## Deg. of Freedom          2          2         54
##
## Residual standard error: 0.03970147
## 4 out of 8 effects not estimable
## Estimated effects may be unbalanced
##
## Stratum 3: ID:Distractors
##
## Terms:
##                 Distractors Group:Distractors  Residuals
## Sum of Squares   0.20179408        0.00000597 0.07577765
## Deg. of Freedom           1                 1         27
##
## Residual standard error: 0.05297716
## 4 out of 6 effects not estimable
## Estimated effects may be unbalanced
##
## Stratum 4: ID:Task:Distractors
##
## Terms:
##                 Task:Distractors Group:Task:Distractors  Residuals
## Sum of Squares        0.01173242             0.00690856 0.08485660
```

```
## Deg. of Freedom                2                         2         54
##
## Residual standard error: 0.03964112
## Estimated effects may be unbalanced
```

Constrasts for Hit Rates

Hit rate by LMM - joint tests and facet line plot of interactions

```
## NULL
```




```
##  model term             df1 df2 F.ratio p.value
##  Group                    1  27   0.000 0.9914
##  Distractors              1  27  71.837 <.0001
##  Task                     2  54   0.416 0.6620
##  Group:Distractors        1  27   0.002 0.9636
##  Group:Task               2  54   0.048 0.9536
##  Distractors:Task         2  54   3.910 0.0259
##  Group:Distractors:Task   2  54   2.195 0.1212
```

```
## Group = Control:
##  model term       df1 df2 F.ratio p.value
##  Distractors        1  27  35.100 <.0001
##  Task               2  54   0.152 0.8595
##  Distractors:Task   2  54   5.612 0.0061
##
## Group = ADHD:
##  model term       df1 df2 F.ratio p.value
```

```
##  Distractors        1  27  36.797 <.0001
##  Task               2  54   0.317 0.7296
##  Distractors:Task   2  54   0.311 0.7342

## Distractors = Absent, Task = AttendFull:
##  model term df1   df2 F.ratio p.value
##  Group        1 41.74   0.215 0.6454
##
## Distractors = Present, Task = AttendFull:
##  model term df1   df2 F.ratio p.value
##  Group        1 41.74   0.393 0.5344
##
## Distractors = Absent, Task = AttendLeft:
##  model term df1   df2 F.ratio p.value
##  Group        1 41.74   0.019 0.8913
##
## Distractors = Present, Task = AttendLeft:
##  model term df1   df2 F.ratio p.value
##  Group        1 41.74   0.015 0.9022
##
## Distractors = Absent, Task = AttendRight:
##  model term df1   df2 F.ratio p.value
##  Group        1 41.74   0.103 0.7500
##
## Distractors = Present, Task = AttendRight:
##  model term df1   df2 F.ratio p.value
##  Group        1 41.74   0.193 0.6627

## Distractors = Absent:
##  model term df1    df2 F.ratio p.value
##  Group        1  31.17   0.000 0.9985
##  Task         2 108.00   3.318 0.0399
##  Group:Task   2 108.00   0.806 0.4492
##
## Distractors = Present:
##  model term df1    df2 F.ratio p.value
##  Group        1  31.17   0.001 0.9819
##  Task         2 108.00   1.008 0.3684
##  Group:Task   2 108.00   1.436 0.2424

## Task = AttendFull, Group = Control:
##  model term  df1  df2 F.ratio p.value
##  Distractors   1 74.6  42.230 <.0001
##
## Task = AttendLeft, Group = Control:
##  model term  df1  df2 F.ratio p.value
##  Distractors   1 74.6   8.918 0.0038
##
## Task = AttendRight, Group = Control:
##  model term  df1  df2 F.ratio p.value
##  Distractors   1 74.6   7.388 0.0082
##
## Task = AttendFull, Group = ADHD:
##  model term  df1  df2 F.ratio p.value
##  Distractors   1 74.6  20.833 <.0001
```

```
##
## Task = AttendLeft, Group = ADHD:
##  model term  df1  df2 F.ratio p.value
##  Distractors   1 74.6  13.026 0.0006
##
## Task = AttendRight, Group = ADHD:
##  model term  df1  df2 F.ratio p.value
##  Distractors   1 74.6  18.672 <.0001
```

```
## Task = AttendFull:
##  model term        df1   df2 F.ratio p.value
##  Group               1 31.79   0.008 0.9308
##  Distractors         1 74.60  61.543 <.0001
##  Group:Distractors   1 74.60   2.257 0.1372
##
## Task = AttendLeft:
##  model term        df1   df2 F.ratio p.value
##  Group               1 31.79   0.000 0.9941
##  Distractors         1 74.60  21.672 <.0001
##  Group:Distractors   1 74.60   0.130 0.7199
##
## Task = AttendRight:
##  model term        df1   df2 F.ratio p.value
##  Group               1 31.79   0.004 0.9497
##  Distractors         1 74.60  24.575 <.0001
##  Group:Distractors   1 74.60   1.097 0.2983
```

```
## Distractors = Absent, Group = Control:
##  model term df1 df2 F.ratio p.value
##  Task         2 108   3.439 0.0356
##
## Distractors = Present, Group = Control:
##  model term df1 df2 F.ratio p.value
##  Task         2 108   2.324 0.1027
##
## Distractors = Absent, Group = ADHD:
##  model term df1 df2 F.ratio p.value
##  Task         2 108   0.587 0.5578
##
## Distractors = Present, Group = ADHD:
##  model term df1 df2 F.ratio p.value
##  Task         2 108   0.041 0.9600
```

Distractor effect interacts with Task=Full vs Left/Right in CTRL, and the difference of this effect with ADHD is also noticeable

```
## TEST CONTRAST: drAF_ctrl 0.5 0 -0.5 0 -0.25 0 0.25 0 -0.25 0 0.25 0
```

```
##
##   General Linear Hypotheses
##
## Multiple Comparisons of Means: User-defined Contrasts
##
##
## Linear Hypotheses:
##                Estimate
```

```
## drAF_ctrl == 0   0.0307
##
## Global Test:
##       F DF1 DF2   Pr(>F)
## 1 9.664   1 160 0.002225
```

```
## TEST CONTRAST: drAF_adhd 0 0.5 0 -0.5 0 -0.25 0 0.25 0 -0.25 0 0.25
```

```
##
##   General Linear Hypotheses
##
## Multiple Comparisons of Means: User-defined Contrasts
##
##
## Linear Hypotheses:
##                 Estimate
## drAF_adhd == 0 0.004873
##
## Global Test:
##        F DF1 DF2 Pr(>F)
## 1 0.2609   1 160 0.6102
```

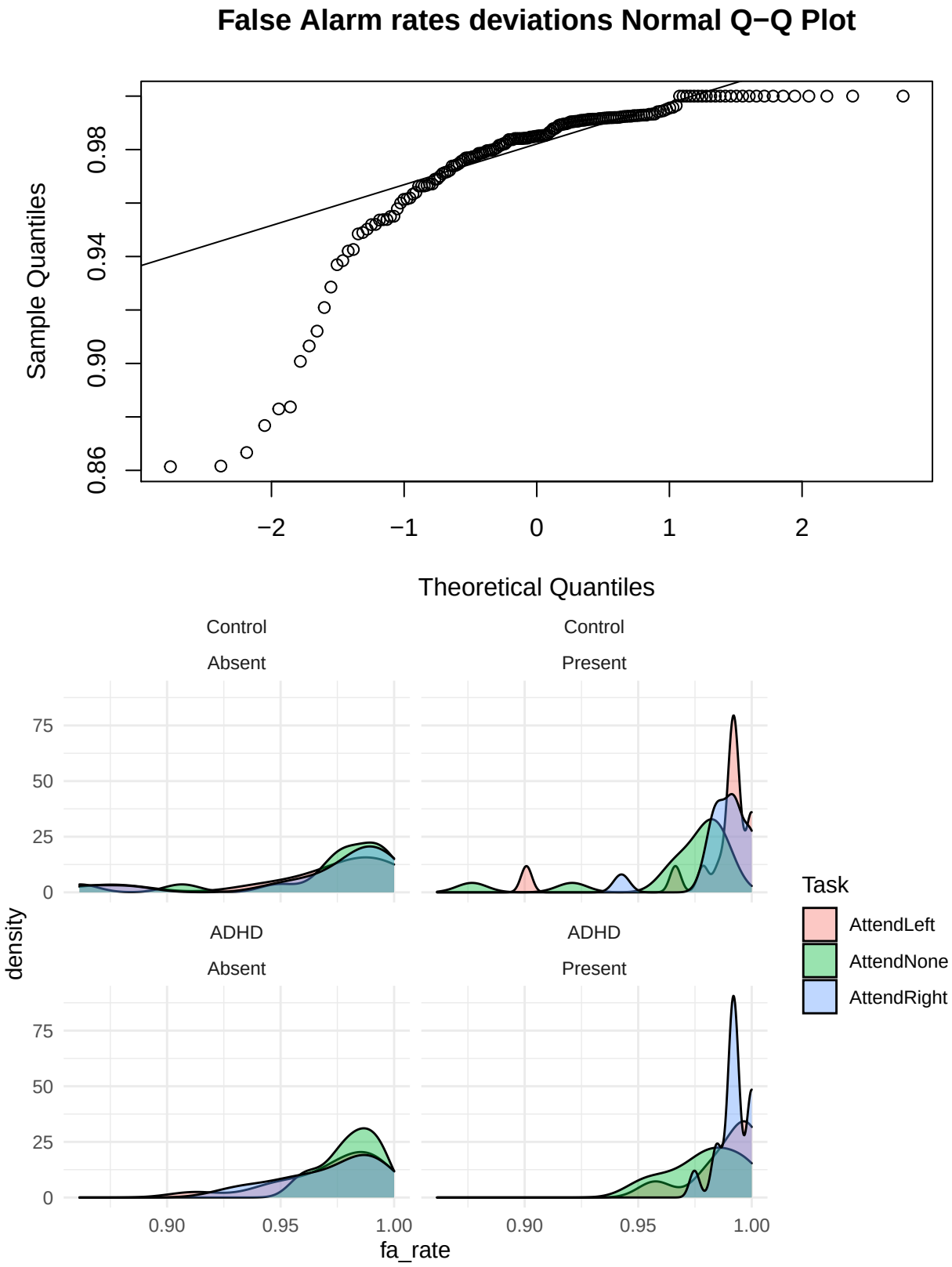
```
## TEST CONTRAST: drAF_ctrl V ADHD 0.25 -0.25 -0.25 0.25 -0.125 0.125 0.125 -0.125 -0.125 0.125 0.125 -
```

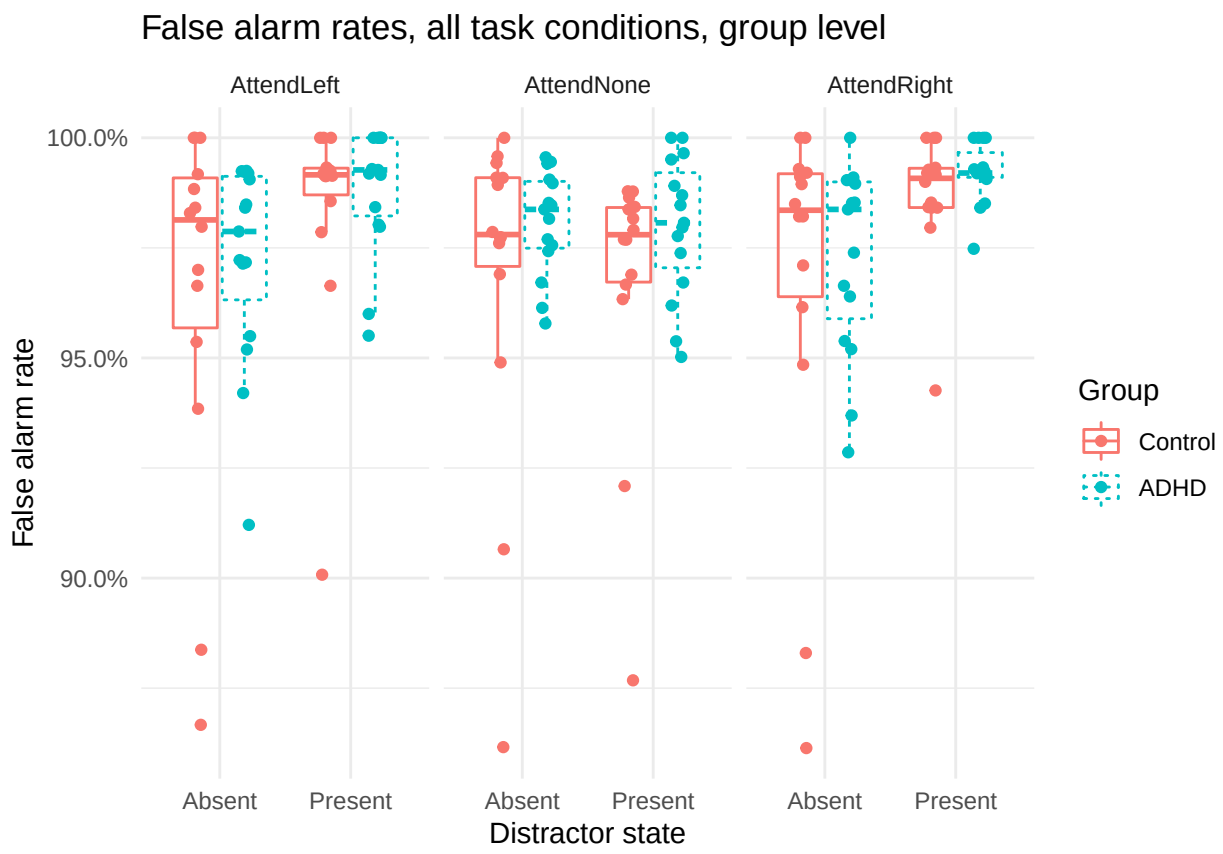
```
##
##   General Linear Hypotheses
##
## Multiple Comparisons of Means: User-defined Contrasts
##
##
## Linear Hypotheses:
##                Estimate
## drAF_CvA == 0  0.01291
##
## Global Test:
##       F DF1 DF2  Pr(>F)
## 1 3.537   1 160 0.06182
```

Hit Rate summary

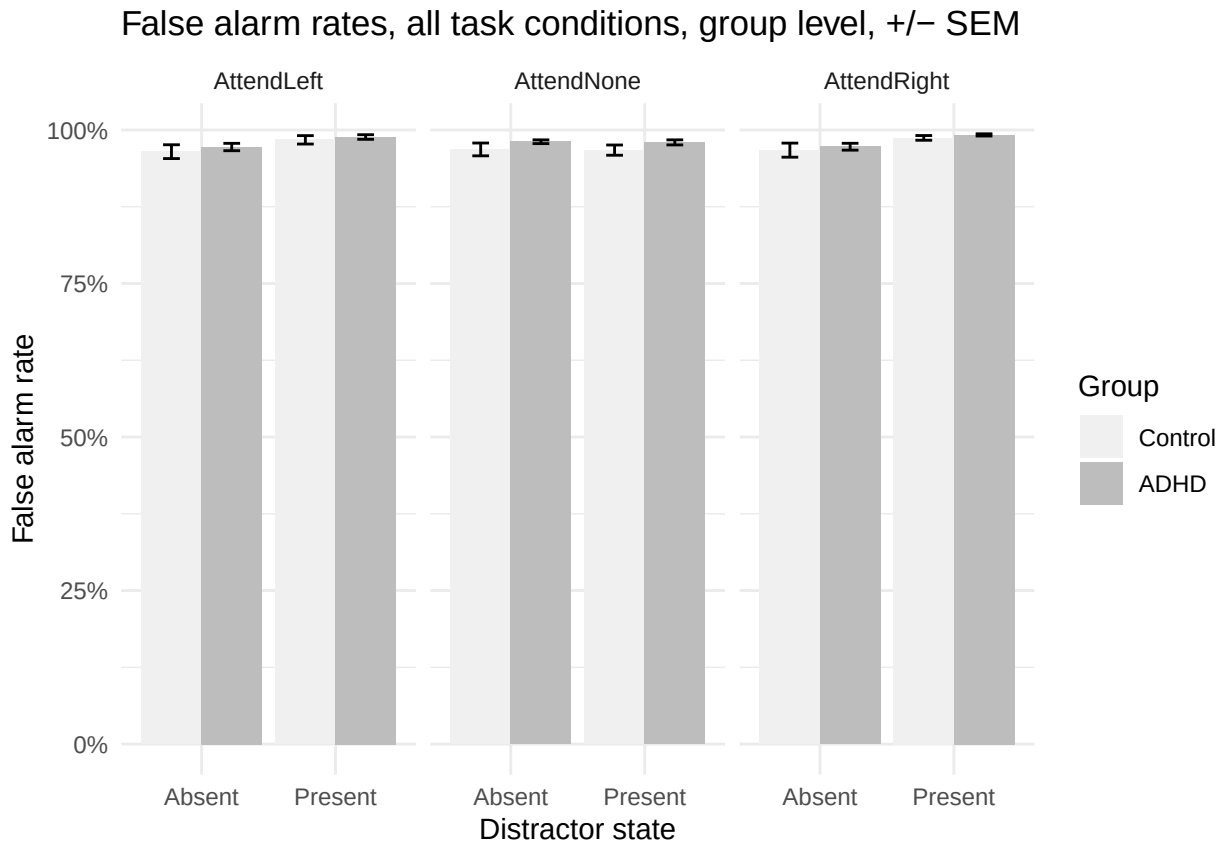
CTRL performance was affected by response handedness, rendering this DV problematic for group comparison (even this result is counter-intuitive as the dominant-hand CTRL subgroup performed worse than the non-dominant hand subgroup). However, the most noteworthy result here is intra-group: CTRL show again a large interaction between Distractor effect and Task, with more impact of Distractors on Task=attend-Full than Left/Right (F = 9.7). The interaction is not present in ADHD (F = 0.3), such that the difference between groups in terms of this interaction is noteworthy (F = 3.5).

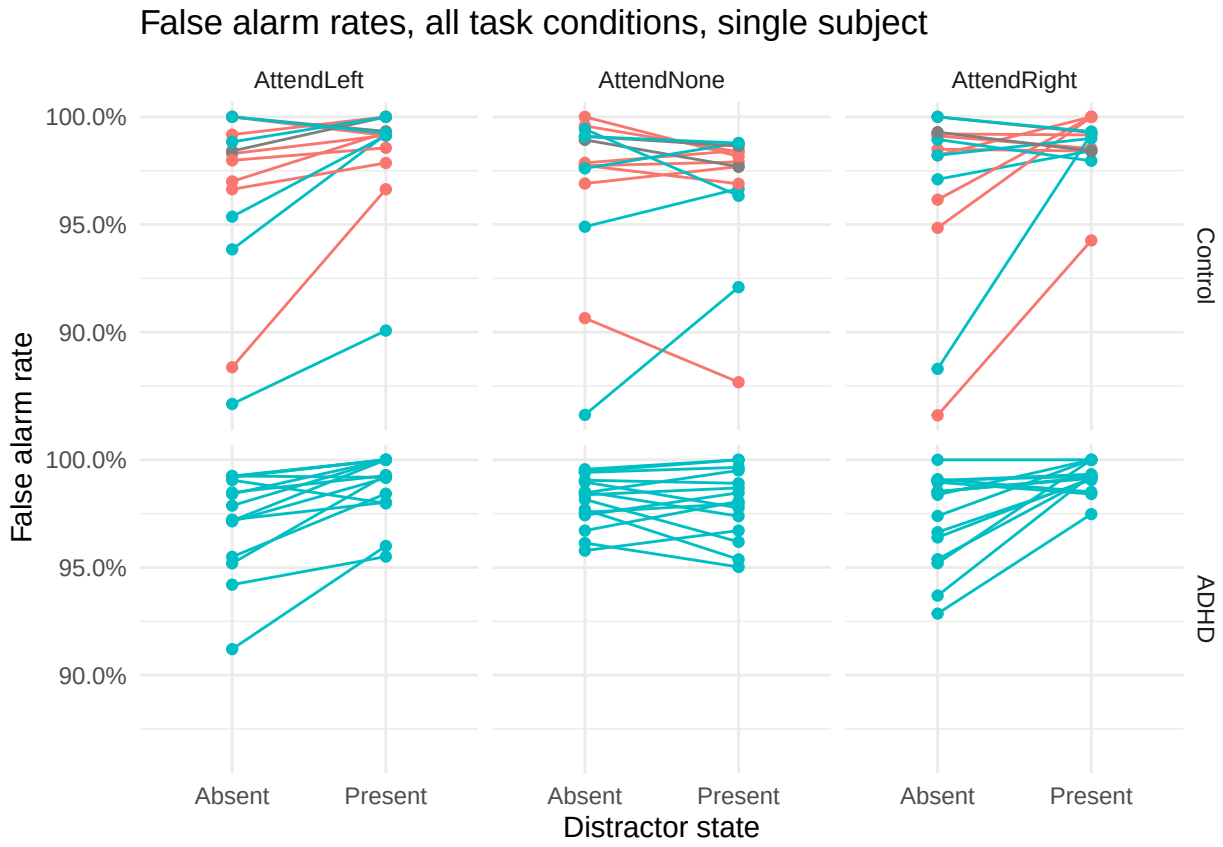
FALSE ALARMS





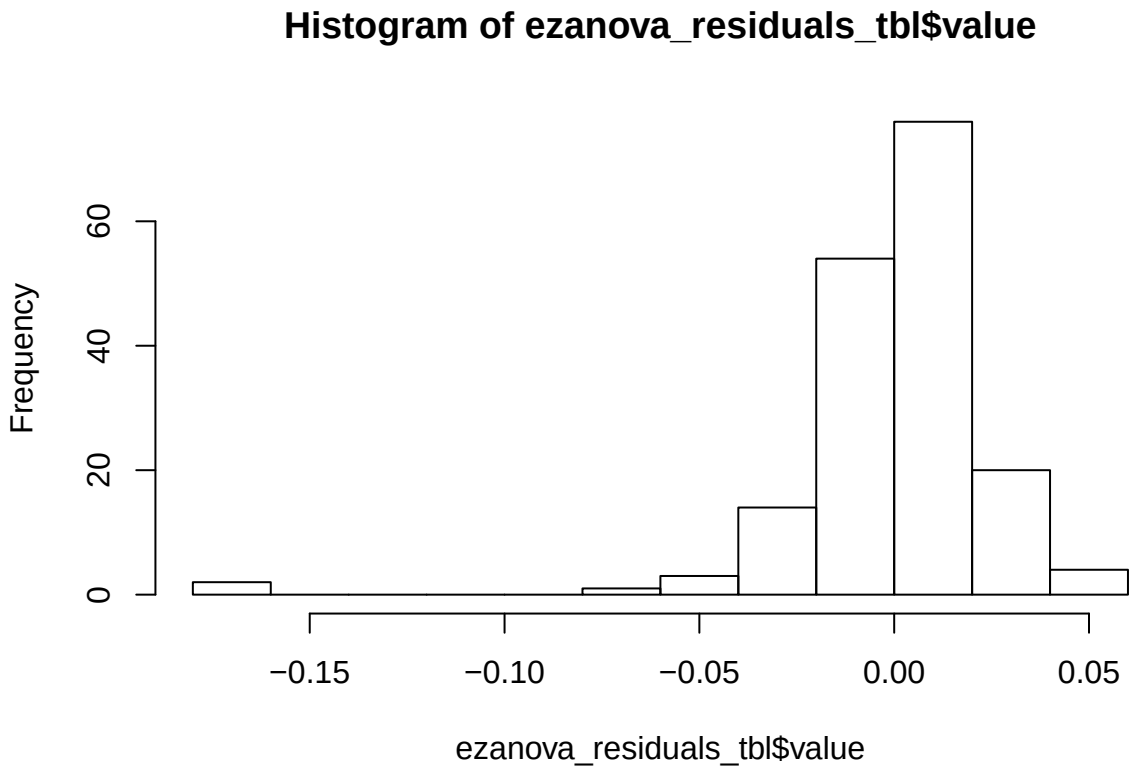

```
## `summarise()` regrouping output by 'Group', 'Task' (override with `.groups` argument)
```


False alarm rates, all task conditions, group level, +/− SEM
AttendLeft
AttendNone
AttendRight
100%
75%
50%
25%
0%
False alarm rate
Absent
Present
Distractor state
Group
Control
ADHD


False alarm rates, all task conditions, single subject
AttendLeft
AttendNone
AttendRight
100.0%
95.0%
90.0%
False alarm rate
Absent
Present
Distractor state
Control
ADHD

```
##
##  Two-sample Kolmogorov-Smirnov test
##
## data:  fa_rates[Group == "Control" & dom_resp == FALSE, ]$fa_rate and fa_rates[Group == "Control" & d
## D = 0.16667, p-value = 0.7159
## alternative hypothesis: two-sided
```

Statistics for false alarm rates:



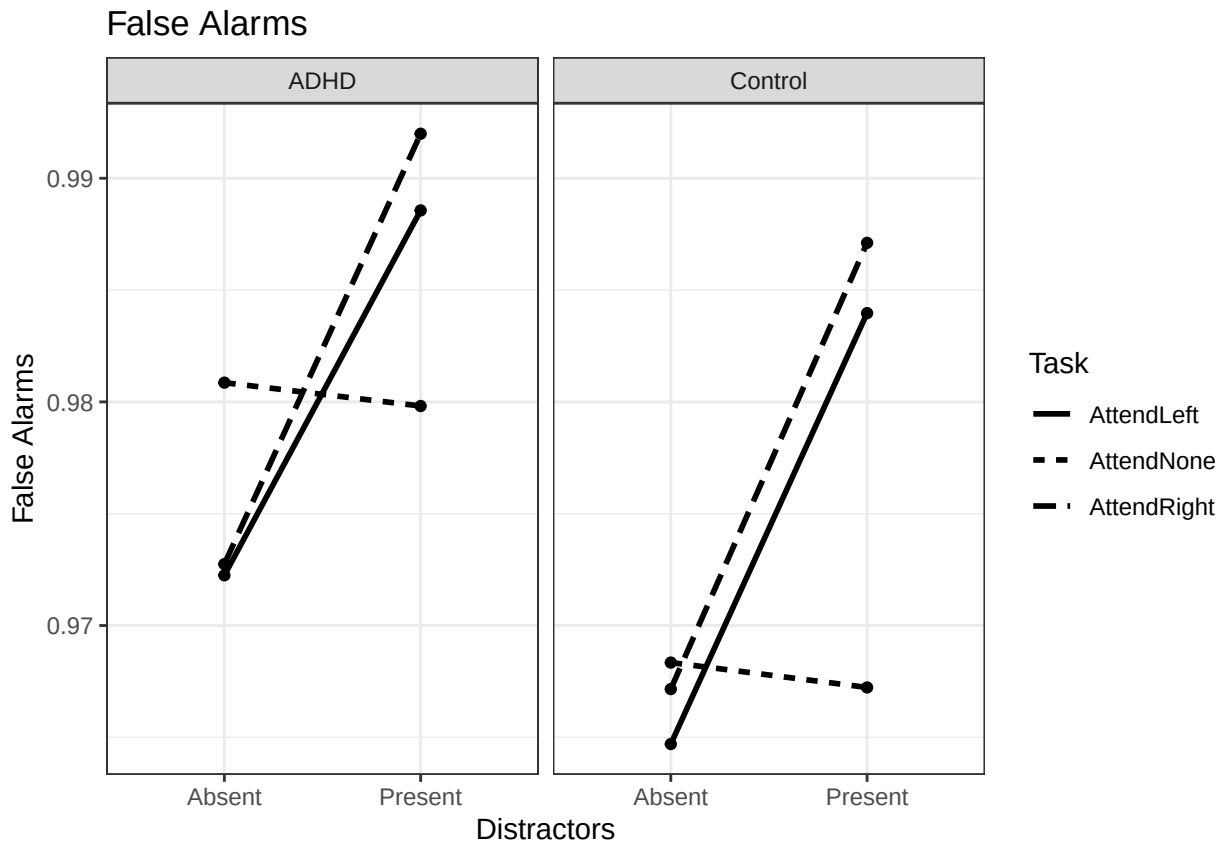

```
## $ANOVA
##                   Effect DFn DFd           F            p p<.05          ges
## 2                  Group   1  27  0.99624544 0.3270825057       0.0235676226
## 3                   Task   2  54  1.47716918 0.2373600463       0.0082416656
## 5            Distractors   1  27 15.43837908 0.0005336195     * 0.0529696664
## 4             Group:Task   2  54  0.72569044 0.4886497069       0.0040659392
## 6      Group:Distractors   1  27  0.03775998 0.8473805867       0.0001367836
## 7       Task:Distractors   2  54  9.37433253 0.0003201517     * 0.0323030917
## 8 Group:Task:Distractors   2  54  0.04387023 0.9571122216       0.0001561948
##
## $`Mauchly's Test for Sphericity`
##                   Effect         W         p p<.05
## 3                   Task 0.9653826 0.6325478
## 4             Group:Task 0.9653826 0.6325478
## 7       Task:Distractors 0.9583853 0.5754691
## 8 Group:Task:Distractors 0.9583853 0.5754691
##
## $`Sphericity Corrections`
##                   Effect       GGe        p[GG] p[GG]<.05      HFe        p[HF]
## 3                   Task 0.9665409 0.2378270702          1.039743 0.2373600463
```

```
## 4             Group:Task 0.9665409 0.4843929958           1.039743 0.4886497069
## 7       Task:Distractors 0.9600479 0.0003975696         * 1.031955 0.0003201517
## 8 Group:Task:Distractors 0.9600479 0.9524710628           1.031955 0.9571122216
##   p[HF]<.05
## 3
## 4
## 7         *
## 8
##
## $aov
##
## Call:
## aov(formula = formula(aov_formula), data = data)
##
## Grand Mean: 0.9771982
##
## Stratum 1: ID
##
## Terms:
##                       Group  Residuals
## Sum of Squares  0.00274685 0.07444458
## Deg. of Freedom          1         27
##
## Residual standard error: 0.05250911
## 5 out of 6 effects not estimable
## Estimated effects are balanced
##
## Stratum 2: ID:Task
##
## Terms:
##                         Task  Group:Task   Residuals
## Sum of Squares  0.000904047 0.000464614 0.017286406
## Deg. of Freedom           2           2          54
##
## Residual standard error: 0.01789186
## 4 out of 8 effects not estimable
## Estimated effects may be unbalanced
##
## Stratum 3: ID:Distractors
##
## Terms:
##                 Distractors Group:Distractors   Residuals
## Sum of Squares  0.006351256       0.000015569 0.011132366
## Deg. of Freedom           1                 1          27
##
## Residual standard error: 0.02030541
## 4 out of 6 effects not estimable
## Estimated effects may be unbalanced
##
## Stratum 4: ID:Task:Distractors
##
## Terms:
##                 Task:Distractors Group:Task:Distractors   Residuals
## Sum of Squares       0.003792034            0.000017779 0.010941836
```

```
## Deg. of Freedom                2                          2          54
##
## Residual standard error: 0.0142347
## Estimated effects may be unbalanced
```

Constrasts for False Alarms

False Alarm by LMM - joint tests and facet line plot of interactions




```
##  model term             df1 df2 F.ratio p.value
##  Group                    1  27   0.996 0.3271
##  Distractors              1  27  15.438 0.0005
##  Task                     2  54   1.477 0.2374
##  Group:Distractors        1  27   0.038 0.8474
##  Group:Task               2  54   0.726 0.4887
##  Distractors:Task         2  54   9.374 0.0003
##  Group:Distractors:Task   2  54   0.044 0.9571
```

```
## Group = Control:
##  model term       df1 df2 F.ratio p.value
##  Distractors        1  27   8.218 0.0079
##  Task               2  54   2.013 0.1435
##  Distractors:Task   2  54   4.949 0.0106
##
## Group = ADHD:
##  model term       df1 df2 F.ratio p.value
##  Distractors        1  27   7.224 0.0122
```

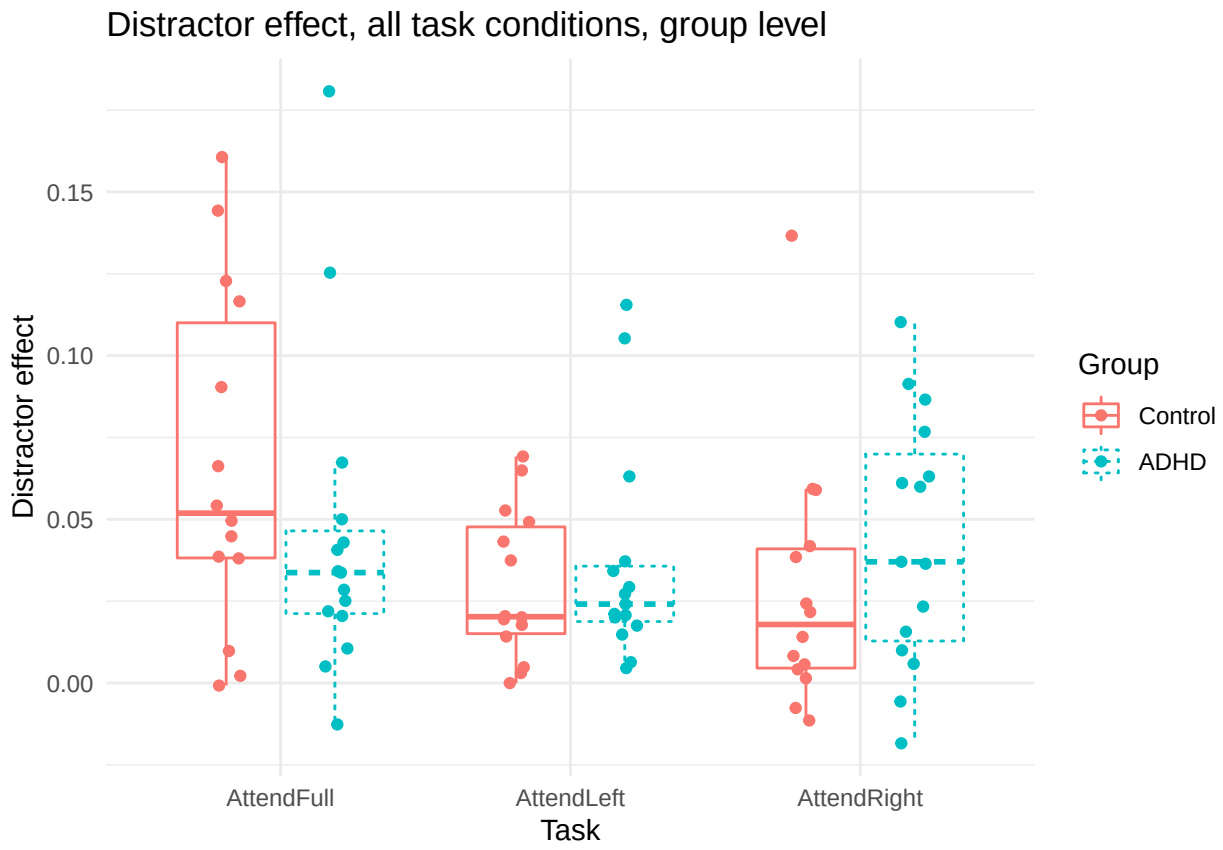
```
##  Task               2  54   0.125 0.8831
##  Distractors:Task   2  54   4.452 0.0162
```

```
## Task = AttendLeft:
##  model term        df1   df2 F.ratio p.value
##  Group               1 39.92   0.471 0.4964
##  Distractors         1 71.58  16.822 0.0001
##  Group:Distractors   1 71.58   0.116 0.7348
##
## Task = AttendNone:
##  model term        df1   df2 F.ratio p.value
##  Group               1 39.92   2.014 0.1636
##  Distractors         1 71.58   0.062 0.8043
##  Group:Distractors   1 71.58   0.000 0.9938
##
## Task = AttendRight:
##  model term        df1   df2 F.ratio p.value
##  Group               1 39.92   0.350 0.5573
##  Distractors         1 71.58  20.414 <.0001
##  Group:Distractors   1 71.58   0.007 0.9351
```

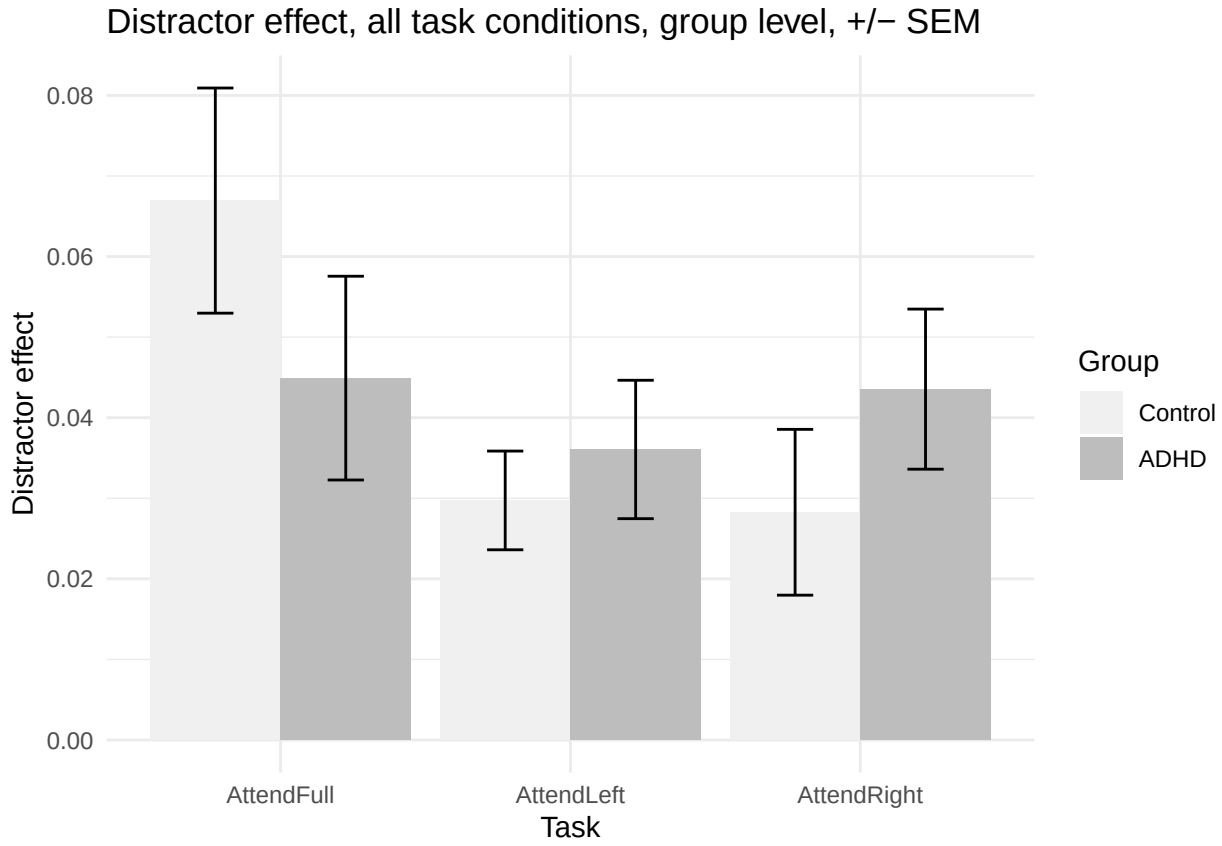
False Alarm summary

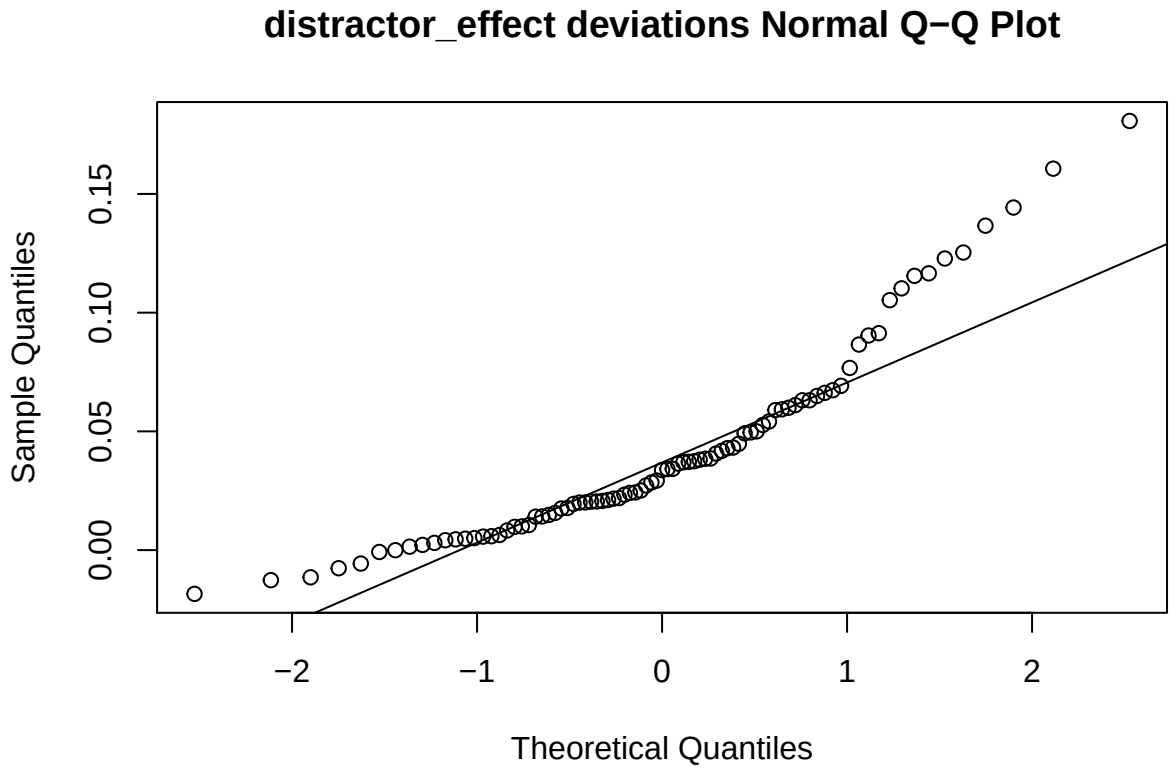
There were no noteworthy effects of False Alarms: groups were not different in any condition; Distractor effects behaved as expected (large effect in Task = attend-Left/Right (F = 17/20), no effect in attend-None (F = 0.1)); there was an interaction between Distractor and Task.

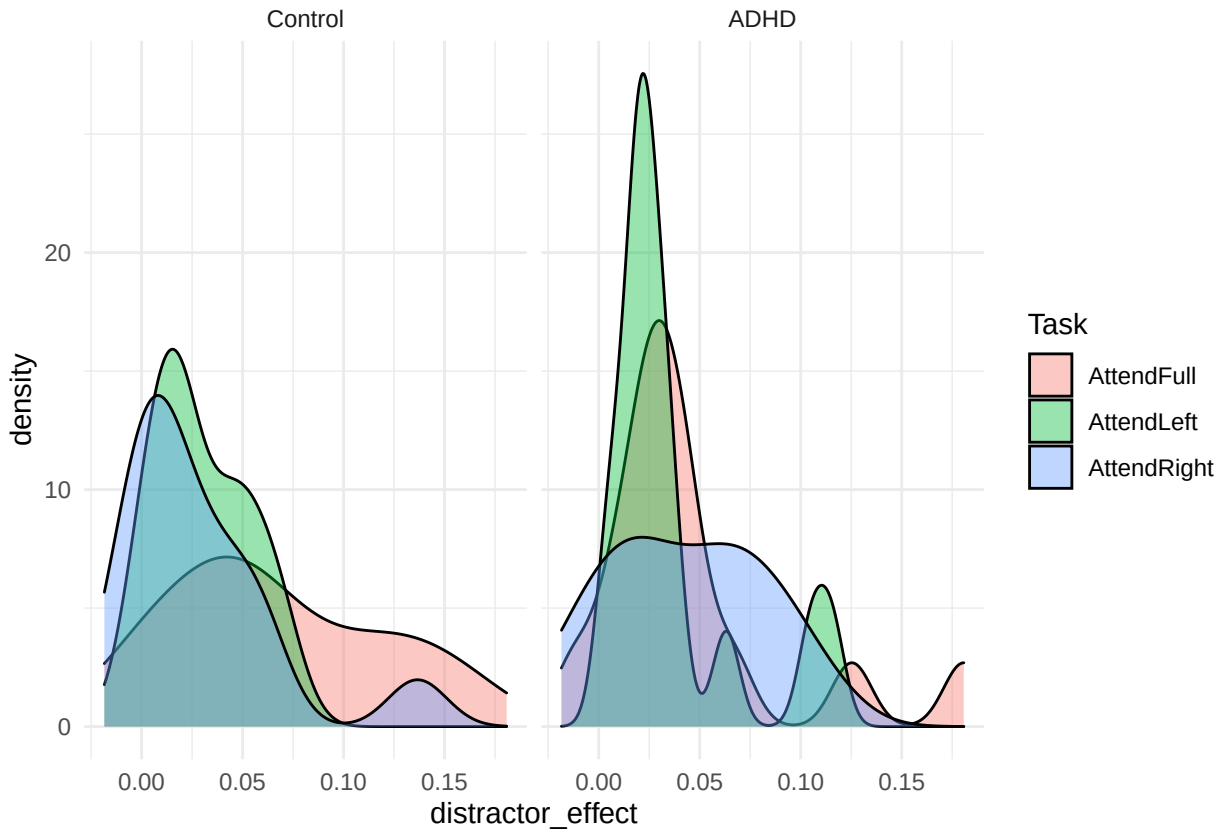
DISTRACTOR EFFECT



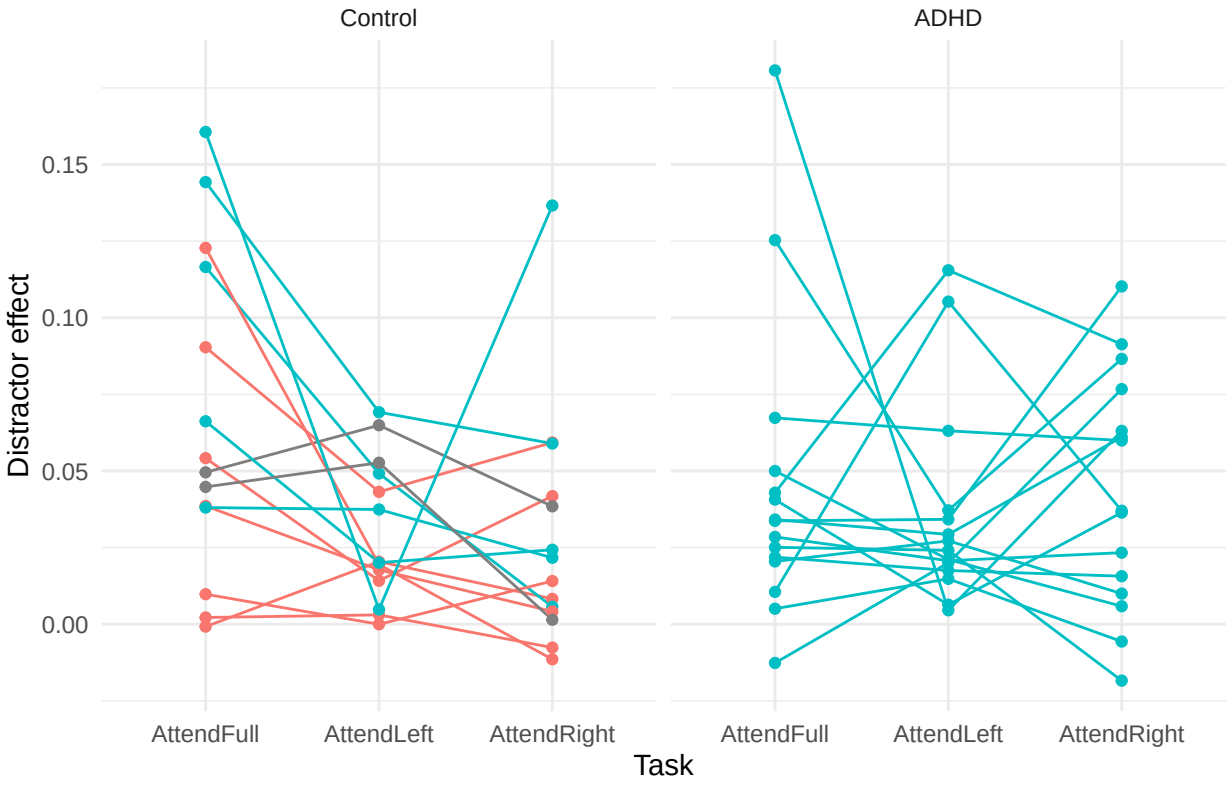

```
## `summarise()` regrouping output by 'Group' (override with `.groups` argument)
```


Distractor effect, all task conditions, group level, +/− SEM
Distractor effect
0.08
0.06
0.04
0.02
0.00
AttendFull
AttendLeft
AttendRight
Task
Group
Control
ADHD

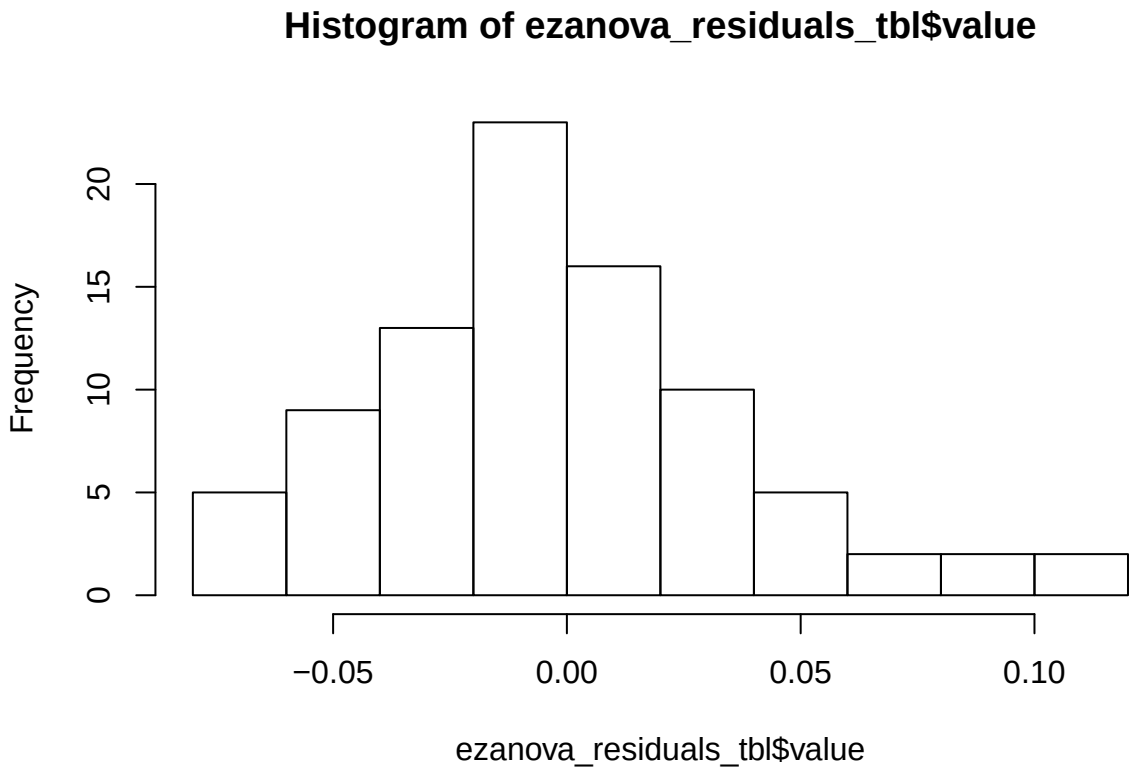

distractor_effect deviations Normal Q−Q Plot
Sample Quantiles
0.00
0.05
0.10
0.15
−2
−1
0
1
2
Theoretical Quantiles



Distractor effect, all task conditions, single subject



Statistics for distractor effect:

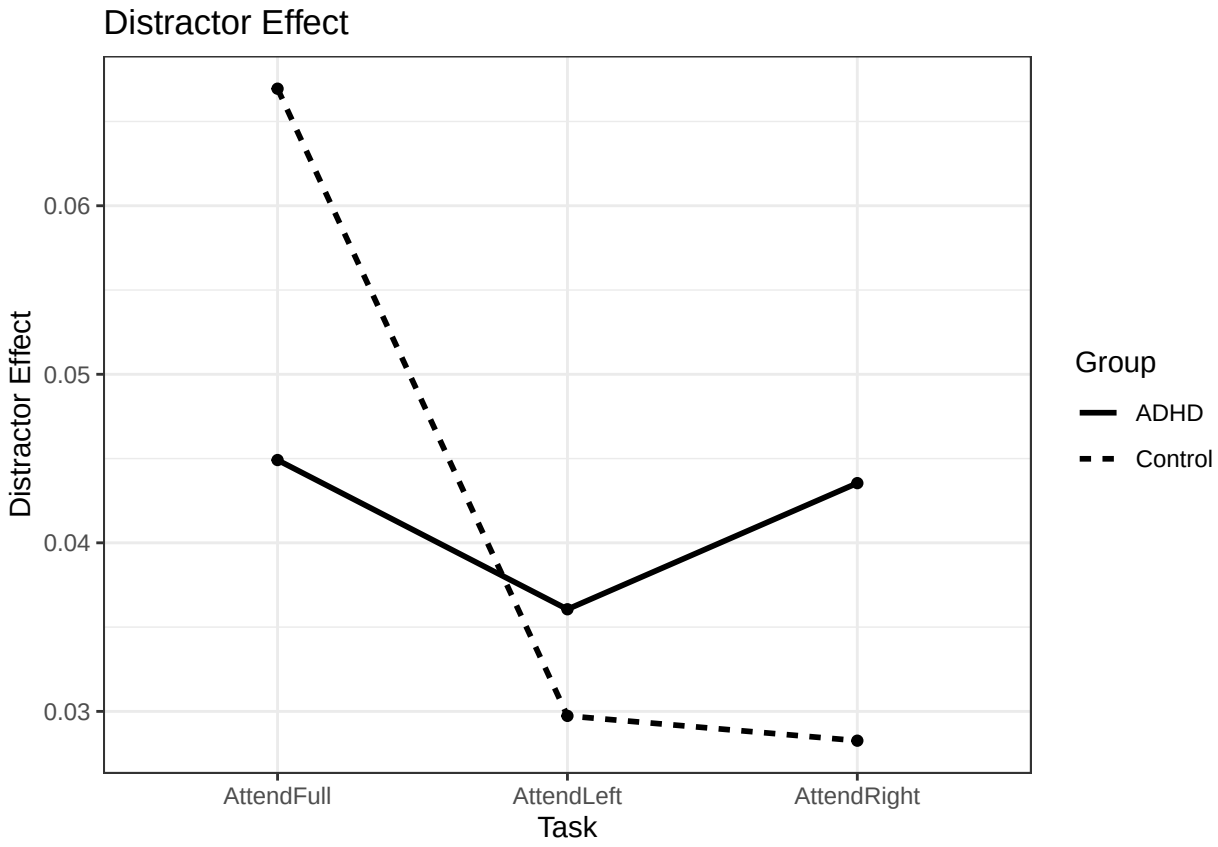



```
## $ANOVA
##       Effect DFn DFd           F         p p<.05          ges
## 2      Group   1  27 0.000181595 0.9893473       3.337908e-06
## 3       Task   2  54 3.703857225 0.0310894     * 6.463280e-02
## 4 Group:Task   2  54 2.241067418 0.1161461       4.013131e-02
##
## $`Mauchly's Test for Sphericity`
##       Effect         W         p p<.05
## 3       Task 0.8796146 0.1887128
## 4 Group:Task 0.8796146 0.1887128
##
## $`Sphericity Corrections`
##       Effect     GGe     p[GG] p[GG]<.05       HFe     p[HF] p[HF]<.05
## 3       Task 0.89255 0.0364544         * 0.9514771 0.0334055         *
## 4 Group:Task 0.89255 0.1225835           0.9514771 0.1190267
##
## $aov
##
## Call:
## aov(formula = formula(aov_formula), data = data)
##
## Grand Mean: 0.04157256
##
## Stratum 1: ID
##
## Terms:
##                      Group  Residuals
```

```
## Sum of Squares  0.00000044 0.06523006
## Deg. of Freedom          1         27
##
## Residual standard error: 0.04915209
## 2 out of 3 effects not estimable
## Estimated effects are balanced
##
## Stratum 2: ID:Task
##
## Terms:
##                       Task Group:Task  Residuals
## Sum of Squares  0.00864155 0.00549520 0.06620525
## Deg. of Freedom          2          2         54
##
## Residual standard error: 0.03501461
## Estimated effects may be unbalanced
```

```
## [1] "Control.AttendFull"  "ADHD.AttendFull"     "Control.AttendLeft"
## [4] "ADHD.AttendLeft"     "Control.AttendRight" "ADHD.AttendRight"
```

Contrasts for distractor effect:




```
##  model term df1 df2 F.ratio p.value
##  Group        1  27   0.000 0.9893
##  Task         2  54   3.704 0.0311
##  Group:Task   2  54   2.241 0.1161
```

```
## Group = Control:
```

```
##  model term df1 df2 F.ratio p.value
##  Task         2  54   5.487 0.0068
##
## Group = ADHD:
##  model term df1 df2 F.ratio p.value
##  Task         2  54   0.278 0.7584
## Task = AttendFull:
##  model term df1   df2 F.ratio p.value
##  Group        1 72.35   2.166 0.1454
##
## Task = AttendLeft:
##  model term df1   df2 F.ratio p.value
##  Group        1 72.35   0.179 0.6739
##
## Task = AttendRight:
##  model term df1   df2 F.ratio p.value
##  Group        1 72.35   1.042 0.3107
##
##   General Linear Hypotheses
##
## Multiple Comparisons of Means: User-defined Contrasts
##
##
## Linear Hypotheses:
##                Estimate
## FvLR_adhd == 0 0.005112
##
## Global Test:
##        F DF1 DF2 Pr(>F)
## 1 0.2132   1  79 0.6455
##
##   General Linear Hypotheses
##
## Multiple Comparisons of Means: User-defined Contrasts
##
##
## Linear Hypotheses:
##                Estimate
## FvLR_ctrl == 0  0.03795
##
## Global Test:
##       F DF1 DF2   Pr(>F)
## 1 10.96   1  79 0.001403
##
##   General Linear Hypotheses
##
## Multiple Comparisons of Means: User-defined Contrasts
##
##
## Linear Hypotheses:
##                Estimate
## RvFL_ctrl == 0 -0.02008
```

```
##
## Global Test:
##       F DF1 DF2 Pr(>F)
## 1 3.069   1  79 0.0837
```

```
## TEST CONTRAST: FvLR ctrl V ADHD 0.5 -0.5 -0.25 0.25 -0.25 0.25
```

```
##
##   General Linear Hypotheses
##
## Multiple Comparisons of Means: User-defined Contrasts
##
##
## Linear Hypotheses:
##               Estimate
## FvLR_CvA == 0  0.01642
##
## Global Test:
##       F DF1 DF2  Pr(>F)
## 1 4.245   1  79 0.04265
```

DE summary

There was no effect of group on Distractor effect. Task = attend-Full differed strongly from Left/Right for CTRL group (F = 11), and this induced a between groups difference with ADHD in the same Task contrast (F = 4.2)