

Tummy Time

Blind for Review

2023-10-19

Full Model

```
require(tidyverse)
```

```
## Loading required package: tidyverse
```

```
## -- Attaching core tidyverse packages ----- tidyverse 2.0.0 --
```

```
## v dplyr      1.1.3      v readr      2.1.4
```

```
## v forcats    1.0.0      v stringr    1.5.0
```

```
## v ggplot2    3.4.4      v tibble     3.2.1
```

```
## v lubridate  1.9.2      v tidyr      1.3.0
```

```
## v purrr      1.0.1
```

```
## -- 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
```

```
require(nlme)
```

```
## Loading required package: nlme
```

```
##
```

```
## Attaching package: 'nlme'
```

```
##
```

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

```
##
```

```
## collapse
```

```
require(scdhlm)
```

```
## Loading required package: scdhlm
```

```
require(readxl)
```

```
## Loading required package: readxl
```

```
df <- read_xlsx("tummy_df.xlsx", col_names = TRUE)
dim(df)
```

```
## [1] 781 11
```

```
colnames(df)
```

```
## [1] "participant"      "order"             "condition"
## [4] "outcome"          "phase_name"        "dependent_variable"
## [7] "figure"           "sex"               "ethnicity"
## [10] "format"           "observation"
```

```
names(df)
```

```
## [1] "participant"      "order"             "condition"
## [4] "outcome"          "phase_name"        "dependent_variable"
## [7] "figure"           "sex"               "ethnicity"
## [10] "format"           "observation"
```

```
#Estimate a hierarchical linear model for head elevation and preferred item
```

```
HEP_df <- df %>%
  filter(dependent_variable == "head elevation") %>%
  filter(phase_name == "baseline" | phase_name == "preferred item")

HEP_hlm <- lme(outcome ~ condition,
               random = ~ 1 | participant,
               correlation = corAR1(0, ~ observation | participant),
               data = HEP_df)

summary(HEP_hlm)
```

```
## Linear mixed-effects model fit by REML
##   Data: HEP_df
##       AIC      BIC    logLik
##  2203.581 2220.942 -1096.79
##
## Random effects:
## Formula: ~1 | participant
##      (Intercept) Residual
## StdDev:    5.272983 31.99618
##
## Correlation Structure: ARMA(1,0)
## Formula: ~observation | participant
## Parameter estimate(s):
##      Phi1
## 0.6956415
## Fixed effects: outcome ~ condition
##              Value Std.Error  DF  t-value p-value
## (Intercept) 50.69245  4.959908 224 10.22044      0
## conditionB  34.17088  4.713414 224  7.24971      0
## Correlation:
```

```
##          (Intr)
## conditionB -0.514
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -2.5935758 -0.6253880  0.3723167  0.5014087  1.6002341
##
## Number of Observations: 240
## Number of Groups: 15
```

```
HEP_es <- g_qlm(HEP_hlm, p_const = c(0,1), r_const = c(1,0,1))
summary(HEP_es)
```

```
##                                     est      se
## Tau.participant.participant.var((Intercept))  27.804 118.114
## cor_params                                0.696   0.055
## sigma_sq                                1023.756 180.521
## total variance                            1051.560 153.419
## (Intercept)                               50.692   4.960
## conditionB                                34.171   4.713
## treatment effect at a specified time         34.171   4.713
## unadjusted effect size                      1.054   0.166
## adjusted effect size                       1.045   0.165
## degree of freedom                          93.960
## constant kappa                             0.145
## logLik                                     -1096.790
```

```
CI_HEP <- CI_g(HEP_es, symmetric = FALSE)
summary(CI_HEP)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.7294  0.8904  1.0515  1.0515  1.2126  1.3737
```

```
#Estimate a hierarchical linear model for head elevation and attention
```

```
HEA_df <- df %>%
  filter(dependent_variable == "head elevation") %>%
  filter(phase_name == "baseline" | phase_name == "attention")

HEA_hlm <- lme(outcome ~ condition,
               random = ~ 1 | participant,
               correlation = corAR1(0, ~ observation | participant),
               data = HEA_df)
summary(HEA_hlm)
```

```
## Linear mixed-effects model fit by REML
##   Data: HEA_df
##       AIC       BIC    logLik
##  2284.555 2302.062 -1137.278
##
## Random effects:
## Formula: ~1 | participant
```

```
##          (Intercept) Residual
## StdDev:    12.75533 31.65443
##
## Correlation Structure: ARMA(1,0)
## Formula: ~observation | participant
## Parameter estimate(s):
##      Phil
## 0.6790859
## Fixed effects: outcome ~ condition
##              Value Std.Error DF t-value p-value
## (Intercept) 47.89910  5.749732 231 8.330666      0
## conditionB  30.49563  5.342103 231 5.708543      0
## Correlation:
##      (Intr)
## conditionB -0.481
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -2.2055209 -0.4877182  0.2550138  0.6918526  1.9832073
##
## Number of Observations: 247
## Number of Groups: 15
```

```
HEA_es <- g_qlm(HEA_hlm, p_const = c(0,1), r_const = c(1,0,1))
summary(HEA_es)
```

```
##                                     est      se
## Tau.participant.participant.var((Intercept)) 162.698 149.440
## cor_params                                0.679   0.054
## sigma_sq                                1002.003 160.930
## total variance                           1164.701 178.759
## (Intercept)                              47.899   5.750
## conditionB                               30.496   5.342
## treatment effect at a specified time        30.496   5.342
## unadjusted effect size                     0.894   0.173
## adjusted effect size                       0.886   0.171
## degree of freedom                         84.903
## constant kappa                           0.157
## logLik                                    -1137.278
```

```
CI_HEA <- CI_g(HEA_es, symmetric = FALSE)
summary(CI_HEA)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.5565 0.7239 0.8913 0.8913 1.0588 1.2262
```

#Estimate a hierarchical linear model for negative vocalization and preferred item

```
NPI_df <- df %>%
  filter(dependent_variable == "negative vocalization") %>%
  filter(phase_name == "baseline" | phase_name == "preferred item")
```

```
NPI_hlm <- lme(outcome ~ condition,
               random = ~ 1 | participant,
               correlation = corAR1(0, ~ observation | participant),
               data = NPI_df)
summary(NPI_hlm)
```

```
## Linear mixed-effects model fit by REML
## Data: NPI_df
##      AIC      BIC    logLik
## 2102.004 2119.428 -1046.002
##
## Random effects:
## Formula: ~1 | participant
##      (Intercept) Residual
## StdDev:      5.965197 17.98529
##
## Correlation Structure: ARMA(1,0)
## Formula: ~observation | participant
## Parameter estimate(s):
##      Phi1
## 0.153648
## Fixed effects: outcome ~ condition
##              Value Std.Error DF   t-value p-value
## (Intercept)  21.14339  2.532278 227   8.349552      0
## conditionB  -21.89428  2.625371 227  -8.339496      0
## Correlation:
##      (Intr)
## conditionB -0.562
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -1.585326379 -0.379859655  0.004544033  0.158210140  4.056343820
##
## Number of Observations: 243
## Number of Groups: 15
```

```
NPI_es <- g_qlm(NPI_hlm, p_const = c(0,1), r_const = c(1,0,1), infotype = "expected")
summary(NPI_es)
```

```
##              est      se
## Tau.participant.participant.var((Intercept))  35.584 24.654
## cor_params              0.154  0.073
## sigma_sq              323.471 31.784
## total variance          359.054 37.317
## (Intercept)            21.143  2.532
## conditionB             -21.894  2.625
## treatment effect at a specified time          -21.894  2.625
## unadjusted effect size          -1.155  0.152
## adjusted effect size          -1.151  0.151
## degree of freedom          185.160
## constant kappa              0.139
## logLik                  -1046.002
```

```
CI_NPI <- CI_g(NPI_es, symmetric = FALSE)
summary(CI_NPI)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -1.4501 -1.3021 -1.1541 -1.1541 -1.0062 -0.8582
```

#Estimate a hierarchical linear model for negative vocalization and attention

```
NA_df <- df %>%
  filter(dependent_variable == "negative vocalization") %>%
  filter(phase_name == "baseline" | phase_name == "attention")

NA_hlm <- lme(outcome ~ condition,
              random = ~ 1 | participant,
              correlation = corAR1(0, ~ observation | participant),
              data = NA_df)

summary(NA_hlm)
```

```
## Linear mixed-effects model fit by REML
##   Data: NA_df
##       AIC      BIC    logLik
## 2190.897 2208.464 -1090.449
##
## Random effects:
## Formula: ~1 | participant
##      (Intercept) Residual
## StdDev:      5.749237 19.47245
##
## Correlation Structure: ARMA(1,0)
## Formula: ~observation | participant
## Parameter estimate(s):
##      Phi1
## 0.2474705
## Fixed effects: outcome ~ condition
##              Value Std.Error DF   t-value p-value
## (Intercept)  21.42078  2.742598 234   7.810396      0
## conditionB  -19.50733  2.995931 234  -6.511275      0
## Correlation:
##      (Intr)
## conditionB -0.606
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -1.53584260 -0.53405120 -0.11408951  0.07002714  3.79514787
##
## Number of Observations: 250
## Number of Groups: 15
```

```
NA_es <- g_mlm(NA_hlm, p_const = c(0,1), r_const = c(1,0,1), infotype = "expected")
summary(NA_es)
```

```
##                                est      se
```

```
## Tau.participant.participant.var((Intercept))    33.054 26.766
## cor_params                                     0.247  0.072
## sigma_sq                                       379.176 38.305
## total variance                                412.230 42.534
## (Intercept)                                   21.421  2.743
## conditionB                                    -19.507  2.996
## treatment effect at a specified time          -19.507  2.996
## unadjusted effect size                        -0.961  0.157
## adjusted effect size                         -0.957  0.156
## degree of freedom                             187.864
## constant kappa                               0.148
## logLik                                         -1090.449
```

```
CI_NA <- CI_g(NA_es, symmetric = FALSE)
summary(CI_NA)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -1.2647 -1.1122 -0.9596 -0.9596 -0.8071 -0.6546
```

In-Person Model

Format Type: In-Person. Estimate a hierarchical linear model for head elevation and preferred item

```
HEP_IP_df <- df %>%
  filter(dependent_variable == "head elevation") %>%
  filter(phase_name == "baseline" | phase_name == "preferred item") %>%
  filter(format == "in person")

HEP_IP_df_hlm <- lme(outcome ~ condition,
  random = ~ 1 | participant,
  correlation = corAR1(0, ~ observation | participant),
  data = HEP_IP_df)

summary(HEP_IP_df_hlm)
```

```
## Linear mixed-effects model fit by REML
##   Data: HEP_IP_df
##       AIC      BIC    logLik
## 1041.268 1054.816 -515.6342
##
## Random effects:
## Formula: ~1 | participant
##      (Intercept) Residual
## StdDev:    7.090898 31.3981
##
## Correlation Structure: ARMA(1,0)
## Formula: ~observation | participant
## Parameter estimate(s):
##      Phi1
## 0.657972
```

```
## Fixed effects: outcome ~ condition
##           Value Std.Error   DF   t-value p-value
## (Intercept) 45.88573   7.091568  105  6.470464      0
## conditionB  36.91740   6.819442  105  5.413552      0
## Correlation:
##           (Intr)
## conditionB -0.504
##
## Standardized Within-Group Residuals:
##           Min           Q1           Med           Q3           Max
## -2.5268594 -0.9391638  0.3931832  0.6320563  1.8078407
##
## Number of Observations: 113
## Number of Groups: 7
```

```
HEP_IP_es <- g_mlm(HEP_IP_df_hlm, p_const = c(0,1), r_const = c(1,0,1))
summary(HEP_es)
```

```
##                                     est      se
## Tau.participant.participant.var((Intercept))    27.804 118.114
## cor_params                                     0.696   0.055
## sigma_sq                                     1023.756 180.521
## total variance                                1051.560 153.419
## (Intercept)                                    50.692   4.960
## conditionB                                     34.171   4.713
## treatment effect at a specified time            34.171   4.713
## unadjusted effect size                         1.054   0.166
## adjusted effect size                           1.045   0.165
## degree of freedom                             93.960
## constant kappa                                0.145
## logLik                                         -1096.790
```

```
CI_HEP_IP <- CI_g(HEP_IP_es, symmetric = FALSE)
summary(CI_HEP_IP)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6641  0.9031  1.1420  1.1420  1.3810  1.6200
```

Format Type: In-Person. Estimate a hierarchical linear model for head elevation and attention

```
HEA_IP_df <- df %>%
  filter(dependent_variable == "head elevation") %>%
  filter(phase_name == "baseline" | phase_name == "attention") %>%
  filter(format == "in person")

HEA_IP_hlm <- lme(outcome ~ condition,
  random = ~ 1 | participant,
  correlation = corAR1(0, ~ observation | participant),
  data = HEA_IP_df)
summary(HEA_IP_hlm)
```

```
## Linear mixed-effects model fit by REML
```



```
## Data: HEA_IP_df
##      AIC      BIC    logLik
## 1093.781 1107.462 -541.8907
##
## Random effects:
## Formula: ~1 | participant
##      (Intercept) Residual
## StdDev:    10.12495 33.60359
##
## Correlation Structure: ARMA(1,0)
## Formula: ~observation | participant
## Parameter estimate(s):
##      Phi1
## 0.6315015
## Fixed effects: outcome ~ condition
##      Value Std.Error DF t-value p-value
## (Intercept) 38.18550  8.003487 108 4.771108      0
## conditionB 43.32137  8.268147 108 5.239549      0
## Correlation:
##      (Intr)
## conditionB -0.547
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -2.2557917 -0.6167758  0.2074869  0.6719112  1.9598597
##
## Number of Observations: 116
## Number of Groups: 7
```

```
HEA_IP_es <- g_qlm(HEA_IP_hlm, p_const = c(0,1), r_const = c(1,0,1))
summary(HEA_es)
```

```
##      est      se
## Tau.participant.participant.var((Intercept)) 162.698 149.440
## cor_params      0.679  0.054
## sigma_sq      1002.003 160.930
## total variance 1164.701 178.759
## (Intercept)      47.899  5.750
## conditionB      30.496  5.342
## treatment effect at a specified time      30.496  5.342
## unadjusted effect size      0.894  0.173
## adjusted effect size      0.886  0.171
## degree of freedom      84.903
## constant kappa      0.157
## logLik      -1137.278
```

```
CI_HEA_IP <- CI_g(HEA_IP_es, symmetric = FALSE)
summary(CI_HEA_IP)
```

```
##      Min. 1st Qu. Median      Mean 3rd Qu.      Max.
## 0.7056 0.9675 1.2293 1.2293 1.4911 1.7530
```

Format Type: In-Person. Estimate a hierarchical linear model for negative vocalization and preferred

```
NPI_IP_df <- df %>%
  filter(dependent_variable == "negative vocalization") %>%
  filter(phase_name == "baseline" | phase_name == "preferred item") %>%
  filter(format == "in person")

NPI_IP_hlm <- lme(outcome ~ condition,
  random = ~ 1 | participant,
  correlation = corAR1(0, ~ observation | participant),
  data = NPI_IP_df)
summary(NPI_IP_hlm)
```

```
## Linear mixed-effects model fit by REML
##   Data: NPI_IP_df
##       AIC      BIC    logLik
##  997.7904 1011.338 -493.8952
##
## Random effects:
## Formula: ~1 | participant
##      (Intercept) Residual
## StdDev:    5.974153 20.04861
##
## Correlation Structure: ARMA(1,0)
## Formula: ~observation | participant
## Parameter estimate(s):
##      Phi1
## 0.2034495
## Fixed effects: outcome ~ condition
##              Value Std.Error DF   t-value p-value
## (Intercept)  23.11668  3.997460 105   5.782843     0
## conditionB  -25.02017  4.328061 105  -5.780918     0
## Correlation:
##      (Intr)
## conditionB -0.578
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -1.415226712 -0.724878426 -0.006623423  0.198884855  3.236471332
##
## Number of Observations: 113
## Number of Groups: 7
```

```
NPI_IP_es <- g_qlm(NPI_IP_hlm, p_const = c(0,1), r_const = c(1,0,1))
summary(NPI_IP_es)
```

```
##              est      se
## Tau.participant.participant.var((Intercept))  35.691 43.451
## cor_params              0.203  0.107
## sigma_sq              401.947 59.742
## total variance              437.637 67.381
## (Intercept)              23.117  3.997
## conditionB              -25.020  4.328
```

```
## treatment effect at a specified time      -25.020  4.328
## unadjusted effect size                    -1.196  0.229
## adjusted effect size                      -1.185  0.227
## degree of freedom                        84.370
## constant kappa                           0.207
## logLik                                   -493.895
```

```
CI_IP_NPI <- CI_g(NPI_IP_es, symmetric = FALSE)
summary(CI_IP_NPI)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -1.6367 -1.4149 -1.1930 -1.1930 -0.9712 -0.7493
```

Format Type: In-Person. Estimate a hierarchical linear model for negative vocalization and attention

```
NA_IP_df <- df %>%
  filter(dependent_variable == "negative vocalization") %>%
  filter(phase_name == "baseline" | phase_name == "attention") %>%
  filter(format == "in person")

NA_IP_hlm <- lme(outcome ~ condition,
  random = ~ 1 | participant,
  correlation = corAR1(0, ~ observation | participant),
  data = NA_IP_df)
summary(NA_IP_hlm)
```

```
## Linear mixed-effects model fit by REML
## Data: NA_IP_df
##      AIC      BIC    logLik
## 1037.462 1051.23 -513.7309
##
## Random effects:
## Formula: ~1 | participant
##      (Intercept) Residual
## StdDev:    4.678868 20.11762
##
## Correlation Structure: ARMA(1,0)
## Formula: ~observation | participant
## Parameter estimate(s):
##      Phil
## 0.2778153
## Fixed effects: outcome ~ condition
##              Value Std.Error DF   t-value p-value
## (Intercept) 23.20184  3.885568 110   5.971287     0
## conditionB -22.94348  4.509026 110  -5.088345     0
## Correlation:
##      (Intr)
## conditionB -0.642
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -1.33588607 -0.72992991 -0.08296972  0.19711733  3.20047378
##
```

```
## Number of Observations: 118
## Number of Groups: 7
```

```
NA_IP_es <- g_mlm(NA_IP_hlm, p_const = c(0,1), r_const = c(1,0,1), infotype = "expected")
summary(NA_IP_es)
```

```
##
##              est      se
## Tau.participant.participant.var((Intercept))  21.892 36.424
## cor_params              0.278 0.104
## sigma_sq              404.719 61.010
## total variance          426.610 63.558
## (Intercept)            23.202  3.886
## conditionB             -22.943  4.509
## treatment effect at a specified time          -22.943  4.509
## unadjusted effect size          -1.111  0.236
## adjusted effect size          -1.102  0.234
## degree of freedom          90.105
## constant kappa           0.218
## logLik                 -513.731
```

```
CI_IP_NA <- CI_g(NA_IP_es, symmetric = FALSE)
summary(CI_IP_NA)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -1.5656 -1.3369 -1.1081 -1.1081 -0.8794 -0.6506
```

Remote Model

Format Type: Remote. Estimate a hierarchical linear model for head elevation and preferred item

```
HEP_R_df <- df %>%
  filter(dependent_variable == "head elevation") %>%
  filter(phase_name == "baseline" | phase_name == "preferred item") %>%
  filter(format == "remote")
```

```
HEP_R_hlm <- lme(outcome ~ condition,
  random = ~ 1 | participant,
  correlation = corAR1(0, ~ observation | participant),
  data = HEP_R_df)
```

```
summary(HEP_R_hlm)
```

```
## Linear mixed-effects model fit by REML
##   Data: HEP_R_df
##       AIC       BIC    logLik
##  1158.268 1172.409 -574.1338
##
## Random effects:
## Formula: ~1 | participant
```

```
##          (Intercept) Residual
## StdDev:      3.22559 32.75018
##
## Correlation Structure: ARMA(1,0)
## Formula: ~observation | participant
## Parameter estimate(s):
##      Phi1
## 0.728603
## Fixed effects: outcome ~ condition
##              Value Std.Error   DF  t-value p-value
## (Intercept) 54.99321  7.038372 118  7.813342      0
## conditionB  32.10343  6.529447 118  4.916716      0
## Correlation:
##          (Intr)
## conditionB -0.517
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -2.6348849 -0.4406795  0.2558568  0.3998968  1.3987860
##
## Number of Observations: 127
## Number of Groups: 8
```

```
HEP_R_es <- g_mlm(HEP_R_hlm, p_const = c(0,1), r_const = c(1,0,1))
summary(HEP_R_es)
```

```
##                                     est      se
## Tau.participant.participant.var((Intercept))  10.404 184.717
## cor_params                                     0.729   0.073
## sigma_sq                                       1072.574 280.111
## total variance                               1082.979 229.561
## (Intercept)                                   54.993   7.038
## conditionB                                    32.103   6.529
## treatment effect at a specified time          32.103   6.529
## unadjusted effect size                        0.976   0.229
## adjusted effect size                          0.959   0.225
## degree of freedom                            44.511
## constant kappa                               0.198
## logLik                                         -574.134
```

```
HEP_R_ci <- CI_g(HEP_R_es, symmetric = FALSE)
summary(HEP_R_ci)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.5329 0.7521 0.9712 0.9712 1.1903 1.4094
```

Format Type: Remote. Estimate a hierarchical linear model for head elevation and attention

```
HEA_R_df <- df %>%
  filter(dependent_variable == "head elevation") %>%
  filter(phase_name == "baseline" | phase_name == "attention") %>%
  filter(format == "remote")
```

```
HEA_R_hlm <- lme(outcome ~ condition,
  random = ~ 1 | participant,
  correlation = corAR1(0, ~ observation | participant),
  data = HEA_R_df)
summary(HEA_R_hlm)
```

```
## Linear mixed-effects model fit by REML
## Data: HEA_R_df
##      AIC      BIC    logLik
## 1170.144 1184.443 -580.0719
##
## Random effects:
## Formula: ~1 | participant
##      (Intercept) Residual
## StdDev:      14.57865 31.16699
##
## Correlation Structure: ARMA(1,0)
## Formula: ~observation | participant
## Parameter estimate(s):
##      Phi1
## 0.7781972
## Fixed effects: outcome ~ condition
##      Value Std.Error DF t-value p-value
## (Intercept) 58.10770  8.533766 122 6.809151 0.0000
## conditionB  14.17338  6.732151 122 2.105327 0.0373
## Correlation:
##      (Intr)
## conditionB -0.394
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -2.0242006 -0.2889639  0.4005964  0.7295665  1.7174534
##
## Number of Observations: 131
## Number of Groups: 8
```

```
HEA_R_es <- g_qlm(HEA_R_hlm, p_const = c(0,1), r_const = c(1,0,1))
summary(HEA_R_es)
```

```
##
##      est      se
## Tau.participant.participant.var((Intercept)) 212.537 280.530
## cor_params      0.778  0.064
## sigma_sq      971.381 265.451
## total variance 1183.918 301.759
## (Intercept)      58.108  8.534
## conditionB      14.173  6.732
## treatment effect at a specified time      14.173  6.732
## unadjusted effect size      0.412  0.210
## adjusted effect size      0.402  0.204
## degree of freedom      30.786
## constant kappa      0.196
## logLik      -580.072
```

```

HEA_R_ci <- CI_g(HEA_R_es, symmetric = FALSE)
summary(HEA_R_ci)

##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.01187 0.21034 0.40880 0.40880 0.60727 0.80573

# Format Type: Remote. Estimate a hierarchical linear model for negative vocalization and preferred item

NPI_R_df <- df %>%
  filter(dependent_variable == "negative vocalization") %>%
  filter(phase_name == "baseline" | phase_name == "preferred item") %>%
  filter(format == "remote")

NPI_R_hlm <- lme(outcome ~ condition,
  random = ~ 1 | participant,
  correlation = corAR1(0, ~ observation | participant),
  data = NPI_R_df)
summary(NPI_R_hlm)

## Linear mixed-effects model fit by REML
##   Data: NPI_R_df
##       AIC      BIC    logLik
## 1098.535 1112.795 -544.2676
##
## Random effects:
## Formula: ~1 | participant
##      (Intercept) Residual
## StdDev:      6.708945 16.09996
##
## Correlation Structure: ARMA(1,0)
## Formula: ~observation | participant
## Parameter estimate(s):
##      Phi1
## 0.1189598
## Fixed effects: outcome ~ condition
##              Value Std.Error DF   t-value p-value
## (Intercept) 19.28843  3.426619 121   5.628997     0
## conditionB -19.82794  3.221812 121  -6.154283     0
## Correlation:
##      (Intr)
## conditionB -0.506
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -1.75007735 -0.51852501  0.04643261  0.15452329  4.57429152
##
## Number of Observations: 130
## Number of Groups: 8

NPI_R_es <- g_mlm(NPI_R_hlm, p_const = c(0,1), r_const = c(1,0,1))
summary(NPI_R_es)

```

```
##                                est      se
## Tau.participant.participant.var((Intercept))  45.010 37.163
## cor_params                                0.119  0.100
## sigma_sq                                259.209 34.453
## total variance                          304.219 48.008
## (Intercept)                             19.288  3.427
## conditionB                             -19.828  3.222
## treatment effect at a specified time      -19.828  3.222
## unadjusted effect size                   -1.137  0.208
## adjusted effect size                     -1.126  0.206
## degree of freedom                        80.311
## constant kappa                           0.185
## logLik                                  -544.268
```

```
CI_R_NPI <- CI_g(NPI_R_es, symmetric = FALSE)
summary(CI_R_NPI)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -1.5363 -1.3351 -1.1339 -1.1339 -0.9327 -0.7316
```

Format Type: Remote. Estimate a hierarchical linear model for negative vocalization and attention

```
NA_R_df <- df %>%
  filter(dependent_variable == "negative vocalization") %>%
  filter(phase_name == "baseline" | phase_name == "attention") %>%
  filter(format == "remote")

NA_R_hlm <- lme(outcome ~ condition,
  random = ~ 1 | participant,
  correlation = corAR1(0, ~ observation | participant),
  data = NA_R_df)
summary(NA_R_hlm)
```

```
## Linear mixed-effects model fit by REML
##   Data: NA_R_df
##       AIC      BIC    logLik
##  1151.489 1165.827 -570.7446
##
## Random effects:
## Formula: ~1 | participant
##      (Intercept) Residual
## StdDev:    6.983587 18.99277
##
## Correlation Structure: ARMA(1,0)
## Formula: ~observation | participant
## Parameter estimate(s):
##      Phi1
## 0.2362212
## Fixed effects: outcome ~ condition
##              Value Std.Error DF   t-value p-value
## (Intercept) 19.61342  3.991034 123  4.914371  0e+00
## conditionB -16.54449  4.072846 123 -4.062145  1e-04
## Correlation:
```



```
##          (Intr)
## conditionB -0.559
##
## Standardized Within-Group Residuals:
##      Min      Q1      Med      Q3      Max
## -1.55379783 -0.54989115 -0.17238527  0.04459427  3.95657293
##
## Number of Observations: 132
## Number of Groups: 8
```

```
NA_R_es <- g_mlm(NA_R_hlm, p_const = c(0,1), r_const = c(1,0,1), infotype = "expected")
summary(NA_R_es)
```

```
##                                     est      se
## Tau.participant.participant.var((Intercept))  48.770 46.563
## cor_params                                0.236  0.099
## sigma_sq                                360.725 50.085
## total variance                           409.496 63.269
## (Intercept)                              19.613  3.991
## conditionB                               -16.544  4.073
## treatment effect at a specified time        -16.544  4.073
## unadjusted effect size                     -0.818  0.214
## adjusted effect size                       -0.810  0.212
## degree of freedom                          83.782
## constant kappa                             0.201
## logLik                                    -570.745
```

```
CI_R_NA <- CI_g(NA_R_es, symmetric = FALSE)
summary(CI_R_NA)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -1.2287 -1.0220 -0.8153 -0.8153 -0.6087 -0.4020
```

#Kruskal-Wallis Test to detect differences between preferred item condition and the caregiver attention

```
library("ggpubr")
library("dplyr")
```

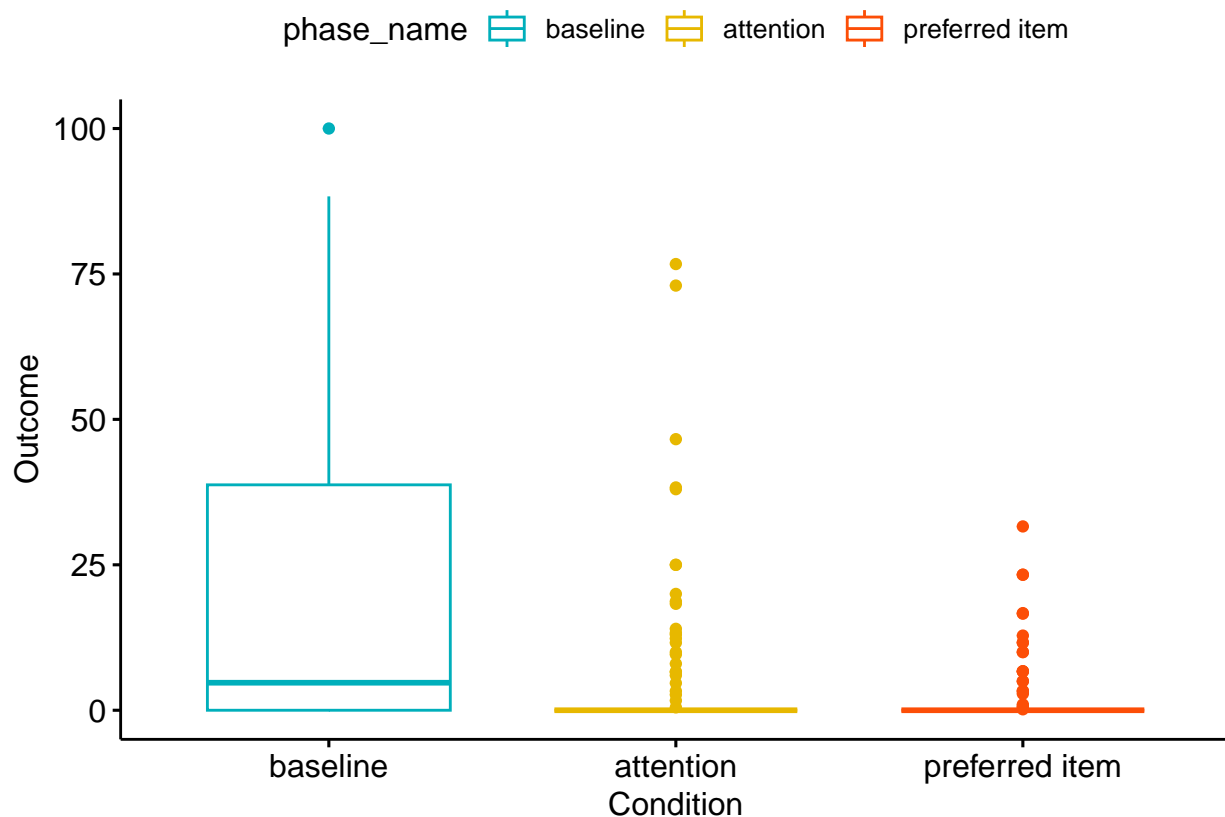
#Negative Vocalization

```
df1 <- df %>%
  filter(dependent_variable == "negative vocalization") %>%
  select(phase_name, outcome) %>%
  group_by(phase_name) %>%
  summarise(
    count = n(),
    mean = mean(outcome, na.rm = TRUE),
    sd = sd(outcome, na.rm = TRUE),
    median = median(outcome, na.rm = TRUE),
    IQR = IQR(outcome, na.rm = TRUE)
  )
df1
```

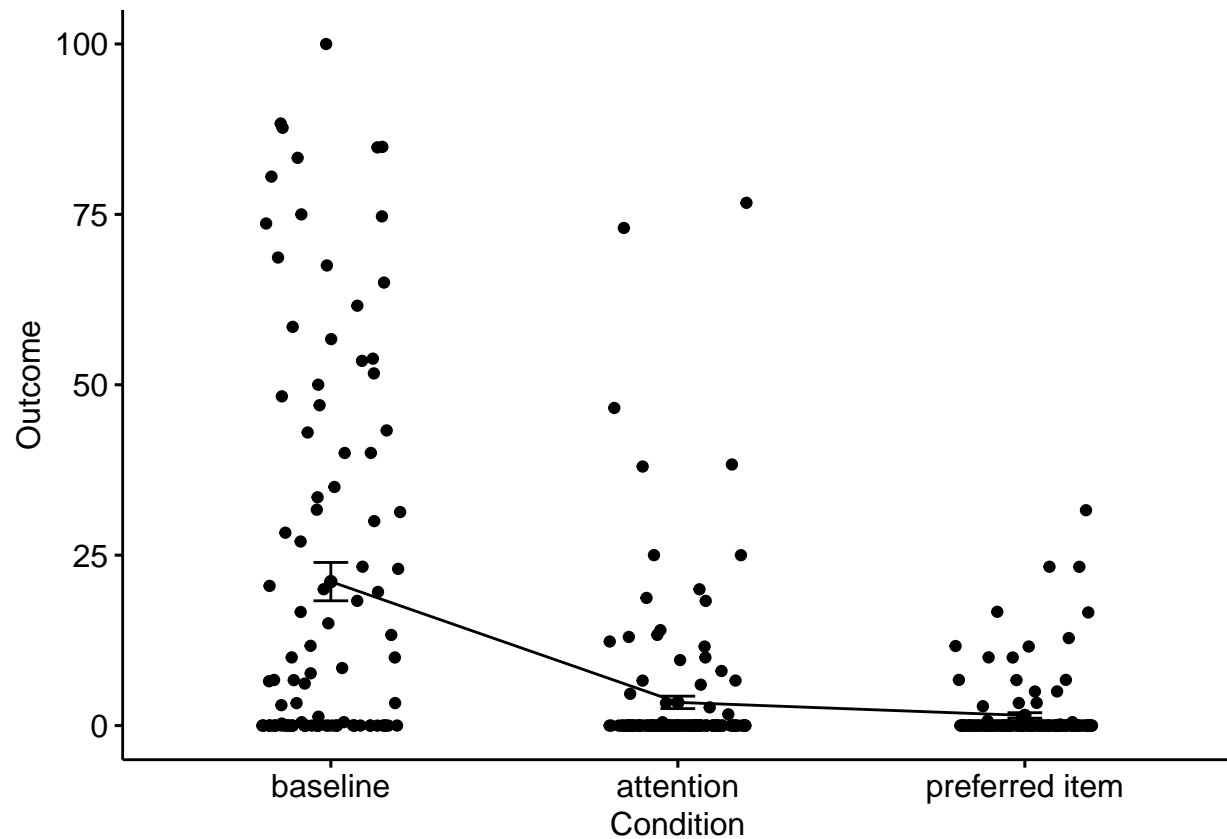
```
## # A tibble: 3 x 6
##   phase_name    count  mean    sd median   IQR
##   <chr>         <int> <dbl> <dbl> <dbl> <dbl>
## 1 attention     148  3.40 11.1    0     0
## 2 baseline     102 21.1 28.4   4.73 38.8
## 3 preferred item 141  1.49  4.77    0     0
```

```
dfn <- df %>%
  filter(dependent_variable == "negative vocalization")

ggboxplot(dfn, x = "phase_name", y = "outcome",
  color = "phase_name", palette = c("#00AFBB", "#E7B800", "#FC4E07"),
  order = c("baseline", "attention", "preferred item"),
  ylab = "Outcome", xlab = "Condition")
```



```
ggline(dfn, x = "phase_name", y = "outcome",
  add = c("mean_se", "jitter"),
  order = c("baseline", "attention", "preferred item"),
  ylab = "Outcome", xlab = "Condition")
```



```
kruskal.test(outcome ~ phase_name, data = dfn)
```

```
##
## Kruskal-Wallis rank sum test
##
## data: outcome by phase_name
## Kruskal-Wallis chi-squared = 76.116, df = 2, p-value < 2.2e-16
```

```
pairwise.wilcox.test(dfn$outcome, dfn$phase_name,
  p.adjust.method = "BH")
```

```
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: dfn$outcome and dfn$phase_name
##
##           attention baseline
## baseline      5.0e-12      -
## preferred item 0.52      1.8e-13
##
## P value adjustment method: BH
```

```
#Head Elevation
```

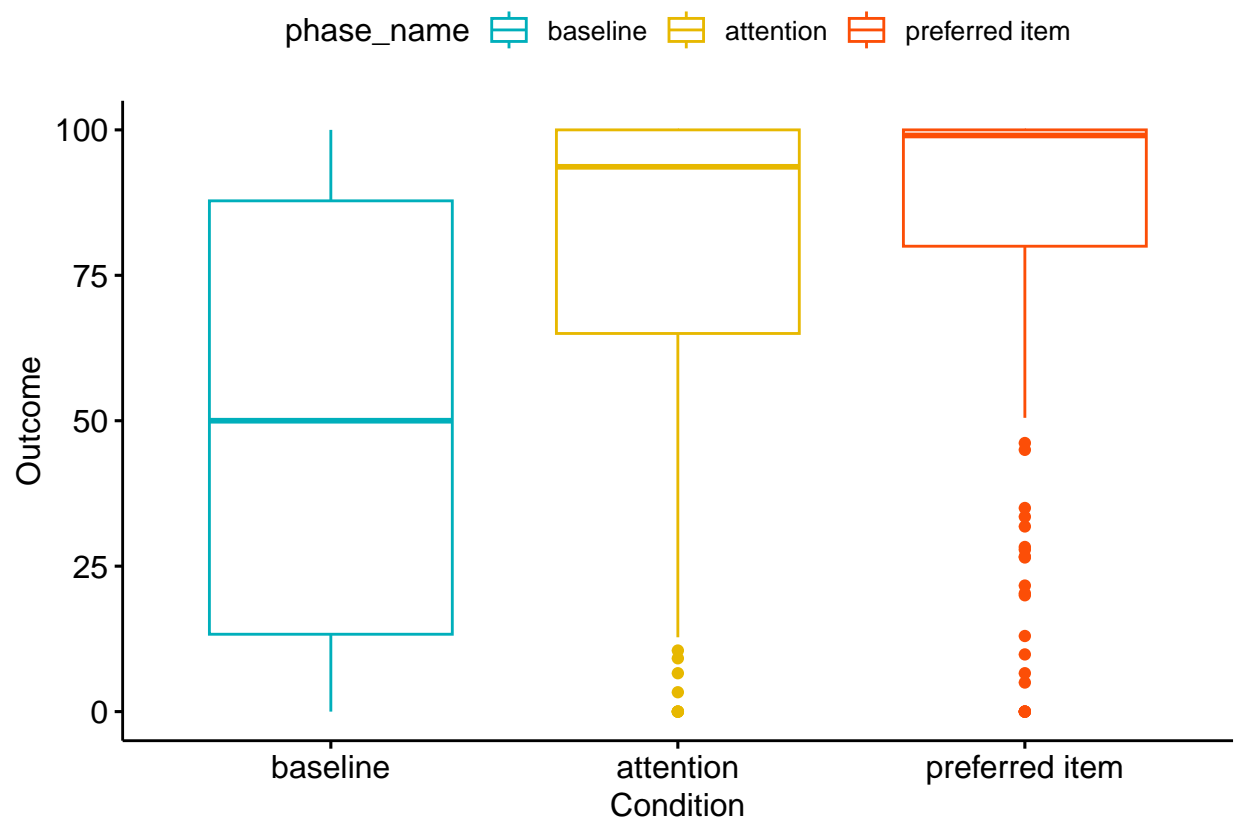
```
df2 <- df %>%
  filter(dependent_variable == "head elevation") %>%
  select(phase_name, outcome) %>%
  group_by(phase_name) %>%
  summarise(
    count = n(),
    mean = mean(outcome, na.rm = TRUE),
    sd = sd(outcome, na.rm = TRUE),
    median = median(outcome, na.rm = TRUE),
    IQR = IQR(outcome, na.rm = TRUE)
  )

df2
```

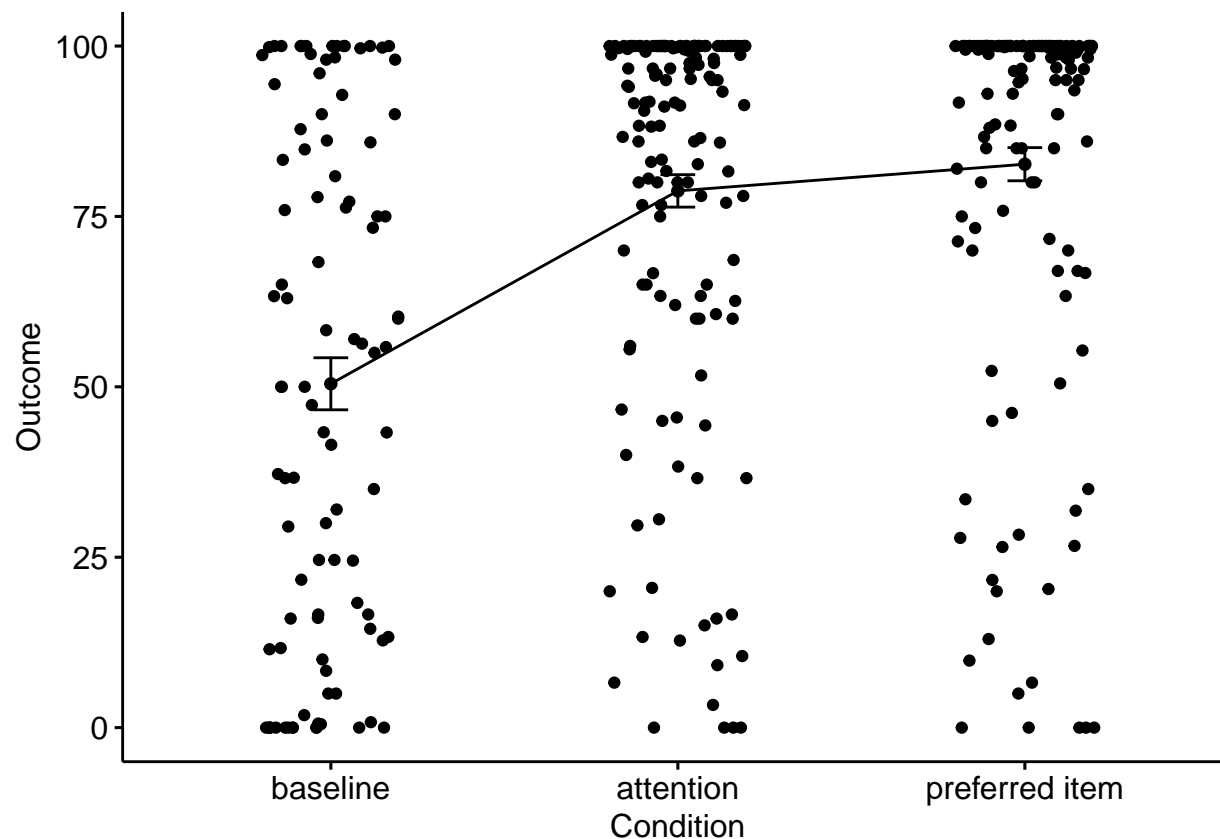
```
## # A tibble: 3 x 6
##   phase_name      count  mean    sd median  IQR
##   <chr>          <int> <dbl> <dbl> <dbl> <dbl>
## 1 attention      150  78.7  29.2  93.6  35
## 2 baseline       97  50.4  37.6   50  74.5
## 3 preferred item 143  82.7  29.1  99.0  20
```

```
dfh <- df %>%
  filter(dependent_variable == "head elevation")

ggboxplot(dfh, x = "phase_name", y = "outcome",
  color = "phase_name", palette = c("#00AFBB", "#E7B800", "#FC4E07"),
  order = c("baseline", "attention", "preferred item"),
  ylab = "Outcome", xlab = "Condition")
```



```
ggline(dfh, x = "phase_name", y = "outcome",
  add = c("mean_se", "jitter"),
  order = c("baseline", "attention", "preferred item"),
  ylab = "Outcome", xlab = "Condition")
```



```
kruskal.test(outcome ~ phase_name, data = dfh)
```

```
##
## Kruskal-Wallis rank sum test
##
## data: outcome by phase_name
## Kruskal-Wallis chi-squared = 56.418, df = 2, p-value = 5.611e-13
```

```
pairwise.wilcox.test(dfh$outcome, dfh$phase_name,
  p.adjust.method = "BH")
```

```
##
## Pairwise comparisons using Wilcoxon rank sum test with continuity correction
##
## data: dfh$outcome and dfh$phase_name
##
##           attention baseline
## baseline      3.9e-09      -
## preferred item 0.032      7.3e-12
##
## P value adjustment method: BH
```

#Kruskal-Wallis Test to detect differences between telehealth and in-person condition and the caregiver

```
library("ggpubr")
library("dplyr")

# Negative Vocalization

df3 <- df %>%
  filter(dependent_variable == "negative vocalization") %>%
  select(condition, format, outcome) %>%
  group_by(condition, format) %>%
  summarise(
    count = n(),
    mean = mean(outcome, na.rm = TRUE),
    sd = sd(outcome, na.rm = TRUE),
    median = median(outcome, na.rm = TRUE),
    IQR = IQR(outcome, na.rm = TRUE)
  )
```

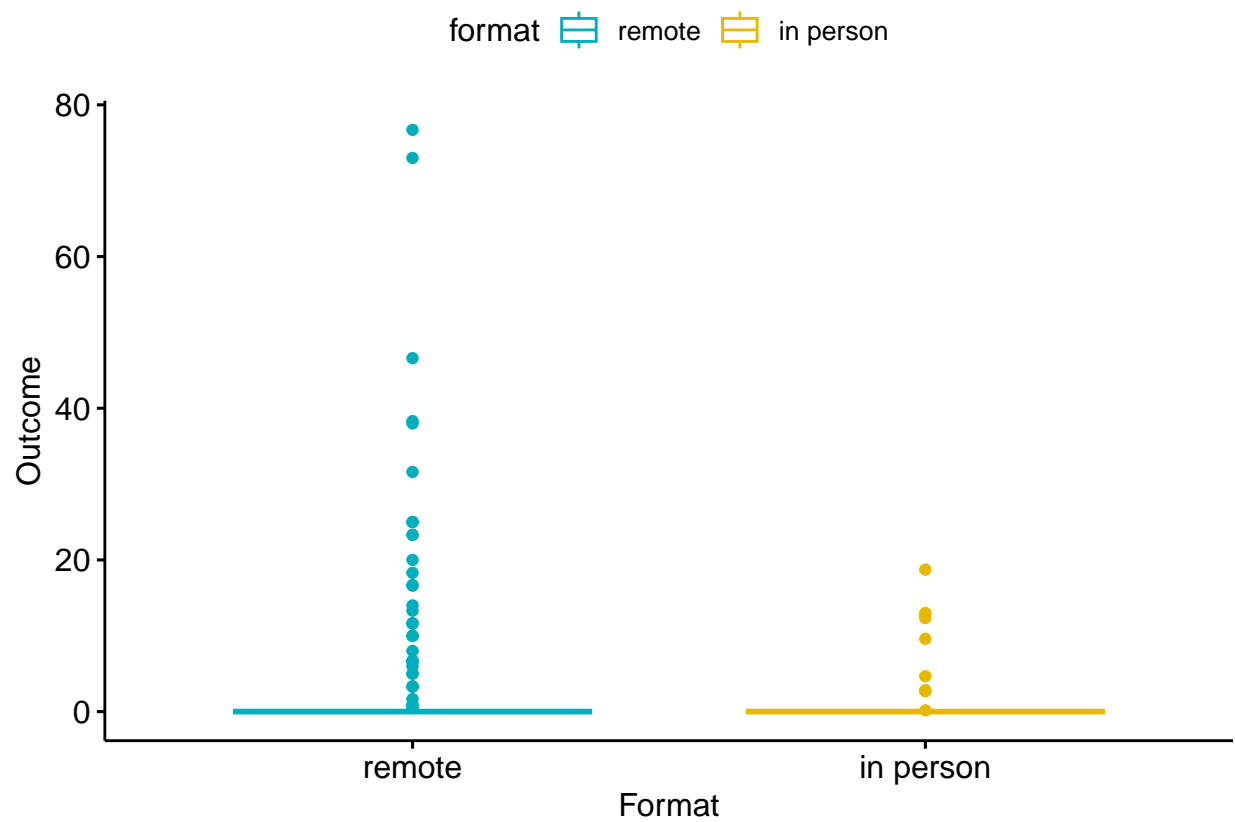
'summarise()' has grouped output by 'condition'. You can override using the
'.groups' argument.

```
df3
```

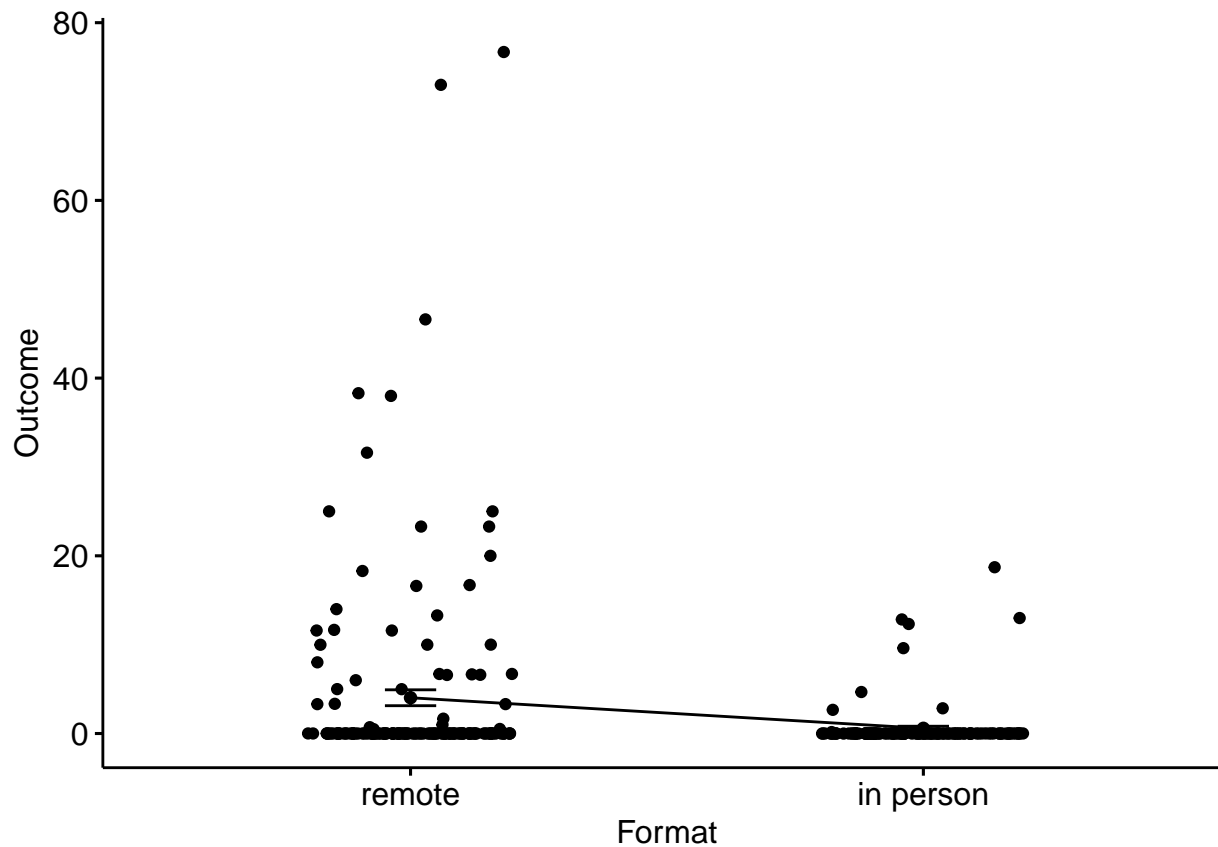
```
## # A tibble: 4 x 7
## # Groups:   condition [2]
##   condition format    count    mean    sd median    IQR
##   <chr>      <chr>    <int>  <dbl>  <dbl>  <dbl>  <dbl>
## 1 A        in person     50  22.0   30.9    0   34.6
## 2 A        remote      52  20.3   26.0   8.35   40
## 3 B        in person    131  0.586  2.66    0     0
## 4 B        remote     158  4.03  11.2    0     0
```

```
dfr <- df %>%
  filter(dependent_variable == "negative vocalization") %>%
  filter(condition == "B")

ggboxplot(dfr, x = "format", y = "outcome",
  color = "format", palette = c("#00AFBB", "#E7B800"),
  order = c("remote", "in person"),
  ylab = "Outcome", xlab = "Format")
```



```
ggline(dfr, x = "format", y = "outcome",  
  add = c("mean_se", "jitter"),  
  order = c("remote", "in person"),  
  ylab = "Outcome", xlab = "Format")
```

```
kruskal.test(outcome ~ format, data = dfr)
```

```
##
## Kruskal-Wallis rank sum test
##
## data: outcome by format
## Kruskal-Wallis chi-squared = 16.945, df = 1, p-value = 3.847e-05
```

```
#Head Elevation
```

```
df4 <- df %>%
  filter(dependent_variable == "head elevation") %>%
  select(condition, format, outcome) %>%
  group_by(condition, format) %>%
  summarise(
    count = n(),
    mean = mean(outcome, na.rm = TRUE),
    sd = sd(outcome, na.rm = TRUE),
    median = median(outcome, na.rm = TRUE),
    IQR = IQR(outcome, na.rm = TRUE)
  )
```

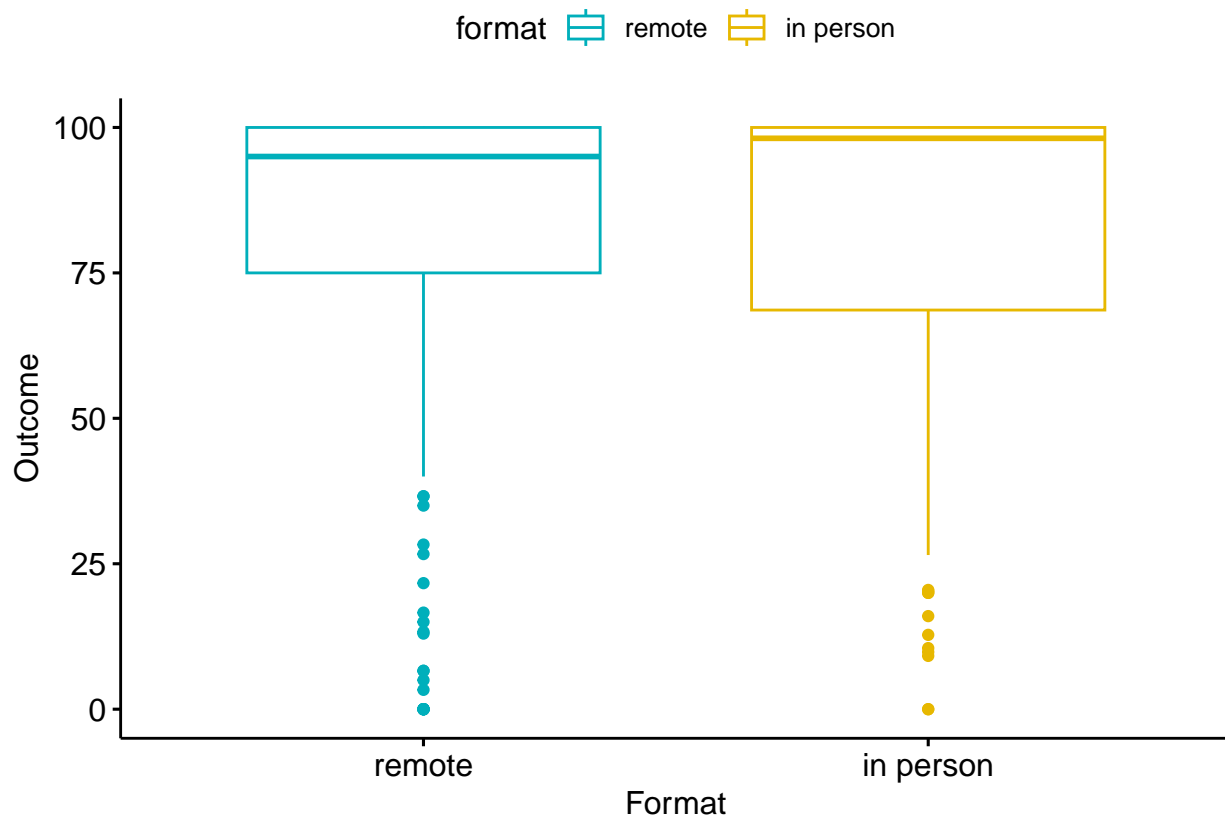
```
## 'summarise()' has grouped output by 'condition'. You can override using the
## '.groups' argument.
```

```
df4
```

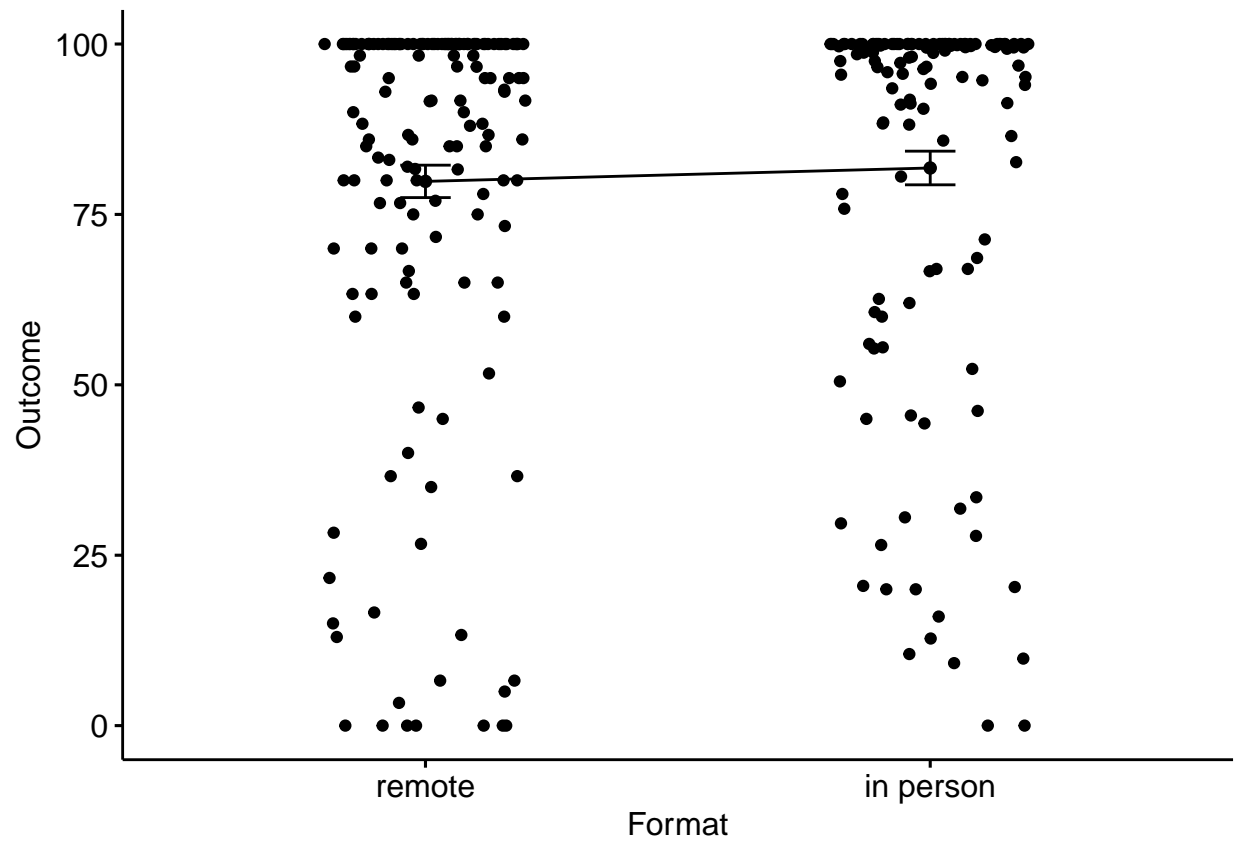
```
## # A tibble: 4 x 7
## # Groups:   condition [2]
##   condition format    count  mean    sd median  IQR
##   <chr>      <chr>    <int> <dbl> <dbl> <dbl> <dbl>
## 1 A        in person    48  43.5  37.8   31  72.0
## 2 A        remote     52  58.1  36.1  60.2  65.4
## 3 B        in person   133  81.8  28.5  98.1  31.4
## 4 B        remote    157  79.8  29.8   95   25
```

```
dfi <- df %>%
  filter(dependent_variable == "head elevation") %>%
  filter(condition == "B")

ggboxplot(dfi, x = "format", y = "outcome",
  color = "format", palette = c("#00AFBB", "#E7B800"),
  order = c("remote", "in person"),
  ylab = "Outcome", xlab = "Format")
```



```
ggline(dfi, x = "format", y = "outcome",
  add = c("mean_se", "jitter"),
  order = c("remote", "in person"),
  ylab = "Outcome", xlab = "Format")
```



```
kruskal.test(outcome ~ format, data = dfi)
```

```
##  
## Kruskal-Wallis rank sum test  
##  
## data: outcome by format  
## Kruskal-Wallis chi-squared = 0.039846, df = 1, p-value = 0.8418
```